2011

2011-2012 Graduate Bulletin

Rochester Institute of Technology

R·I·T

GRADUATE BULLETIN

2011-2012

Rochester Institute of Technology
2011–12 University Calendar

Fall Quarter (20111)

April 19-September 5, 2011
Fall registration

September 5
Day, evening, and online classes begin

September 10
Saturday classes begin

September 11
Last day to add/drop courses

September 12
First day to withdraw online via SIS; receive a "W" grade

October 28
Last day to withdraw online with a "W" grade

November 11
Last day and evening classes

November 12
Last Saturday and online classes

November 14, 15, 16, 17, 18, 19*
Final exams

November 20-27
Fall/Winter break

November 24-25
Thanksgiving
(University closed)

Winter Quarter (20112)

October 18-November 28, 2011
Winter registration

November 28
Day, evening, and online classes begin

December 3
Saturday classes begin

December 4
Last day to add/drop courses

December 5
First day to withdraw online via SIS; receive a "W" grade

December 16
Last day and evening classes before break

December 17
Last Saturday and online classes before break

December 18, 2011–January 2, 2012
Holiday break

December 25, 2011–January 2, 2012
(University closed)

January 3
University re-opens

January 9
Day, evening, and online classes resume

January 14
Saturday classes resume

February 10
Last day to withdraw online with a "W" grade

February 24
Last day and evening classes

February 25
Last Saturday and online classes

February 27, 28, 29, March 1, 2, 3*
Final exams

March 4- March 11
Winter/Spring break

Spring Quarter (20113)

January 24-March 12, 2012
Spring registration

March 12
Day, evening, and online classes begin

March 17
Saturday classes begin

March 18
Last day to add/drop courses

March 19
First day to withdraw online via SIS; receive a "W" grade

May 4
Last day to withdraw online with a "W" grade

May 18
Last day and evening classes

May 19
Last Saturday and online classes

May 21, 22, 23, 24, 25*
Final exams

May 25
Academic Convocation and Commencement Ceremonies

May 26
Commencement Ceremonies

May 27-June 3
Spring/Summer break

May 28
Memorial Day
(University closed)

Summer Quarter (20114)

April 16-June 4, 2012
Summer quarter registration

June 4
Day, evening, and online classes begin

June 9
Saturday classes begin

June 10
Last day to add/drop summer courses

June 11
First day to withdraw online via SIS; receive a "W" grade

July 4
Independence Day
(University closed)

July 27
Last day to withdraw online with a "W" grade

August 10
Last day and evening classes

August 11
Last Saturday and online classes

August 13, 14, 15, 16, 18*
Final exams

** Day students can view their individual exam schedules online through SIS. Others can view the complete exam schedule at infocenter.rit.edu by selecting Exam Schedule in the public box. Students attending evening, Saturday and on-line courses should check with their instructors regarding their final*

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Rochester Institute of Technology

About This Bulletin

This *Graduate Bulletin* does not constitute a contract between the university and its students on either a collective or individual basis. It represents RIT's best academic, social, and financial planning at the time of publication. Course and curriculum changes, modifications of tuition, fee, dormitory, meal, and other charges, plus unforeseen changes in other aspects of RIT life, sometimes occur after the *Graduate Bulletin* has been printed but before the changes can be incorporated in a later edition of the same publication. Because of this, Rochester Institute of Technology does not assume a contractual obligation with its students for the contents of this *Graduate Bulletin*. RIT promotes and values diversity within its workforce and provides equal opportunity to all qualified individuals regardless of race, color, creed, age, marital status, gender, religion, sexual orientation, gender identity, gender expression, national origin, veteran status, or disability.

Rochester Institute of Technology
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Graduate Bulletin 2011–12
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Why Get Your Graduate Degree from Rochester Institute of Technology?

Choices

RIT is one of the nation's top comprehensive universities and sets the national standard for career-oriented education in many technological, scientific, and professional areas of study. With more than 70 graduate programs in high-growth and high-tech career fields including business, computer science and information technology, engineering, science, and art, RIT offers the choices you want in graduate education.

Graduate study options include master's and doctoral degrees, as well as advanced graduate certificates. RIT offers several ways to obtain your graduate degree, including part-time study, evening programs, online learning, accelerated executive education programs, and one-year master's degree options.

Quality

RIT is chartered by the legislature of the state of New York, and is accredited by the well recognized Middle States Association of Colleges and Schools. In addition, many of our individual programs and departments have professional accreditation from business and industry organizations.

At RIT, you'll interact with faculty members who have extensive teaching experience and are internationally respected for their contributions in their professional fields. RIT enrolls more than 17,500 students from across the United States and 110 foreign countries.

Selected faculty and student awards, honors, and partnerships

- Ford Foundation Grants
- Fulbright Scholars
- Edmund S. Muskie Fellows
- Excellence in Engineering Education Award
- National GEM Fellows
- Ronald McNair Scholars
- Pulitzer Prizes
- Student Academy Awards
- National Science Foundation Awards
- National Endowment for the Humanities Awards
- New York Foundation for the Arts Fellowship
- Alfred P. Sloan Foundation Grants

Reputation

Fueled by significant support from government, industry, and private donors, RIT offers a unique, career-oriented graduate education tailored to meet your individual needs.

RIT is the 15th largest private university in the United States, and is consistently recognized by leading college guides, industry publications, and the media. RIT has been cited by *U.S. News & World Report* as the most comprehensive university in the north for academic reputation.

More than 106,000 alumni worldwide include business, industry, and government leaders. Hundreds of top companies and government agencies—from global giants to startup companies—rely on RIT as a source for filling full-time positions and providing ongoing employee development.

Results

RIT graduates are highly sought after by companies of all sizes in virtually every industry in the U.S. and abroad. More than 600 companies visit RIT annually to recruit students, and employment and advancement opportunities for our graduate students remain strong.

Graduate students take advantage of government and industry-sponsored programs and research projects to broaden their experience and increase their visibility with potential employers. Research projects and experiential education often result in permanent employment offers and opportunities for our graduates. Some of our graduate students currently work for such companies as Bausch & Lomb, Boeing, Google, Johnson & Johnson, Microsoft, NASA, Toyota, and Xerox.

You want a degree that will be recognized and valued in today's competitive marketplace, and RIT delivers.

Graduate Education at RIT

RIT, founded in 1829, is a privately endowed university in suburban Rochester, NY. It is comprised of nine colleges and two degree-granting units:

College of Applied Science and Technology

E. Philip Saunders College of Business

B. Thomas Golisano College of Computing and Information Sciences

Kate Gleason College of Engineering

College of Health Sciences and Technology

College of Imaging Arts and Sciences

College of Liberal Arts

Center for Multidisciplinary Studies

National Technical Institute for the Deaf

College of Science

Golisano Institute For Sustainability

For additional information, contact us at:
Rochester Institute of Technology
Office of Graduate Enrollment Services
58 Lomb Memorial Drive
Rochester, NY 14623-5604
(585) 475-2229
gradinfo@rit.edu
www.rit.edu/grad

Message from the Dean of Graduate Studies

The graduate learning experience at RIT is focused. RIT graduate programs concentrate on the conceptual structure and organization of knowledge in the chosen subject—an understanding that is essential to accept and lead technological change in the professions.

They also build an educational base for additional learning and for generating new knowledge and insights through research.

The programs themselves are centered in fields that combine both theoretical knowledge and practical applications, especially those with a proven need in the marketplace. Thesis topics often relate directly to situational concerns, rather than theoretical discourse. Many programs require a thesis or project, and encourage other avenues for professional experience, such as cooperative education or an internship.

Students often use employers as primary sources for research and special projects. This application-oriented approach attracts faculty who value problem-solving skills in students. Whether a thesis, project, or professional portfolio is required of them, our students are encouraged to incorporate both independent study and experiential learning into their programs. Graduate students also may assist in undergraduate education, as teaching, research, or laboratory assistants.

A philosophy supported by campus resources

RIT's international reputation as an applied technological university gives graduate students the advantage of working with sophisticated technology and in laboratories found on and off campus. Students in microelectronic engineering have access to clean-room facilities that meet industry standards. Students majoring in computer graphics design access digital media using a variety of systems and software, including Macintosh, IBM, Silicon Graphics, and Media 100 digital video editing. Our telecommunications technology workstations were donated by an industry eager to hire students experienced with equipment used in their own laboratories.

Technology also has brought together students in design, photography, and printing. In RIT's Electronic Still Photography Laboratory, the three disciplines have merged through electronics.

Regardless of the program, RIT encourages and promotes technological innovation in all areas.

Specialized and diverse programs

While technology is integral to all graduate programs, the essence of RIT graduate education is found in the diversity of programs, course offerings, and learning options. Our reputation as a technologically advanced university is matched by our commitment to offering programs designed to meet the specialized needs

of employers. A dozen international corporations—including Eastman Kodak Co., Konica, Agfa Gevaert, Xerox Corp., and Fuji Photo Film Co.—have sponsored the building of laboratories in the Chester F. Carlson Center for Imaging Science, which houses the nation's most comprehensive imaging science programs. Enriched by the perspective provided by the National Technical Institute for the Deaf, one of RIT's colleges, we offer full access to deaf and hard-of-hearing students seeking graduate-level academic programs.

Across campus, graduate students engage in exciting research and stimulating dialogues with faculty and such distinguished visitors as George Bush, Bill Clinton, Joe Torre, Jesse Jackson, John Hockenberry, Maya Angelou, Annie Leibovitz, Jerry Uelsmann, and Greg Heisler. The E. Philip Saunders College of Business draws prominent figures from the business world—including U.S. Steel CEO Thomas Usher and Robert Bartley, editor and vice president of *The Wall Street Journal*—through the William D. Gasser Distinguished Lectureship in Business.

The university continues to receive international recognition for the quality of its academic programs. In a recent ranking of national photography programs, *U.S. News & World Report* named RIT's School of Photographic Arts and Sciences in the top five. This publication has also consistently ranked RIT in the top 20 in its master of fine arts category.

Convenient and flexible programs

RIT's diversity also extends to the manner in which courses and programs are scheduled. Many of our graduate programs are available on a part-time, online, or evening basis and are designed for working professionals. Examples of programs offered through online learning include networking and systems administration; environmental, health and safety management; telecommunications engineering technology; imaging science; microelectronics manufacturing engineering; and health systems administration. These programs allow students access to an RIT education without attending classes on campus.

In addition, RIT's executive MBA program offers professionals an opportunity to earn a master's degree by studying on campus Friday and Saturday, every other week, or through online learning. Professionals from California to England visit RIT every year for executive leader master's degree programs in service management, hospitality and tourism management, health systems administration, and packaging science, which combine on-campus residencies with classes using distance-learning technology.

The RIT philosophy and mission

RIT's mission is the education of men and women for work and life in a democratic, technological, and global society. It is integral to the university's mission to be a dynamic center of higher education—one in which technology, the arts and sciences, and other dimensions of human knowledge and civilization are valued, cultivated, and applied.

Throughout its history, the university has been at the forefront in preparing students for technological and professional careers. RIT structures itself as an educational resource for all who seek to be competent and enthusiastic lifelong learners, whether they are young adults or professionals seeking to upgrade their skills by studying for an advanced degree. Our goal is that all graduates will understand the ethical, technological, humanitarian, and aesthetic challenges of a diverse workplace and an international community.

The university's educational philosophy emphasizes not only theory—the natural foundation of knowledge—but also the practical workplace application of theories. This dual emphasis is prized by employers and offers graduates upward career mobility and the flexibility for changes in career direction. Another asset of an RIT education is cooperative education, offering students in selected programs the opportunity for paid, professional work experience while completing their degrees.

History of graduate education

Starting in 1955 with the master of fine arts degree, RIT continually has created new graduate programs to meet employers' and students' requests for education in particular functional areas. When surveys in the 1960s indicated the need for sophisticated statistical knowledge, a master of science degree in applied and mathematical statistics was created. More recently, the Golisano Institute for Sustainablity began doctoral and master's degrees in sustainability. Other graduate programs have taken similar routes, and all nine RIT colleges exhibit continuous concern for the emerging needs of the business, industrial, and scholarly communities.

To support RIT's continuing endeavor to provide education in emerging career fields, the university has six doctoral programs in the fields of astrophysical sciences and technology, color science, computing and information sciences, imaging science, microsystems engineering, and sustainability. These degrees are six of more than 70 graduate degrees now offered by the university.

Sponsored research projects

Externally sponsored projects are a vital and integral component of RIT's educational and research activity. Faculty and students undertake sponsored projects for a variety of important reasons: to add to the body of knowledge, for professional development, and to strengthen academic programs. Sponsored projects enhance the university's academic programs, broaden its research

resources, provide opportunities for student participation in research, strengthen university-industrial partnerships, and serve the wider community.

Moreover, grants and contracts enhance existing resources and provide new opportunities for faculty, staff, and students. External funding comes from federal and state agencies, private foundations, and corporations. RIT's major sponsors include the National Science Foundation, the National Institutes of Health, the U.S. Department of Education, the Department of Defense, the National Aeronautics and Space Administration, and New York state.

Additional information is available through the Office of Sponsored Research Services at (585) 475-7985, research@rit.edu, or on their website at www.research.rit.edu.

Accreditation

RIT is chartered by the New York state legislature and accredited by:

The Commission on Higher Education
Middle States Association of Colleges and Schools
3624 Market Street
Philadelphia, PA 19104-2680
(215) 662-5606

and

New York State Education Department
Office of College and University Evaluation
5 North Mezzanine
Albany, NY 12234
(518) 474-2593

In addition to institutional accreditation, many of RIT's academic programs have been granted accreditation by appropriate professional accreditation bodies. Where applicable, specific mention of accreditation is included in program descriptions. Students wishing to review documents describing accreditation should contact the Office of the Vice President for Academic Affairs.

The *Graduate Bulletin* provides comprehensive information on all graduate programs at RIT. I encourage you to explore its contents to find the educational and research opportunities you seek. I look forward to welcoming you to our campus, and wish you success in your chosen program of study.

Andrew Moore
Dean, Graduate Studies

Graduate Programs of Study

		Degree and HEGIS Code								
		Adv. Cert	Ph.D.	MBA	ME	MFA	MS	MST	M. Arch	Page #
Business and Management										
Business Administration–Traditional	Business			0506						30
Business Administration–Accounting	Business			0502						37
Elements of Health Care Leadership*	Applied Science and Technology	1202								123
Executive MBA†	Business			0506						35
Facility Management*	Applied Science and Technology						0599			10
Finance	Business						0504			38
Health Systems Administration*	Health Sciences and Technology						1202			121
Hospitality-Tourism Management†	Applied Science and Technology						0510.10			15
Human Resource Development†	Applied Science and Technology	0515					0515.00			18
Innovation Management	Business						0506			39
Management	Business						0513			40
Manufacturing Leadership	Engineering						0599			86
Project Management*	Applied Science and Technology	0506								173
Senior Living Management*	Applied Science and Technology	0599								123
Service Leadership and Innovation	Applied Science and Technology	0510					0599			16
Strategic Training	Applied Science and Technology	0515								173
Computer and Information Sciences										
Computer Engineering	Engineering						0999			81
Computer Science	Computing and Information Sciences						0701			50
Computing Security and Information Assurance	Computing and Information Sciences						0799			58
Computing and Information Sciences	Computing and Information Sciences		1701							47
Game Design and Development	Computing and Information Sciences						0799			51
Human Computer Interaction	Computing and Information Sciences						0799			53
Information Assurance*	Computing and Information Sciences	0799								61
Information Technology*	Computing and Information Sciences						0699			54
Interactive Multimedia Development	Computing and Information Sciences	0699								57
Medical Informatics	Computing and Information Sciences/ URMC						1217			56
Networking and System Administration*	Computing and Information Sciences	0702								62
Networking and Systems Administration*	Computing and Information Sciences						0702			60
Networking Planning and Design	Computing and Information Sciences	0702								62
Software Engineering	Computing and Information Sciences						0999			63
Technical Information Design*	Applied Science and Technology	0605								174
Professional Studies (Individualized Program)										
Professional Studies*	Applied Science and Technology						4999			171
Education and Liberal Arts										
Applied Experimental and Engineering Psychology	Liberal Arts						2099			156
Visual Art–All Grades	Imaging Arts and Sciences							0831		132
Communication and Media Technologies	Liberal Arts						0605.00			159
Criminal Justice	Liberal Arts						2209			161
Human Resource Development †	Applied Science and Technology	0515					0515			18
School Psychology	Liberal Arts						0826.02			158
Science, Technology and Public Policy	Liberal Arts						2102			161
Secondary Education of Students Who Are Deaf or Hard-of-Hearing	NTID						0803			178

Graduate Programs of Study

		Degree and HEGIS Code								
		Adv. Cert	Ph.D.	MBA	ME	MFA	MS	MST	M. Arch	Page #
Engineering and Technology										
Applied Statistics*	Engineering						1702			80
Architecture	Engineering								0202	221
Computer Engineering	Engineering						0999			81
Electrical Engineering	Engineering						0909			82
Engineering Management	Engineering				0913					84
Environmental, Health and Safety Management*	Applied Science and Technology						0420			9
Industrial and Systems Engineering	Engineering				0913		0913			85
Manufacturing and Mechanical Systems Integration	Applied Science and Technology						0913			11
Manufacturing Leadership	Engineering						0599			86
Materials Science and Engineering	Engineering/Science	0915					0915			188
Mechanical Engineering	Engineering				0910		0910			87
Microelectronic Engineering*	Engineering						0999			89
Microelectronics Manufacturing Engineering*	Engineering				0999					91
Microsystems Engineering	Engineering		0999							92
Packaging Science†	Applied Science and Technology						4999			13
Product Development	Engineering						0599			95
Statistical Quality*	Engineering	1702								99
Sustainable Engineering	Engineering				0999		0999			96
Systems Engineering	Engineering				0913					98
Telecommunications Engineering Technology*	Applied Science and Technology						0925			14
Photography, Fine Art, and Graphic Communication										
Ceramics and Ceramic Sculpture	Imaging Arts and Sciences					1009				129
Computer Graphics Design	Imaging Arts and Sciences					1009				133
Film and Animation	Imaging Arts and Sciences					1011				136
Fine Arts Studio	Imaging Arts and Sciences					1002		1002		132
Glass	Imaging Arts and Sciences					1009				129
Graphic Design	Imaging Arts and Sciences					1009				134
Imaging Arts/Photography	Imaging Arts and Sciences					1011				138
Industrial Design	Imaging Arts and Sciences					1009				134
Medical Illustration	Health Sciences and Technology					1299				123
Metalcrafts and Jewelry Design	Imaging Arts and Sciences					1009				130
Nontoxic Intaglio Printmaking	Imaging Arts and Sciences	1009								133
Print Media*	Imaging Arts and Sciences						0699			135
Visual Art–All Grades	Imaging Arts and Sciences								0831	132
Wood	Imaging Arts and Sciences					1009				131
Science, Mathematics, and Imaging Science										
Applied and Computational Mathematics	Science						1799			185
Applied Statistics*	Engineering						1702			80
Astrophysical Sciences and Technology	Science		1912				1912			190
Bioinformatics	Science						0499			183
Chemistry	Science						1905			186
Clinical Chemistry	Health Sciences and Technology						1223			121
Color Science	Science		1999.20				1999.20			192
Environmental Science	Science						0420			184
Imaging Science*	Science		1999.20				1999.20			197
Materials Science and Engineering	Engineering/Science	0915								188
Statistical Quality*	Engineering	1702								99
Statistical Methods for Product and Process Improvement*	Engineering	1702								99
Sustainability	Sustainability Institute		4904							220
Sustainability Systems	Sustainability Institute						4904			220

* Online learning option available. † Executive education option available.

Doctoral Study at RIT

Doctoral programs at RIT are multidisciplinary, cutting-edge, and unique. Our highly interdisciplinary programs were developed out of RIT's unique areas of strengths in imaging, computing, science, engineering, and sustainability. Our long history of providing education focused on emerging technologies has led to the development of doctorate level programs that draw upon our expertise and experience in these dynamic disciplines of study.

Our six doctorate programs focus on the discovery and application of technology to solve problems in society. The interdisciplinary nature of the programs means students will work alongside more than 50 Ph.D. faculty members who are experts in a wide range of fields that are influenced by imaging, computing, science, engineering, and sustainability.

Programs of study

RIT offers six doctoral degrees in areas where RIT shares national and international recognition. Our programs are cross-college collaborations that support interdisciplinary research.

Astrophysical sciences and technology: Students in the astrophysical sciences and technology program will experience a comprehensive curriculum and a broad range of research opportunities that span forefront topics, such as supermassive black holes, dark energy, gravitational waves, supernovae, massive stars, the Galactic center, star formation, clusters of galaxies, Active Galactic Nuclei, astro-informatics, computational astrophysics, and instrument and detector development. This doctoral program not only focuses on discovery and analysis, but also on the development of the technologies—including the instruments, analysis, and modeling techniques—that will enable the next major strides in astrophysics.

Color science: Color science research at RIT encompasses such diverse fields as medical data visualization, computer graphics and animation, art conservation, spectral and spatial measurements of materials, color printing, digital photography, motion picture and television, and modeling of our perceptions for use in defining color quality. RIT has a long history of scholarship in this area. Defined as the quantification of our perception of color, the field of color science requires a mastery of physics, chemistry, physiology, statistics, computer science, and psychology. Color science is used in the design of most man-made products from textiles to polymers and to specify such diverse materials as soil and wine. It is used exclusively in color reproduction in digital photography, desktop and projection display, and printing.

Computing and information sciences: This use-inspired basic research degree is designed to produce independent scholars, well-prepared educators, and cutting-edge researchers poised to excel in their work within interdisciplinary environments and industries. The degree highlights two of the most unique characteristics of the Golisano College—the breadth of its program offerings and its scholarly focus on discovering solutions to real-world problems by balancing theory and practice.

The program focuses on the theoretical and practical aspects of cyberinfrastructure as applied to specific problems across multiple domains. It is a blend of the intra-disciplinary computing knowledge areas and interdisciplinary domain areas.

Imaging science: The imaging science doctoral program is designed to provide a fundamental understanding of the physical, electro-optical, mathematical, computational, and statistical foundations of imaging science that are necessary to understand, analyze, and optimize imaging systems. Integrated into these core courses are laboratory experiments intended to provide hands-on

experience and a common framework for describing and understanding various imaging systems.

Microsystems engineering: The integration of entire systems into micron-scale devices and the sensing technology to interface these devices to the real world is the core emphasis of the microsystems engineering doctoral program. These systems are at the core of the next generation of technology. Within the past decade, microsystems (micro-optical, micro-electrical, and micro-mechanical systems) have emerged as a critical technology worldwide and this dynamic field is positioned for outstanding growth in the future.

Sustainability: The first program in the world to focus on sustainable production, the doctorate in sustainability focuses on sustainable production systems—systems that create goods and services using processes that are non-polluting; conserving of energy and natural resources; economically viable; and safe and healthful for workers, communities, and consumers. This program also serves to advance research and education in alternative-energy development, sustainable design, green product development, industrial ecology, and pollution prevention.

Leaders in research

Research is a driving force in the university, engaging more than 2,700 students in hands-on research opportunities in each of our colleges. These opportunities combine classroom learning with laboratory discovery, which enhances each student's education and builds powerful skills that are applicable in a wide range of career paths.

At the core of our doctoral programs is a focus on research, which is intensive and demanding. It is this successful resolution of societal problems that leads to deep professional and personal fulfillment as new discoveries are made and applications are developed. Ph.D. students from a range of academic backgrounds work with world-renowned faculty who are leaders in their fields of study. A focus on teamwork, research, and the intersection of the disciplines gives students the opportunity to collaborate with others, share ideas, and develop innovative solutions using emerging technologies.

We build on our strengths when creating doctoral programs, emphasize research across disciplines, and rely on our interdisciplinary faculty to produce the next generation of educators and researchers with the ability to develop solutions to real world problems.

RIT Research Centers and Organizations

RIT is home to more than 50 interdisciplinary research centers, institutes, and organizations that bring together faculty and students from across the university. These entities explore a wide range of topics and cover everything from business and entrepreneurship to biomedical sciences, nanolithography, printing, social computing, remanufacturing, microsystems fabrication, environmental sustainability, and visual perception.

- Analog Devices Integrated Microsystems Laboratory
- Astrophysics Science and Technology
- Biomedical Imaging/MRI
- Biomedical Imaging/Ultrasound
- Center for Advanced Device Research
- Center for Advancing the Study of Cyberinfrastructure
- Center for Applied and Computational Math
- Center for Biosciences Education and Technology
- Center for Computational Relativity and Gravitation
- Center for Education Research Partnerships
- Center for Electronic Manufacturing and Assembly
- Center for Excellence in Lean Enterprise
- Center for Innovation and Entrepreneurship
- Center for Integrated Manufacturing Studies
- Center for Nanolithography Research
- Center for Quality and Applied Statistics
- Center on Access Technology
- Chester F. Carlson Center for Imaging Science
- Digital Imaging and Remote Sensing Laboratory
- Image Permanence Institute
- Imaging Products Laboratory
- International Center for Hearing and Speech Research
- IT Collaboratory
- Laboratory for Advanced Communication Technology
- Laboratory for Computer-Human Interaction
- Laboratory for Digital Image Restoration
- Laboratory for Environmental Computing and Decision Making
- Laboratory for Graphical Simulation, Visualization and Virtual Worlds
- Laboratory for Imaging Algorithms and Systems
- Laboratory for Intelligent Systems
- Laboratory for Printing Materials and Process
- Laboratory for Social Computing
- Laboratory for Wireless Networks and Security
- Manufacturing Technologies Program
- Munsell Color Science Laboratory
- NanoPower Research Laboratory
- National Center for Remanufacturing and Resource Recovery
- Print Research and Imaging Systems Modeling Laboratory
- Printing Applications Laboratory
- Printing Industry Education Program
- Research and Teacher Education Center
- RF/Analog Mixed Signal Laboratory
- RIT Venture Creations Incubator
- Semiconductor and Microsystems Fabrication Laboratory
- Sloan Printing Industry Center
- Sustainable Systems Research Center
- Systems Modernization and Sustainment Center
- Thermal Analysis and Microfluidics Laboratory
- Visual Perception Laboratory

College of Applied Science and Technology

H. Fred Walker, Dean
www.rit.edu/cast

Programs of study

Master of Science degrees in:	Page
Environmental, Health, and Safety Management	9
Facility Management	10
Hospitality-Tourism Management	15
Human Resource Development	18
Manufacturing and Mechanical Systems Integration	11
Packaging Science*	13
Service Leadership and Innovation*	16
Telecommunications Engineering Technology	14

Advanced Certificate in:	
Service Leadership and Innovation	17

*Executive leader option: These programs are available in a non-traditional, accelerated format, designed for working professionals with significant work experience.

Online learning option available.

Graduate education in any discipline requires the commitment of both the student and the institution involved. The diverse, graduate-level academic areas within the College of Applied Science and Technology represent RIT's commitment to curricular innovation, program flexibility, and academic rigor. We also are committed to advancing the state of the education we provide through the latest technology, management theories, and educational philosophies.

Admission requirements
The colleges make all decisions regarding graduate admission. Please refer to each individual program for information regarding specific admission criteria. For general graduate admission information, please refer to the Admission section of this bulletin.

Financial aid and scholarship
Please refer to the Financial Aid and Scholarship section of this bulletin for information regarding financial aid, scholarships, grants, loans, and graduate assistantships.

Faculty
The College of Applied Science and Technology faculty bring a unique blend of academic credentials, scholarship, and significant industrial experience into the classroom. On-going participation as professional consultants and researchers allows them to integrate the latest innovations, theories, and content into their classes. This blend creates a learning environment where both theoretical knowledge and application are important.

Facilities
The college's facilities include state-of-the-art laboratories in support of courses that address current and future applications in the areas of electrical, computer, and telecommunications engineering technology; manufacturing and mechanical engineering technology; and packaging science. In addition to laboratories in computer networking and telecommunications, the college also offers a circuits studio, and mechanics and materials labs.

The Center for Integrated Manufacturing Studies gives graduate students the opportunity to test new technologies for actual companies seeking solutions to real problems. Continual upgrades to our computer laboratories mean we have technology that is considered the industry standard.

Most importantly, the academic leadership of our programs is world-renowned. In addition, our close ties to business and industry mean that our course content is relevant and practical for tomorrow's managers, whether they oversee computer-integrated manufacturing or a resort hotel. Graduates are eagerly sought out by employers. We have a high placement rate that assures graduates can pick the best positions for their personal and professional development.

Study options

Most graduate programs offer a variety of study options, including full-time, part-time, and online study. Please refer to each individual program for specific information regarding these options.

Department of Civil Engineering Technology, Environmental Management and Safety

Environmental, Health and Safety Management, MS

http://www.rit.edu/cast/cetems/

John Morelli, Department Chair
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Joseph Rosenbeck, Graduate Program Director
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Program overview

The last decade has seen significant changes in how organizations view and manage environmental, health, and safety (EHS) issues. Increasingly, companies are capitalizing on the synergies among these three areas by managing them together creating a need for professionals who are cross-trained in all three functions. The emergence of voluntary standards and codes of conduct, including international standards, coupled with the need to manage costs and limit resources has resulted in a trend to go beyond regulatory compliance. Now, companies work toward sustainability through the use of environmental, health, and safety management systems, which are integrated into key business processes.

The master of science degree in environmental, health, and safety management was developed by experienced professionals and designed to provide students with a solid foundation in both the technical and managerial aspects of developing, designing, and implementing environmental, health, and safety systems. The program utilizes an integrated systems focus to ensure that students can:

- identify and leverage the regulatory, voluntary, and business drivers for environmental, health, and safety programs;
- design and implement effective management systems and programs;
- design and implement performance measurement processes to verify effectiveness; and
- demonstrate how an effective environmental, health, and safety management system adds value to the organization.

The program is primarily designed for EHS professionals or those planning a career move into the EHS field.

Curriculum

The MS program in environmental, health and safety management consists of 48 quarter credit hours of graduate study. The program is available in both classroom and online learning formats, with some courses only available online. The curriculum consists of a sequence of core courses (28 credits), professional electives (8-16 credits), and a graduate thesis or project (4-8 credits). Students have the option of completing an applied research graduate project that will be documented in a manuscript suitable for publication in a professional journal or a traditional graduate thesis.

COURSE	QTR. CR. HRS. THESIS OPTION	QTR. CR. HRS. PROJECT OPTION
0102-740 Organizational Behavior and Leadership	4	4
0630-720 EHS Management*	4	4
0630-725 EHS Accounting and Finance	4	4
0630-740 EHS Management System Design	4	4
0630-760 Integrating EHS into Business Management	4	4
0630-790 EHS Internal Auditing	4	4
0630-755 Research Methods	4	4
0630-890 Thesis Planning	4	--
0630-891 Graduate Project	--	4
0630-899 Graduate Thesis	4-8	--
Total Core Courses and Research	36-40	32
Graduate Professional Electives	8-12	16
Total Quarter Credit Hours	**48**	**48**

* Requires onsite executive leader sessions.

Admission requirements

To be considered for admission to the MS program in environmental, health and safety management, candidates must fulfill the following requirements:

- Hold a baccalaureate degree from an accredited university or college,
- Have a minimum undergraduate grade-point average of 3.0 (B) over the junior- and senior-level years; (applicants with a grade point average below 3.0 will be evaluated on a case-by-case basis and may be admitted on a probationary basis. These

students will have to secure a B or better in their first three graduate courses.),
- Have completed at least 20 credit hours (or 14 semester hours) of college-level science course work, with at least 4 credit hours (or 3 semester credit hours) in each of the following categories: general or organic chemistry; biology, microbiology, ecology, or biochemistry; and physics, geology, hydrology, or geochemistry (applicants with appropriate professional certification who do not meet the minimum level of science course work will be evaluated on a case-by-case basis to determine if they are eligible for admission.),
- Have completed at least one college-level course in statistics,
- Have completed at least one college-level course (or equivalent experience) in computer science,
- Submit two professional recommendations,
- Submit official transcripts (in English) of all previously completed undergraduate and graduate course work,
- Submit a clearly written one-page statement of purpose,
- Complete a graduate application, and
- Submit a current resume or curriculum vitae.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language (TOEFL). A minimum score of 570 (paper-based), 230 (computer-based), or 88 (Internet-based) is required. Scores from the International English Language Testing System (IELTS) will be accepted in place of the TOEFL exam. Minimum acceptable scores will vary; however, the absolute minimum score for an unconditional acceptance is 6.5. It is recommended that international students begin the program in the fall quarter.

Generally, applicants are expected to have formal academic training or documented experience in the areas of environmental management (air, water, solid, and hazardous waste), occupational health, and occupational safety. Academic and experiential gaps in these areas may be addressed through the program's foundation courses or through the selection of professional electives. Applicants without any documented, relevant work experience in the EHS profession may be required to complete a graduate cooperative education placement during their program of study. This co-op requirement may be up to two quarters in length.

Graduate Record Examination scores are not required; however, applicants may submit test scores to support their candidacy.

Additional information

Transfer credit

Up to 12 credit hours of relevant graduate course work may be transferred into the program with the permission of the Admissions Committee, or the student's adviser and the department chair. However, RIT cannot accept credits from courses that are more than seven years old at the time the student graduates from RIT.

Flexible learning options

The program is available in two learning formats, on campus or through online learning, and may be completed in 15 months of full-time study, or in two years of part-time study. Students can tailor an individual program of study by complementing core and foundation courses with professional electives that match their academic and career interests. Students completing the degree through online learning are required to come to campus once for a two- or three-day executive leader session.

Facility Management, MS

http://www.rit.edu/cast/cetems/

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Program overview

The physical assets of an organization are typically one of its largest financial holdings. The strategic planning, development, and maintenance of these assets are critical to an organization's long term financial health and stability.

Facility managers need to be knowledgeable about business management, strategic planning, environmental management, interior and architectural design, construction management, information technology, real estate, engineering, safety labor relations, and quality of life aspects in the work environment. It's a broad-based field that requires individuals to have breadth and depth in their education and, eventually, their work experience.

The facility management program prepares graduates to work in a management capacity where they will oversee the planning, design, operations, planning, and maintenance decommissioning of facilities. Graduates will be able to intelligently communicate facility issues with corporate officers, customers, contractors, vendors, and employees.

The master of science degree in facility management was developed by a panel of experienced facility management professionals and designed to provide students with a solid foundation in both the technical and managerial aspects of the field. The curriculum was developed using educational standards established by the International Facility Management Association (IFMA).

Curriculum

The MS in facility management consists of 52 credit hours of graduate study. The program is available predominately in the online learning format, although some courses and electives are available as on-campus classes. The curriculum consists of a sequence of core courses (40 credits), professional electives chosen from the program or other departments (8 credits), and a graduate project (4 credits). Project topics should complement the student's interests and professional position and are generally considered applied in nature.

Courses include:

0101-703	Accounting for Decision Makers
0102-740	Organizational Behavior and Leadership
0630-750	Project Management
0632-700	Principles and Practice in Facility Management
0632-720	Environmental, Health and Safety Management for Facility Management
0632-760	Space Planning in Facility Management
0632-800	Operation and Maintenance of Facilities I
0632-810	Operation and Maintenance of Facilities II
0632-830	Real Estate of Facilities
0632-850	Digital Communication and Analytical Tools in Facility Management
0630-891	Graduate Project
	Two Technical Electives

Admission requirements

To be considered for admission to the MS degree in facility management, candidates must fulfill the following requirements:

- Hold a bachelor's degree from an accredited university or college. Generally, applicants are expected to have formal academic training or documented experience in the areas common to facility management (i.e., engineering technology, engineering, construction management, interior design, architecture, technology, and business). Academic and experiential gaps in these areas may be addressed through program electives.
- Have a minimum undergraduate GPA of 3.0 overall, or a minimum GPA of 3.0 for course work completed in the junior and senior years.
- Submit two writing samples to demonstrate written communication skills.
- Submit a current resume or curriculum vitae with sufficient detail to identify specific work experience, tasks, and level of responsibility.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language. Minimum scores of 570 (paper-based), 230 (computer-based), or 88-89 (Internet-based) are required. International applicants must also submit scores from the Graduate Record Exam (GRE). Minimum scores of 1,200 (V&Q) and an analytical writing score of 3.5 or higher are required. Applicants with low GRE scores may be admitted conditionally; they will take a prescribed English language test and, if required, English language courses along with a reduced program course load.

GRE scores normally are not required. Applicants who do not meet the above requirements, however, may be required to submit GRE scores to support their candidacy.

Students who do not meet the academic admission requirements may be asked to complete certain undergraduate courses as a bridge for the required content knowledge. The graduate program director will design a bridge program specific to each individual student's needs based on the evaluation of academic records and documented work experience.

Some students' work experience may exempt them from one or more of the core courses. In these cases, students may substitute other course work, with the permission of the graduate program director and in accordance with RIT policy.

The admission requirements for the facility management program ensure that students entering the program will have a reasonable chance for success. The requirements also establish areas of prerequisite knowledge that students will need to integrate into graduate-level courses.

Applicants without any documented, relevant work experience in the facility management profession may be required to complete a graduate cooperative education requirement during their program of study. This co-op requirement may be up to two quarters in length.

Additional information

Flexible learning options

The program can be completed on campus or through distance learning in 20 months of full-time study, or in two years of part-time study if a student elects to work full time. Students can tailor an individual program of study by complementing core courses with professional electives that match their academic and career interests. Students will complete a graduate project that integrates facility management concepts into applied research so solve real world problems.

Transfer credit

Up to 12 credit hours of graduate course work may be accepted and applied toward the program if the course work is appropriate. The student's major professor or the admissions committee must review all courses.

Department of Manufacturing and Mechanical Engineering Technology/Packaging Science

Manufacturing and Mechanical Systems Integration, MS

http://www.rit.edu/cast/mmetps/ms_manu_mech.php

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Program overview

The master of science program in manufacturing and mechanical systems integration is a multidisciplinary degree offered by the department of manufacturing and mechanical engineering technology and packaging science, in collaboration with the E. Philip Saunders College of Business, the Kate Gleason College of Engineering, and the B. Thomas Golisano College of Computing and Information Sciences. This program is designed for individuals who wish to achieve competence in the effective integration of the computing, manufacturing, design, quality, and management functions found in many manufacturing enterprises. Students take a set of common core courses and then elect a concentra-

tion in automated manufacturing, electronics packaging, management, product design, quality improvement, or software development.

Curriculum

The program consists of 52 quarter credit hours and is comprised of core courses, a concentration, electives, and a capstone project or thesis. Students may be required to take additional prerequisite courses depending on their background and elected concentration. The program adviser may approve the waiver of courses in the prerequisite group from graduation requirements, depending on students' academic and employment backgrounds. Full-time students are eligible for two co-op blocks (three months for each block) after completing three quarters (nine months) of study at RIT.

Core courses (20 quarter credits)

0617-850	Flexible Manufacturing and Assembly Systems
0307-782	Quality Engineering
0617-631	Computer Aided Engineering
0101-794	Cost Accounting in the Manufacturing Environment
0106-744	Project Management

Concentration options (20 quarter credits)

Automated Manufacturing

0617-833	Robotics in CIM
0617-870	Manufacturing Automation Controls
0610-830	Instrumentation and Computer Aided Data Acquisition
0303-710	Systems Simulation
0303-729	Advanced Systems Integration

Electronics Packaging

0617-855	Electronics Packaging Fundamentals
0617-856	Advanced Concepts in Electronics Packaging
0307-721	Statistical Process Control
0307-770	Design of Experiments for Engineers and Scientists
0307-862	Reliability Statistics I

Management

0101-703	Financial Accounting Systems
0102-742	Introduction to Technology Management
0106-743	Operations Management and Process Improvement
0106-749	Manufacturing Strategy and Tactics
0307-781	Quality Management

Product Design

0610-630	Tolerance Design
0610-710	Product Development and Integration
0610-820	Concept Design and Critical Parameter Management
0610-830	Instrumentation and Computer Aided Data Acquisition
0610-870	Robust Design

Quality Improvement

0307-721	Statistical Process Control
0307-731	Statistical Acceptance Control
0307-781	Quality Management
0307-801	Design of Experiments I
0307-802	Design of Experiments II

Software Development

0610-830	Instrumentation and Computer Aided Data Acquisition
4002-710	Object Technologies
4002-720	Data Object Development
4002-733	Fundamentals of Computer Communication
4002-750	Distributed Systems

Capstone project/thesis (4 quarter credits)

Electives

Each student must take two graduate-level elective courses (8 quarter credits) according to his or her concentration. Courses selected must be:

- any course from another concentration.
- any course from another graduate program, if approved by the program adviser and faculty member teaching the course.
- any independent study course if approved by the student's academic adviser.

Admission requirements

To be considered for admission to the MS program in manufacturing and mechanical systems integration, candidates must fulfill the following requirements:

- Hold a baccalaureate degree (or equivalent) from an accredited academic institution in the field of engineering, engineering technology, computing, or business. Students with degrees in other disciplines will be considered on an individual basis.
- Have a minimum grade point average of 3.0. Students with a grade point average below 3.0 will be evaluated on a case-by-case basis and may be admitted on a probationary basis. These students will have to secure a B or better average in the first three graduate courses to be considered for full admission.
- Have completed college-level course work in computer programming, and probability and statistics,
- Submit two professional recommendations,
- Submit transcripts (in English) of all previously completed undergraduate and graduate course work,
- Submit a clearly written, one-page statement of purpose, and
- Complete a graduate application.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language (TOEFL) and the Graduate Record Exam (GRE). A minimum score of 550 (paper-based), 213 (computer-based), or 79-80 (Internet-based) on the TOEFL is required. A score of 1,200 (V&Q) and an analytical writing score of 3.5 or higher are required on the GRE. Applicants with low GRE scores may be admitted conditionally; they may be required to take additional English language tests and, if required, English language courses along with a reduced MS program course load.

Packaging Science, MS

http://www.rit.edu/mmetps
Deanna Jacobs, Graduate Program Director
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Program overview

The MS program in packaging science is designed to meet the needs of both professionals who have been employed in the field and for students who wish to pursue a graduate program immediately upon earning a BS degree.

Although an undergraduate curriculum in packaging science is preferred as preparation for the MS program, graduates from certain other disciplines can successfully pursue the program if certain introductory packaging science courses are coupled with appropriate work experience.

Curriculum

The curriculum is comprised of three components: required core courses, elective courses, and research. The MS program requires the completion of 48 credit hours of graduate-level course work including a thesis or project.

Required core courses

Students complete five required core courses (20 credit hours), plus a thesis or a project. The thesis option requires 8 credit hours while the project option includes a 4 credit hour project plus one additional elective course (4 credit hours) Faculty advisers assist students in selecting the thesis or project option and the corresponding plan of study is approved by the graduate program chair.

The required core courses include:

0607-701	Research Methods
0607-730	Packaging and the Environment
0607-742	Distribution Systems
0607-763	Packaging for End-Use
0607-783	Packaging Dynamics
Plus one of the following options:	
0607-890	Thesis (8 credit hours)
0607-xxx	Graduate Project (4 credit hours) plus one elective course (4 credit hours)

Elective courses

Students complete 20 credit hours of elective courses for the thesis track and 24 credit hours for the project track. All elective courses are approved by the student's adviser and must meet degree requirements. In certain circumstances, with pre-approval by the graduate adviser and where individual need indicates appropriateness, a limited number of 500-level undergraduate courses may be used to fulfill elective credit. Undergraduate courses used as electives may not exceed 12 credits in total.

Students, with adviser permission, may include 8 credits of Independent Study (0607-978) as part of their elective credits. However, independent study may not be used toward the 20 credits of required packaging core course work.

0607-721	Packaging Administration
0607-731	Advanced Packaging Economics
0607-750	Graduate Seminar
0607-752	The Legal Environment
0607-770	Advanced Computer Applications
0607-799	Advanced Packaging Design

Courses selected for elective credit can be combined to create specialties in areas such as packaging science, print media, or service management with program chair approval.

Research

The 4 credit hour project has a practical, applications-orientation grounding in literature. It is considered secondary research or the compilation of existing information presented in a new way. The project option is for students who desire advanced study in packaging science, but who do not intend to pursue a research career or further studies beyond the master's level.

The 8 credit hour thesis for primary research develops and tests a hypothesis by scientific method and is grounded in a theoretical framework. Individuals who can capture, interpret, and apply information by this method can add value to their role as contributors in the workplace. The thesis option is for students seeking to pursue career options that offer a greater opportunity for further research or advanced study in the field of packaging science. It is meant to provide depth of study, emphasizing the research process.

To accomplish these project and thesis goals the program requires that all students—project and thesis track—understand applied research methodology and engage in writing publishable papers and proposals. This requirement enhances the scholarship required in the program, increases opportunities for students and faculty mentors to collaborate, and helps develop important career skills needed by graduates.

The student's graduate committee will make the final decision regarding the project and whether it meets the program's requirements as a graduate project or thesis.

Admission requirements

To be considered for admission to the MS program in packaging science, candidates must fulfill the following requirements:

- Hold a baccalaureate degree from an accredited institution,
- Have minimum 3.0 (B) grade point average in their final two years of undergraduate degree work,
- Submit two letters of recommendation,
- Submit transcipts (in English) from all previously completed undergraduate and graduate course work, and
- Complete a graduate application.

Graduate Record Exam scores are not required. However, in cases where there may be some question of the capability of an

applicant to complete the program, applicants may wish to submit scores to strengthen their application.

Students who do not have an equivalent bachelor's degree in packaging science will be evaluated and the appropriate undergraduate bridge courses will be prescribed. These courses may not be used for credit toward the MS degree.

Applicants are required to have one semester of physics (mechanics focus), one semester of calculus, one year of chemistry (including organic chemistry), statistics, and basic computer literacy.

Additional information

Advising

Students entering the program will be appointed a thesis adviser and will work with the program director to develop a program of study. Students follow an outlined curriculum to complete their degree requirements, and with adviser approval, choose packaging electives to enhance their career objectives.

Executive leader option

The executive leader option is an intensive program for industry professionals. The program concentrates on the application of packaging technology in the supply chain. The structure of the program provides individuals with an opportunity to obtain an MS degree without interrupting their employment.

The executive leader option consists of one two-week summer session on campus, course work completed online, and a research project. The research project may be conducted over two consecutive summers. In addition to the above stated application requirements admission to the executive leader option requires the endorsement of senior management/administrative personnel from the applicant's employer. Candidates are encouraged to align the program's research project goals with current job responsibilities.

Department of Electrical, Computer and Telecommunications Engineering Technology

www.rit.edu/ectet

Telecommunications Engineering Technology, MS

http://www.rit.edu/ectet

Michael Eastman, Department Chair
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Program overview

Throughout its existence, the telecommunications industry has driven technological innovation and provided outstanding career opportunities for people with the right technical and leadership skills. New services offered through the Internet, mobility offered by wireless technology, and extreme capacity offered by fiber optics, as well as the evolution of policy and regulation, are shaping the telecommunication network of the future. RIT offers a unique program focused on telecommunications that develops the advanced level of skill and knowledge needed by future leaders in the industry.

The master of science degree in telecommunications engineering technology is for individuals who seek graduate education to advance into managerial and leadership roles in a dynamic telecommunications environment. This program can be completed through either online or on-campus study.

Curriculum

The MS in telecommunications engineering technology requires 48 credit hours of study. The program includes six core courses (24 credit hours) that introduce essential fundamental concepts and skills. Each student is required to complete a graduate project/thesis planning seminar (2 credits) and either a capstone project (2 credits) or a master's thesis (6 credits). The remaining credits (20 or 16) consist of technical electives or other approved graduate courses.

Core courses

0614-720	Telecommunications Concepts
0614-722	Principles of Telecommunications Networks
0614-780	Telecommunications Policy and Regulation
0614 732	Fiber Optic Telecommunication Technology
0614-763	Wireless telecommunication Systems
0614-774	WAN/LAN Planning and Design

Technical electives

Network Design

0614-761	Telecommunications Network Engineering
0614-836	Next Generation Networks

Fiber Optic Telecommunications

0614-832	Fiber Optic Telecommunications Networks

Wireless Telecommunications

0614-764	Telecommunications Systems
0614-783	Telecommunications Transmission Systems

Other approved electives

Students may take up to three graduate electives from other graduate programs subject to the approval of the program chair. Many students choose to include management courses from the E. Philip Saunders College of Business.

Master's project/thesis

Each student is required to take the thesis/project planning seminar and complete either a graduate project or master's thesis. Students who elect the graduate project must take an additional course from the technical electives or other approved electives.

Admission requirements

To be considered for admission to the MS program in telecommunications engineering technology, candidates must fulfill the following requirements:

- Hold a baccalaureate degree in engineering technology, engineering, or a related degree from an accredited institution,
- Submit two professional recommendations,
- Have a minimum cumulative GPA of 3.0 (B),
- Submit transcripts (in English) of all previously completed undergraduate and graduate course work, and
- Complete a graduate application.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language (TOEFL). Minimum scores of 570 (paper-based), 230 (computer-based), or 88-89 (Internet-based) are required. Applicants with a lower TOEFL score may be admitted conditionally and may be required to take a prescribed program in English and a reduced program course load. International applicants from universities outside the United States must submit scores from the Graduate Record Examination (GRE).

While scores from the GRE are not required for applicants from American universities, they are recommended for those whose undergraduate grade point average is below 3.0.

Additional Information

Transfer credit

A maximum of 12 credit hours may be transferred from an accredited institution to this program.

Research and cooperative education

Students in the program have the opportunity to apply for research projects or a cooperative education experience. While not a requirement of the program, these opportunities increase the value of the program and the marketability of its graduates.

School of International Hospitality and Service Innovation

The School of International Hospitality and Service Innovation offers academic programs designed to prepare students for careers in service management, hospitality, travel, and client care. Among the skills graduates will acquire are:

- management skills and strategies essential to career advancement.
- ways of assessing and measuring service quality.
- the ability to think innovatively to solve management-level problems.
- ways to implement new technologies and maximize results.
- leadership and teamwork skills.
- a passion for lifelong learning.

The graduate programs in the school may be completed in one to two years. In some cases, where a student does not have industry experience, an internship or cooperative education experience may be required.

International study opportunities

RIT is preparing students around the world for careers in business, industry, and government. The school offers graduate programs and courses on the RIT campus in Rochester, NY, as well as at three RIT-affiliated campuses internationally: the American College of Management and Technology in Dubrovnik, Croatia; the American University in Kosovo (AUK), and RIT Dubai, in the United Arab Emirates. In addition, graduate programs are offered in other international locations, such as the Dominican Republic.

Hospitality-Tourism Management, MS

http://www.rit.edu/cast/hsm/programs/tourism/

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Program overview

Graduates of the MS program in hospitality-tourism management are well prepared to step into numerous mid-level service management and training director positions. The program is focused on service and innovation, as well as leadership functions within many service and corporate settings and at post-secondary academic institutions.

The hospitality-tourism management program may be taken on a full- or part-time basis. The length of time required to earn the degree varies according to the student's undergraduate preparation and the number of graduate courses taken per quarter. To earn the MS degree, all students must take a minimum of 48 credit hours. For full-time students, the program requires a minimum of four quarters of study at the graduate level. Part-time students generally will require seven or eight quarters of study at the graduate level.

Curriculum

The curriculum is a combination of required core courses in service innovation, a concentration, and elective courses chosen by the student to meet career interests and objectives. Students may choose one of three options to complete the program: a research thesis, a capstone project, or a comprehensive exam. Course offerings generally are scheduled for evenings and most are available online to facilitate part-time students.

The MS in hospitality-tourism management introduces the major concepts associated with all aspects of service management, whether they are applied specifically to the hospitality-tourism industry or the wider service industry. Among the general concepts investigated are service strategy delivery (understanding and co-creating customer value, innovation and creativity, service

leadership, service design and metrics development, and change in service organizations), and human resource capital development (human capital strategies).

Core courses

The core courses facilitate the paradigm shift from manufacturing to service and move the focus from traditional organizational structures to an organization where employees must provide several functions, sometimes simultaneously. This multifunctional approach provides a new avenue to examine service organizations and explore such issues as teamwork, learning organizations, organizational change, performance metrics, and customer relationship management.

Each course not only introduces the service philosophy, but also examines the real differences in hospitality-service management outcomes necessitated by the adoption of a new service paradigm. In so doing, these courses set the stage for the professional "cluster" courses.

0625-750	Elements of Service Management: A Systems Approach
0624-825	Strategic Process of Service Firms
0625-849	Service Performance Metrics
0625-790	Research Methods
0624-755	Graduate Writing
0624-826	Tourism Policy Analysis
0624-846	Travel Marketing Systems
0624-867	Tourism Planning and Development
0635-714	Data Analysis
	Two Approved Electives
	Capstone/Comprehensive Exam/Thesis*

* Students who choose to complete a capstone project will add one additional elective to the program of study, those completing a thesis will add one elective, and those taking the comprehensive exam will complete Integrated Project Solving plus one additional elective course.

Electives

Elective courses provide students with an opportunity to individualize their graduate programs in line with their career and professional interests. With the approval of the department chair, students are allowed to take a selection of elective courses from outside the hospitality-tourism management program. Courses may be taken from the hospitality and service management program, the human resource development program, the E. Philip Saunders College of Business, and the Kate Gleason College of Engineering. Students are cautioned to observe course prerequisites in their selections.

Of the 8 credit hours of electives, students are relatively free to select courses that they feel best meet their needs. All elective courses must be graduate-level. If previous course work exists, a maximum of 12 credit hours from another university may be considered for transfer. A maximum of 8 credit hours may be taken as independent study or practicum courses. Students completing a capstone project or the comprehensive exam will need to complete one additional elective (4 credit hours).

Thesis/Capstone/Exam options

Students must complete a thesis, capstone project, or comprehensive exam as a culminating experience allowing for demonstration of competencies for theory and application material for the discipline. Students will be advised by the program adviser and/or program faculty as to which option is most appropriate in fulfilling a student's career and educational objectives. In the program the default is to complete a capstone project. A thesis or comprehensive exam may be completed in place of the capstone, with the approval of the faculty adviser and program director.

Admission requirements

To be considered for admission to the MS program in hospitality-tourism management, candidates must fulfill the following requirements:

- Hold a baccalaureate degree from an accredited institution,
- Submit official transcripts (in English) of all previously completed undergraduate and graduate course work,
- Have a GPA of 3.0 or higher. (A GPA of 2.75 will be considered if applicant has superior recommendations; length of time since the candidate's college graduation also will be considered). Foundation course work with a GPA of 3.0 or higher (if required).
- Submit two professional recommendations,
- Participate in an on-campus interview (when possible),
- Submit a current resume, and
- Complete a graduate application.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language (TOEFL). A minimum score of 550 (paper-based), 213 (computer-based), or 89 (Internet-based) is required. All international students will also take the Michigan Test of English Proficiency upon arrival, unless otherwise waived.

After a review by the program chair, applicants whose prior undergraduate work has been in areas other than hospitality-tourism may be required to complete additional courses. Students may choose elective courses with the approval of the program.

Service Leadership and Innovation, MS

Linda Underhill, Graduate Program Chair
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www.rit.edu/schoolhsm

Program overview

Service leadership and innovation is a program designed to provide students with the capability to transform their service organizations. Service is no longer a subset of manufacturing era thinking. The program includes core courses, professional electives and concentrations, and a capstone project, thesis, or exam, all of which total 48 credit hours.

Curriculum

Core courses

0635-712	Library Research
0624-770	Service Leadership
0625-750	Elements of Service Management: A Systems Approach
0624-790	Research Methods
0624-825	Strategic Process of Service Firms
0626-735	Human Capital Strategies
0625-849	Service Performance Metrics
0625-755	Graduate Writing
0635-714	Data Analysis

Electives

Electives may be chosen from human resource development, hospitality-tourism management, or technical electives. Electives must be approved in advance and students must meet all prerequisite requirements.

Admission requirements

To be considered for admission to the MS in service leadership and innovation, candidates must fulfill the following requirements:

- Hold a baccalaureate degree (or equivalent) from an accredited institution,
- Submit official transcripts (in English) of all previously completed undegraduate and graduate course work,
- Submit two professional recommendations,
- Submit a current resume,
- Have an undergraduate GPA of 3.0 or above, or evidence of relevant professional performance,
- Have completed foundation course work with a GPA of 3.0 or higher (if required), and
- Complete a graduate application.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language (TOEFL). Minimum scores of 550 (paper-based), 213 (computer-based), or 79 (Internet-based) are required. Scores from the International English Language Testing System (IELTS) are accepted in place of the TOEFL exam. Minimum acceptable scores will vary; however, the absolute minimum score for an unconditional acceptance is 6.5.

Additional information

Study options

The program is flexible and can be completed through either full- and part-time study. Courses are offered in the evenings, on weekends, or through a weeklong format. Many of the program's courses may be completed online. Full-time students may complete the program within three quarters, or one academic year.

The executive leader option may be completed in one academic year for candidates whose schedules can accommodate two courses per quarter. The program typically begins in the fall quarter, enabling a class of students to progress through the program together as a group.

Thesis/Capstone/Exam options

All students must complete a thesis, capstone project, or comprehensive exam as a culminating experience allowing for demonstration of competencies for theory and application material for the discipline. Students will be advised by the program adviser and/or program faculty as which option is most appropriate based on career goals and objectives. In the program the default is to complete the comprehensive examination upon completion of required and elective course work unless a student seeks to complete a thesis or capstone project. This alternative strategy is possible if the faculty adviser and department chair agrees with the student in their ability to complete this strategy.

Service Leadership and Innovation, Adv. Cert.

Program overview

The advanced certificate in service leadership and innovation offers service professionals cutting edge skills, abilities, and applied service knowledge. The certificate will heighten the student's capacity to function in today's highly competitive and quickly evolving service environment.

Curriculum

The advanced certificate is made up of five courses that help students master the following concepts:

- understanding service performance system design and implementation parameters,
- understanding and using service value delivery system structures and processes,
- comprehending the evolving strategic environment of service-sector businesses,
- establishing and using service-system elements/dimensions,
- building service metrics from feedback processes,
- understanding and implementing customer relationship management, and
- constructing innovative approaches to service and managing those changes.

0625-750	Elements of Service Management: A Systems Approach
0624-825	Strategic Process of Service Firms
0625-842	Customer Relationship Management
0625-844	Breakthrough Thinking
0625-849	Service Performance Metrics

The certificate may be completed as a stand-alone credential, serve as an entry point for the MS program, or be used to fulfill the requirements for a professional concentration in RIT's MS program in professional studies.

Admission requirements

The advanced certificate is open to qualified students who meet the requirements for graduate study. Certificate courses are introductory to graduate courses in each area and thus require no prerequisite course work. Qualified students may use individual courses or the certificate in other RIT graduate programs with the appropriate approvals.

Human Resource Development, MS

http://www.rit.edu/cast/hsm/programs/Graduate/hrd_index.html

Linda Underhill, Graduate Program Chair
(585) 475-7359, lmuism@rit.edu

Program overview

The master of science degree in human resource development prepares students to influence the human assets of an organization to positively impact organizational outcomes.

The program requires students to build competencies in effective employee and talent development practices as used by world-class organizations, outcome and evidence-based training and learning, instructional design and delivery, career development, and workforce development. The curriculum combines a competency-focused program with the solid scholarship, writing, and analytical skills required of today's human resource professional.

Applicants to this program are often experienced human resource practitioners eager to build new competencies in training, instructional design, talent management, and employee development; managers who want to encourage employees to reach their potential; and individuals interested in starting a career in the human resource field. Courses are offered in the evening and online.

Curriculum

The degree requires completion of a minimum of 48 credit hours at the graduate level, and can usually be completed in four consecutive quarters. However, the majority of students attend part time and take three years to complete the program.

Students choose electives that best meet their career interests. Courses may be taken in other graduate-level programs at RIT with permission. A maximum of 12 credit hours (not counted toward another degree) may be considered for transfer credit from another college or university.

Upon matriculation, each student is assigned an adviser. Together, the student and adviser develop a plan of study. For specific questions about courses and a plan of study, the adviser or program chair should be consulted.

Required courses

0626-707	Applied Data Analysis in Human Resource Development
0626-780	Human Resources Management I
0625-755	Graduate Writing
0635-790	Research Methods
0635-712	Library Research

Choose three of the following courses

0626-710	Theories of Organizational Development
0626-720	Theories of Career Development
0626-730	Strategic Employee Development
0626-781	Human Resource Management II

Electives

0626-703	Facilitation Skills
0626-735	Human Capital Strategies
0626-702	Leveraging Technology
0626-704	Competitive Staffing and Selection
0626-705	Competency Driven Organization
0626-782	Human Performance Management Practices
0626-727	Human Resource Metrics

Graduation Strategies

Choose one of the following graduation strategies:

(1) Students may choose to complete a comprehensive exam (0 quarter credit hours), Change Management (0626-790) (4 quarter credit hours), plus 4 quarter credit hours of approved electives.
(2) Students may choose to complete a capstone project (4 quarter credit hours) plus 4 quarter credit hours of approved electives.
(3) Students may choose to complete a thesis (6 quarter credit hours).

Admission requirements

To be considered for admission to the MS program in human resource development, candidates must fulfill the following requirements:

- Hold a baccalaureate degree from an accredited college or university,
- Submit official transcripts (in English) of all previously completed undergraduate and graduate course work,
- Have a cumulative GPA of 3.0 or above (or evidence of relevant professional performance),
- Submit two letters of reference,
- Submit a writing sample designated by the department, and
- Participate in an interview with a faculty member (when possible).
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language. Minimum scores of 550 (paper-based), 213 (computer-based), or 79 (Internet-based) are required. Upon arrival at RIT, international students may be asked to take an English Language Proficiency exam. Those who do not meet the minimum standard may be required to take additional English language courses.

All required admission materials must be submitted and reviewed by faculty prior to the completion of 12 credit hours of graduate work in the program.

College of Applied Science and Technology

H. Fred Walker, BS, MBA, California State University; MS, Ph.D., Iowa State University—Dean; Professor

Linda A. Tolan, NCC, CPLP, BS, State University College at Geneseo; MS, Rochester Institute of Technology; Ph.D., Andrews University—Senior Associate Dean, Professor

Maureen S. Valentine, PE, BSCE, Tufts University; MECE, Virginia Polytechnic Institute—Associate Dean; Professor

Sean T. Bennett, BS, Clarkson University; M.Ed., State University College at Brockport; Ed.M., Harvard University—Assistant Dean

Civil Engineering Technology/Environmental Management and Safety

Amanda Bao, BS, MS, Tianjin University (China); Ph.D., University of Colorado at Boulder—Assistant Professor

Harry G. Cooke, PE, BS, Northwestern University; MSCE, University of Texas; Ph.D., Virginia Polytechnic Institute—Associate Professor

G. Todd Dunn, PE, BS, Dartmouth College; MSCE, University of California—Associate Professor

Robert H. Easton, PE, BS, United States Military Academy; MSCE, Iowa State University—Professor Emeritus

Abdullah Faruque, PE, B.Sc., Bangladesh University of Engineering and Technology; M.A.Sc., University of Windsor (Canada)—Assistant Professor

Frank Hanna, B.Sc., M.Sc., University of Baghdad (Iraq); Ph.D., University of Wales College of Cardiff (UK)—Associate Professor

William C. Larsen, PE, BS, MSCE, Dartmouth College—Professor Emeritus

Robert E. McGrath Jr., PE, BCE, Rensselaer Polytechnic Institute; MSCE, Syracuse University—Professor Emeritus

Mark Piterman, MCE, Odessa Marine Engineers Institute (Ukraine)—Professor Emeritus

Scott B. Wolcott, PE, BS, MS, State University of New York at Buffalo—Undergraduate Program Coordinator; Professor

Teresa Wolcott, BS, State University of New York at Buffalo; MS, Rochester Institute of Technology—Lecturer

Environmental Management and Safety

Josh Goldowitz, BS, State University of New York at Binghamton; MS, University of Arizona—Professor

Lisa Greenwood, BS, Rochester Institute of Technology; MS, University of New Haven—Lecturer

John Morelli, PE, BS, Syracuse University; MS, Ph.D., State University of New York College of Environmental Science and Forestry—Department Chair; Professor

Joseph M. Rosenbeck, CSP, MS, BS, Central Missouri State University—Graduate Program Director; Professor

Jennifer L. Schneider, CIH, BA, Roberts Wesleyan College; MS, University of Rochester; Ph.D., University of Massachusetts—Professor

Facility Management

Jeffrey Rogers, PE, CPE, BS, Virginia Polytechnic Institute and State University; MS, University of Florida; ME, Old Dominion University; Ph.D., University of Virginia—Assistant Professor

Electrical, Computer, and Telecommunications Engineering Technology

W. David Baker, BSEE, Monmouth College; MS, Rochester Institute of Technology—Professor Emeritus

Jeanne Christman, BS, Clarkson University; MS, University of Texas at Dallas—Assistant Professor

Richard C. Cliver, BS, Rochester Institute of Technology; MSEE, University of Rochester—Associate Professor

Steven A. Ciccarelli, BS, MS, Rochester Institute of Technology—Electrical Engineering Technology Program Chair; Associate Professor

Thomas Dingman, BS, MS, Rochester Institute of Technology—Professor Emeritus

Michael Eastman, BS, MSCS, Rochester Institute of Technology—Department Chair; Professor

Ronald Fulle, BA, State University College at Oswego; MS, University of Colorado at Boulder—Associate Professor

Chance M. Glenn, BS, University of Maryland at College Park; MSEE, Ph.D., Johns Hopkins University—Associate Professor

Clark Hochgraf, BS, State University of New York at Buffalo; Ph.D., University of Wisconsin at Madison—Associate Professor

James J. Hurny, BSEE, Carnegie Institute of Technology; MBA, MS, Rochester Institute of Technology—Associate Professor

Mark J. Indelicato, BEEE, Manhattan College; MS, Polytechnic University—Associate Professor

William P. Johnson, BA, Kings College; BSEE, MSEE, Syracuse University; JD, University at Buffalo Law School—Professor

Warren L. G. Koontz, BSEE, University of Maryland; MSEE, Massachusetts Institute of Technology; Ph.D., Purdue University—Professor

David Krispinsky, BE, MSE, Youngstown State University—Associate Professor

Eldred L. Majors, BS, Rochester Institute of Technology—Lecturer

Drew Maywar, BS, MS, Ph.D., University of Rochester—Assistant Professor

Antonio F. Mondragon, BS, Universidad Iberoamericana (Mexico); MSc, Universidad Nacional Autonoma de Mexico (Mexico); Ph.D., Texas A&M University—Assistant Professor

David M. Orlicki, BS, Michigan State University; MS, Rochester Institute of Technology; Ph.D., Massachusetts Institute of Technology—Lecturer

Carol Richardson, BSEE, University of Wyoming; MSEE, Union College—Professor Emerita

Jacob Schanker, PE, BEE, MEE, City College of the City University of New York—Lecturer

George H. Zion, BS, MS, Rochester Institute of Technology—Professor

Manufacturing and Mechanical Engineering Technology/Packaging Science

Ronald F. Amberger, PE, BME, Rensselaer Polytechnic Institute; ME, Pennsylvania State University—Professor Emeritus

Dianne M. Amuso, BS, Western New England College; MS, Rensselaer Polytechnic Institute—Lecturer

Scott J. Anson, PE, BSME, MSME, Ph.D., State University of New York at Binghamton—Manufacturing Engineering Technology Program Chair; Associate Professor

Beth A. Carle, BSE, University of Pittsburgh; MS, Ph.D., University of Illinois; EIT Professional Certification—Associate Professor

Mario H. Castro-Cedeno, BSME, MSME, University of Puerto Rico at Mayaguez; MEMS, University of California at Berkeley—Assistant Professor

Elizabeth M. Dell, BSME, General Motors Institute; MS, University of Michigan—Paul A. Miller Professorship

Robert D. Garrick, BSEE, GMI Engineering and Management Institute; MBA, Rochester Institute of Technology; MS, University of Rochester; Ph.D., University of South Carolina—Assistant Professor

Martin Gordon, PE, BSME, MSME, MBA, State University of New York at Buffalo—Associate Professor

Christopher M. Greene, BS, Syracuse University; MS, Ph.D., Binghamton University—Assistant Professor

Daniel P. Johnson, BS, MS, Rochester Institute of Technology—Department Chair; Professor

Seung H. Kim, BS, Hanyang University (South Korea); MS, Ph.D., University of Illinois—Associate Professor

James H. Lee, PE, BS, California Polytechnic State University; MS, Ph.D., Texas A&M University—Assistant Professor

William Leonard, AAS, State University College at Canton; BS, MS, Rochester Institute of Technology—Mechanical Engineering Technology Program Chair; Associate Professor

Ti-Lin Liu, MS, Tsinghua University (China)—Associate Professor

Carl A. Lundgren, BS, Rensselaer Polytechnic Institute; MBA, University of Rochester—Professor

Robert A. Merrill, PE, BS, Clarkson College; MS, Northeastern University—Professor

Michael J. Parthum Sr., BS, MS, Rochester Institute of Technology—Electrical/Mechanical Engineering Technology Program Chair; Associate Professor

S. Manian Ramkumar, BE, PSG, College of Technology-Bharathiar (India); ME, Rochester Institute of Technology; Ph.D., State University of New York at Binghamton—Professor

Michael J. Slifka, AAS, Niagara County Community College; BS, MS, Rochester Institute of Technology—Assistant Professor

John A. Stratton, PE, BS, Rochester Institute of Technology; MS, Rensselaer Polytechnic Institute—Professor Emeritus

Larry A. Villasmil, BSME, Universidad del Tachira (Venezuela); MSME, Ph.D., Texas A&M University—Assistant Professor

Packaging Science

Changfeng Ge, BSME, MSME, Tongji University (China); Ph.D., University of Dortmund (Germany)—Associate Professor

Daniel L. Goodwin, BS, MS, Ph.D., Michigan State University—Professor

Deanna M. Jacobs, BS, State University College at Plattsburgh; MA, State University College at Geneseo; MS, Rochester Institute of Technology—Graduate Program Director; Professor

Thomas Kausch, BS, MS, Rochester Institute of Technology—Instructor

Karen L. Proctor, BS, Michigan State University; MBA, Rochester Institute of Technology—Professor

School of International Hospitality and Service Innovation

David H. Crumb, BS, Florida State University; MBA, Michigan State University—Associate Professor

Francis M. Domoy, BS, MA, State University of New York at Buffalo; Ph.D., Michigan State University—Chair Emeritus; Professor

John-Paul Hatala, BA, Laurentian University; MS, Elmira College; Ph.D., University of Toronto—Assistant Professor

Lorraine E. Hems,BS, Nazareth College of Rochester; CS, CWE—Lecturer

Jon Horne, BA, Colorado State University; MA, University of Phoenix; MS, Rochester Institute of Technology—Assistant Professor

James Jacobs, MS, Troy State University; Ph.D., State University of New York at Buffalo—Senior Lecturer

Richard M. Lagiewski, BS, MS, Rochester Institute of Technology—Senior Lecturer

Bonalyn Nelsen, BS, Florida University; MS, Rochester Institute of Technology; Ph.D., Cornell University—Associate Professor

Warren G. Sackler, BA, Michigan State University; MA, New York University—Associate Professor

Edward A. Steffens, BS, MBA, Rochester Institute of Technology—Associate Professor

Linda Underhill, RD, BS, MS, Rochester Institute of Technology; Ph.D., State University of New York at Buffalo—Interim Chair; Associate Professor

Carol B. Whitlock, RD, BS, MS, Pennsylvania State University; Ph.D., University of Massachusetts— Interim Chair; Professor

Packaging Science

0607-701 Research Methods in Packaging
Discussion of procedures, methods and requirements for carrying out the research project. Students pursue advanced study and research in the following areas: distribution packaging, package systems development, product and/or package damage in the physical distribution environment, materials, quality preservation, production and mechanical properties of packaging materials and systems. **Credit 4**

0607-721 Packaging Administration
Study of the role of packaging operations in the corporate enterprise. Positioning of the packaging function in the corporation, managerial practice, interpersonal relationships and control techniques are considered. Individualized instruction, case analysis and/or research papers supplement classroom instruction. **Credit 4**

0607-730 Packaging and the Environment
Considerations of packaging in a social context. Factors that enhance secondary use, recycling, recovery of resources and proper disposal are discussed. Package design in relation to solid waste disposal and materials and energy shortages are considered. Other topics of current social interest are discussed. Primarily a discussion class for graduate students. Open to graduate non-majors. (0607-321, 322 or equivalent). May not also get credit for 0607-530. **Class 4, Recitation 1, Credit 4**

0607-731 Advanced Packaging Economics
An advanced study of the firm's economic behavior in relationship to activities within the packaging function. Included are packaging costs, production theory and case studies demonstrating general trends in the packaging industry. Individual instruction, case study and/or research paper required, as appropriate to the student's level or interest. **Credit 4**

0607-742 Distribution Systems
Study of the shipping and handling environment encountered by goods in packages during distribution to the product user. Materials handling, warehousing and the impact of the distribution environment on shipping container design and development are considered. Case study or individual research appropriate to student's interest. **Credit 4, Class 3, Lab 2**

0607-750 Graduate Seminar
Course concentrates on topic of current interest, depending on instructor, quarter offered and mix of students. Content to be announced prior to registration dates. **Credit 4**

0607-752 The Legal Environment
An intensive study of federal, state and local regulation that affects packaging. Individualized study and research on an interest basis. **Credit 4**

0607-763 Packaging for End-use
An intensive study of package design requirements specific to use of a product at specified end points. Individual design and development of a package system and its specifications, appropriate to the needs of the product and the consumer/user. **Credit 4**

0607-770 Advanced Computer Application
Study of the application of computer techniques and data processing for packaging applications: specification development, test simulation, optimum sizing of package systems, process control and similar applications will be presented. Computer program development and individual research on an interest basis. **Credit 4**

0607-783 Advanced Packaging Dynamics
The study of instrumentation systems for analysis, evaluation and application of shock and vibration test methods and data to package system design and development for specific products. A research paper is required. **Credit 4 Class 3 Lab 2**

0607-798 Independent Study
Student-initiated study in an area of specialized interest, not leading to a thesis. A comprehensive written report of the investigation is required. Cannot be used to fulfill core requirements. **Credit variable (maximum of 8)**

0607-799 Advanced Packaging Design
Advanced package design projects selected in consultation with the instructor. Individual study appropriate to area of interest and background of student. (Consent of department) **Credit variable 1–4**

0607-890 Graduate Thesis
An independent research project to be completed by the student in consultation with the major professor. A written thesis and an oral defense of the thesis are required. (Consent of department) **Credit variable (maximum of 12)**

0607-899 Executive Leader Portfolio
The portfolio credit option is for the Executive Leader students only and is designed to evaluate extensive prior experience. Students must provide extensive documentation of at least 5 years of experience in the packaging industry after completion of the appropriate baccalaureate degree. The content for the portfolio and the number of credits sought are determined in conjunction with the graduate coordinator. Final review and award of credit are then completed through the graduate coordinator and the Program Chair. **Credit 1–10**

0607-999 Packaging Science Grad Co-op
Work experience in packaging science position appropriate to selected major in graduate program. Position to be obtained through interviewing process with the assistance of Cooperative Education and Career Services Office. **Credit 0**

Manufacturing and Mechanical Engineering Technology

0610-710 Product Development and Integration
This course is the first of three classes covering topics, processes and best practices in product development. Using Design for Six Sigma (DFSS) as a motivating philosophy, the course introduces the student to concepts and techniques in the early stages of the product development process, including capturing the voice of the customer, critical parameter management, the phase-gate approach, and system integration for total product life cycle performance. The course provides an overview of DFSS goals, its development process, CDOV (Concept-Design-Optimize-Verify), and technology process (IDOV, Innovate-Develop-Optimize-Verify), as well as strategies in product commercialization. **Credit 4**

0610-750 Applied Systems Dynamics
Students learn how to approach and solve real-world dynamic systems problems primarily involving mechanical and electrical components. Design, analysis and control issues and methodology are discussed in the context of real systems like automobiles and machine tools. Labs will include computer simulation and physical testing. (Graduate standing) **Credit 4**

0610-820 Concept Design and Critical Parameter Management
This course focuses on Design for Six Sigma processes such as translating the voice of the customer into technical requirements, defining functions to fulfill the requirements, generating concepts to physically fulfill the functions, and the evaluation and selection of superior product and subsystem concepts that are safe to take to commercialization. Students are introduced to topics such as quality function deployment, concept generation, Pugh's concept selection process, and Design Failure Modes and Effects Analysis. **Credit 4**

0610-830 Instrumentation and Computer Aided Systems
This course integrates modern methods of acquiring, processing, and analyzing data. The goal is to generate value added information to the critical parameter management process during new product development. The course focus is on the measurement of product or process critical functional responses that are direct indicators of the true physical functions that control product quality. Students will acquire a strong set of skills in hands-on development, design, construction and operation of manual and computer-aided data acquisition systems. Topics include applications for data base management and application for empirical model building, robust design, tolerance design and statistical process control. Students will be introduced into using Lab View for data acquisition and control. **Credit 4**

0610-870 Robust Design for Product and Systems
In this advanced course, students explore methods, such as Taguchi arrays, that support the optimization and verification phases of the Design for Six Sigma development process. Topics covered include additivity, signal-to-noise ratios, analysis of means, ANOVA, and the role of robust design methods in reducing variability for products, processes, and systems. **Credit 4**

Telecommunications Engineering Technology

0614-720 Telecommunications Concepts
The course provides the student with a solid understanding of digital and time division multiplexing and modulation schemes used in the transmission of information in a variety of networks, both packet and circuit switched. Traffic engineering and quality of service concepts are covered as well as a number of network protocols and signaling platforms such as MPLS and SIP. (BS in engineering technology, engineering, or a related degree) **Lecture 4, Credit 4**

0614-722 Principles of Telecommunications Network
The course provides the student with a solid understanding of local access and backbone networks,architecture, equipment and technology related to the Public Switched Telephone (PSTN), Cable (MSO), access and converged/IP networks. passive optical networking and hybrid fiber coax technology is also covered (BS in engineering technology, engineering, or a related degree) **Lecture 4, Credit 4**

0614-732 Fiber Optic Telecommunications Technology
This course will present the student with the basic components of fiber optic telecommunications systems including optical fiber, light sources and transmitters, photodetectors and receivers, optical amplifiers and passive optical components. Fiber optic telecommunication is one of the most dynamic and important technologies in the telecommunications field. The fundamental driving forces, notably including the growth of wideband access to the Internet, are still in place and the demand for telecommunications capacity continues to increase exponentially. (Physics or engineering course including basic optics and electromagnetic waves calculus, and differential equations) **Lecture 4, Credit 4**

0614-761 Telecommunications Network Engineering
This course covers accepted network design principles and methodologies as they apply to circuit, packet, frame, cell and synchronization networks. Course topics are transmission engineering, traffic engineering models, timing and synchronization, design of voice and data networks, and electrical grounding concepts. (Telecommunications Concepts 0614-720, Principles of Telecommunications Networks 0614-722, Telecommunications Network Protocols 4055-746) **Class 4, Credit 4**

0614-763 Wireless RF Telecommunications Systems
The fundamental principles that govern wireless mobile and fixed radio frequency communication systems are studied in this course. At the end of this course, students will understand the radio frequency mobile wireless environment, the common wireless systems, and the regulatory aspects related to deployment of the wireless infrastructure. (An undergraduate/graduate course in communication systems (such as 0609-534) and current facility with technical mathematics and calculus) **Class 4 Credit 4**

0614-764 Telecommunications Systems
The fundamental principles that govern the communication of information are introduced. At the end of this course students will understand signal spectral analysis and the principles of digital and analog modulation formats. Topics in the course are spectral analysis techniques, modulation schemes, and noise and bit error rates. (Calculus and differential equations) **Class 4, Credit 4**

0614-774 WAN/LAN Planning and Design
This course teaches the art and science of metropolitan and wide area network (WAN) design. for both modern delay (data) networks and traditional blocking (voice) networks; the greatest emphasis is on modern delay networks. Both qualitative and quantitative approaches are used as the student progresses through the network analysis, architecture and network design processes. An advanced WAN Fiber Optic design tool, such as OPNET Transport Planner is utilized in a required graduate project. (0614-720 and 0614-722) This course is not appropriate for graduate RIT MSTET credit if the student has completed the undergraduate RIT course Network Planning and Design (0614-574) with an A or B grade within the past five years. **Class 4, Credit 4**

0614-780 Telecommunications Policy Issues
This course provides an introductory overview of domestic and international telecommunications policy and issues with special emphasis on domestic policy, regulation and law. Current issues, trends and standards are also investigated. This course is not appropriate if the student has completed the RIT undergraduate course, Introduction to Policy and Issues (0614-480), with an A or B or an equivalent course at another university in the past five years. **Class 4, Credit 4**

0614-783 Telecommunication Transmissions Systems
The fundamental principles that govern wired and wireless transmission systems are introduced. At the end of this course students will be able to apply transmission system theory to the analysis and design of copper, fiber-optic, and wireless transmission systems. Topics in the course are Transmission Lines, link budgets, satellite communications, and an introduction to cellular engineering and mobile radio transmission. (Calculus, differential equations, and an undergraduate course in electronic communications systems that teaches the concepts of modulation and demodulation and the electronic components in transmitters and receivers) **Class 4, Credit 4**

0614-798 Special Topics in Telecommunications
Special topics in Telecommunications is an experimental graduate level course that will allow innovative topics in the rapidly changing telecommunications field to be offered and evaluated as potential permanent components of the ET curriculum. **Class 4, Credit 4**

0614-832 Fiber Optic Telecommunications Network
This course is focused on the operation of the elements of fiber optic telecommunications networks and the structure and operation of optical telecommunications networks. Students will be able to design optical networks to meet specified capacity, flexibility, and reliability requirements at the end of the course. (Fiber Optic Telecommunications Technology 0614-732) **Lecture 4, Credit 4**

0614-836 Next Generation Networks
This course is a cross between an independent study and a seminar course. It provides MSTET students the opportunity to research and report on near term "Next Generation Networks." The course consists of professor provided discussion on one type of Next Generation Network followed by each student researching two additional Next Generation Network types. A case study approach is utilized. After completing the research and written paper regarding one's selected topic/case, each student will read each others and then present theirs to all other students in the class. Every student will not only benefit from their own research of two topics/cases but also be informed of other Next Generation Network issues by other students. While this course is primarily directed toward the technical side of future networking, with instructor permission, one Next Generation topic with a Policy/Regulation/Law/Security or Market Forces theme may be considered as a valid research case. (Students with an engineering technology or engineering undergraduate degree and or graduate students who have completed ALL core MSTET requirements. Students should already have some understanding of how to perform research and must possess at least adequate writing skills.) **Class 4, Credit 4**

0614-890 Graduate Thesis/Project Plan
This course is a ten-week preparation that will allow the student to develop a detailed description and plan of work along with preliminary data and research. The objective of this preparation is to give focus to the proposed thesis/project. The student will conduct literature reviews, prepare bibliographies, identify and plan methodologies, identify deliverables, prepare schedules, become familiar with report formats and literary guides, and gain a clear understanding of the expectation of faculty and the discipline. The student will be assigned a primary faculty adviser.

0614-892 Graduate Thesis
The graduate thesis is an independent research or development project that provides new knowledge, data, processes, software or other assets that benefit the field of telecommunications. A formal written thesis and an oral defense are required. (0614-890, Thesis/Project Planning Seminar) **Credit 6**

0614-893 Graduate Project
Graduate projects are an applied research project that reflects the student's ability to utilize professional skills to design and develop a project that demonstrates the use of telecommunications technology, tools, or applications. A formal written document and demonstration are required. (0614-890, Thesis/Project Planning Seminar) **Credit 2**

0614-899 Independent Study
Study or laboratory work on a telecommunications or closely related topic. (Approval of the instructor and the telecommunications engineering technology program chair are required.) **Credit 2–4**

0614-999 Graduate Co-op
One quarter of appropriate work experience in a telecommunications related industry. It is expected that a student will normally take no more than two quarters of cooperative education in the course of the MSTET program. **Credit 0**

Manufacturing and Mechanical Systems Integration

0617-730 Data Management and Communication
This is a course in communication and data management. The first part of this course will focus on data communication. Fundamental concepts of computer systems will be explored. This information will be a precursor to such topics as parallel and serial communication, synchronous and asynchronous communication, point-to-point, and broadcast networks. Additional discussion will include application of network applications in CIM such as EDI. The second part of this course will discuss elementary data management topics such as data storage and retrieval, the use of commercial DBMS's and the relational model. It will also discuss data representation in CIM; the melding of representation schemes used by CAD systems and CNC/DNC machine tools. **Class 4, Credit 4**

0617-842 Data Management in CIM
Introduction to data management for manufacturing applications. Topics include conceptual, implementation and physical design of data bases as well as data representation used in manufacturing processes. Geometric modeling of 3D objects for analysis and display is included. Laboratory work required. (0602-710, 730) **Credit 4**

0617-845 Distributed Systems
This is a course in writing distributed applications, as distinguished from distributed operating systems. As such, it focuses on two principal issues: types of implementation platforms and interprocess communication mechanisms. The first issue involves a discussion of different types of environments in which the programmer may find himself or herself, including traditional timesharing systems, event-driven systems and uniprogramming systems. The pros and cons of each are discussed as a basis for implementing distributed systems. The second issue is concerned with how processes, or tasks, communicate with one another, whether this is different when the processes are on a single processor or different processors and how they can synchronize their accesses to shared resources. (0602-710, 730) **Credit 4**

0617-850 Flexible Manufacturing and Assembly Systems
The course enables students to make basic calculations to design and analyze manufacturing and assembly systems. Topics include the design of manual assembly systems, transfer lines and flexible manufacturing systems. Quality systems are discussed including SPC, TQM and Six Sigma. Quality case studies are discussed and associated problems solved. Specific design and production problems are solved using QFD and FMEA techniques. Manufacturing (and company) control systems are discussed including MRP I, MRP II, ERP, the Toyota Production System, Lean Enterprise Model and Next Generation Manufacturing. The combination of Lean and Six Sigma tools is introduced and used to solve problems associated with a manufacturing case study. **Class 4, Credit 4**

0617-855 Electronic Packaging Fundamentals
This course will provide a thorough understanding of the technology, components, equipment, design and manufacturing process for surface mount electronics manufacturing. As an introductory course, it will provide the students with a strong foundation needed for advanced work in the surface mount technology (SMT). The laboratory demonstrations will provide the students an orientation and familiarization of the manufacturing equipment and process for printed circuit board assembly. **Class 4, Credit 4**

0617-856 Advanced Concepts in Electronics Packaging
This course provides an in-depth study of thermal, mechanical, material, manufacturing and reliability aspects of SMT and advanced packaging. The lecture topics will include design and manufacturing standards, thermal modeling and management, mechanical properties of materials, failure mechanisms, materials processing, high-density interconnection, advanced component packaging, technology trends, reliability testing, inspection. **Class 3, Lab 2, Credit 4**

0617-870 Manufacturing Automation Control
This course deals with the principles and application of programmable logic controllers (PLC). Topics include PLC hardware, programming and application of PLCs in a computer integrated manufacturing (CIM) environment. Students will also be exposed to man machine interface (MMI) and PLC networks. (Manufacturing Processes) **Class 3, Lab 2, Credit 4**

0617-896 Capstone Project in CIM
A project related to CIM, System Integration or electronics packaging research area to be monitored and advised by one faculty or one faculty with an industry representative. This project work may serve as the capstone experience for the MMSI degree. (Completion of required courses in MMSI curriculum) **Credit 4**

0617-897 MS Thesis
Interdisciplinary thesis on CIM, System Integration electronics packaging research area to be monitored and advised by committee of two faculty or one faculty with an industry representative. This thesis work may serve as the capstone course of the MMSI degree. (Defense of thesis requires completion of all required courses.) **Credit 4**

0617-898 Graduate Seminar
Special offering of advanced graduate level topics. These topics are developed and taught on a special offering basis and will vary from year to year. **Credit 1–4**

0617-899 Graduate Independent Study
Faculty directed study of appropriate topics on a tutorial basis. This course is generally used to allow an individual to pursue topics in depth under faculty sponsorship. **Credit 1–4**

0617-999 Manufacturing Grad Co-op
Work experience in manufacturing position appropriate to selected major in graduate program. Position to be obtained through interviewing process with the assistance of Cooperative Education and Career Services Office. **Credit 0**

Computer Engineering Technology

0618-700 Introduction to Digital Electronics
An introductory course in digital electronics intended for K–12 technology teachers based on "Project Lead the Way" curriculum. Emphasis will be placed on both theoretical and practical skills needed to teach high school classes in this field. Laboratory assignments will include the computer simulation of circuits, the wiring of prototype circuits. The lecture will touch on the printed circuit board design and implementation of digital circuits. **Class 4, Lab 4, Credit 6**

Hospitality-Tourism Management

0624-770 Service Leadership Examining and Implementing Change
This is a capstone course that examines various personal and personnel leadership functions as applied to the delivery of service excellence. Current literature is used to explore the interrelationship of various conceptual paradigms. The goal is to enhance individual's understanding and to augment his or her ability to interact in the service environment, and to critically understand strategies founded in continuous learning, change and learning organizations. Concepts discussed include: relationship management, empowerment, team building, corporate culture and opportunity management. **Credit 4**

0624 780 Financial Management for Hospitality-Tourism Firms
Financial performance forecasting at both the individual and multi-unit levels of operation is examined. Emphasis on financing, including operating leverage, short- and long-term financing alternatives and tax considerations within a service organizational context. **Credit 4**

0624-825 Strategy Process of Service Firms
An analysis of the organizational structure, operational procedures, corporate policies, financial growth and related factors of service firms. The course traces the evolution of various companies to reveal individual growth strategies. Service discovery, building service relationships, and understanding service as experiences are necessary skills that will be learned and used. **Credit 4**

0624-826 Tourism Policy Analysis
An analysis of the goals and objectives for tourism development in geographic areas of different size. Topics include employment, income redistribution, cultural impact, labor supply and tourism resource base. Specific policies for touristic regions are compared for effectiveness and overall cost benefits. Local, state, national and international examples are included. **Credit 4**

0624 827 Tech Transfer in Hotel Industry
Survey of computer information systems for planning and control in hospitality and tourism operations. Various software and
Hardware packages are examined in relation to planning and control functions. Credit 4

0624-828 Meeting Planning Development
An examination of the role of professional meeting planners as they function in the corporate, association and educational environments. Both corporate and independent meeting planners will be assessed. Methods of planning and programming for meeting will be surveyed and evaluated. A review of the economic impact of conferencing and support service functions will be undertaken. Negotiation skills are examined. **Credit 4**

0624-846 **Travel Marketing Systems**
Includes the identification of markets, product pricing strategies and mixes of communication as they relate to the tourism distribution system. The efficiencies of various channel configurations and their resultant organizational patterns are evaluated. **Credit 4**

0624-867 **Tourism Planning and Development**
Tourism planning defines the frames of reference used in making choices concerning the development of tourism facilities and use of space. Topics include: tourism income and expenditure; pricing policy; taxing authorities; ownership patterns; financing and leakage potentials of the various tourism infrastructures. This course focuses on the planning and development of tourism as it is "packaged" through its distribution channels. **Credit 4**

0624-890 **Practicum in Hotel Training**
An opportunity for the student to apply skills learned in previous courses in a work or laboratory setting. A proposal must be approved by the director of the program prior to enrolling in the course. **Credit variable 1–4**

0624-896 **Graduate Project**
This course number is used to fulfill the graduate paper requirement under the non-thesis option for the MS degree in hospitality/ tourism management. The candidate must obtain the approval of the director of the program and, if necessary, an appropriate faculty member to supervise the paper before registering for this course. A formal written paper and an oral presentation of the project results are required. **Credit variable 1–4**

0624-898 **Thesis**
Thesis based on experimental evidence obtained by the candidate in an appropriate topic demonstrating the reduction of theory into practice. A formal written thesis and oral defense are required. The candidate must obtain the approval of the director of the program and, if necessary, an appropriate faculty member to guide the thesis before registering for the thesis. **Credit variable 1–6**

0624-899 **Independent Study**
An opportunity for the advanced student to undertake independent investigation in a special area under the guidance of a faculty member. A written proposal is to be forwarded to the sponsoring faculty member and approved by the director of the program prior to registering for this course. The independent study must seek to answer questions outside the scope of regular course work. **Credit variable 1–6**

Service Leadership and Innovation

0625-750 **Elements of Service Management: Systems Approach**
A general systems framework is used to explore the major components of service management using a variety of service sectors—health care, banking, insurance, real estate and hospitality-tourism. The course examines the interactions, interdependencies, and interactivity of service systems—to learn about the synergistic effects of the current changeable markets. In addition to this organizational focus above, the course begins the process of examining the learning organization from a professional and personal focus. Lastly, the course provides insights and practical applications to the evolving e-commerce environment and to lean service principles. **Credit 4**

0625-842 **Customer Relationship Management**
The Customer Relationship Management (CRM) course develops the learners ability to help their organization manage its interactions with its customers across multiple channels, maximize revenue opportunities, build foundations to increase customer satisfaction and drive customer retention and loyalty. **Credit 4**

0625-790 **Intro to Grad Research: Options**
This course is designed to introduce the general nature of applied research and evaluation applicable to service industries and to contemporary trends in the field. The course focuses on the nature,types, procedures and applications of research—specifically those attributes needed to prepare a graduate research proposal: problem definition, review of literature, methodology, analysis of findings and recommendations. A graduate research proposal is required at the completion of the course. **Credit 2**

0625-844 **Breakthrough Thinking: Creativity and Innovation**
Learning to solve problems, create profound decisions, and continuously change our organizations has always been a function of leadership. Today's fast-paced global business environment requires that we utilize equally insightful, aggressive, and distinctly new processes to change. This course examines the global phenomenon and builds in the learner new methods to achieve leadership in an age of change—breakthrough thinking, creativity, and innovation. The learner will become adept at true value innovation in a knowledge/ service economy. **Credit 4**

0625-849 **Service Performance Metrics**
This course examines the various self-assessment processes associated with improving service quality. The seven Malcolm Baldrige National Quality Award categories, the eight President's Award for Quality and Productivity categories (Federal Quality Institute), and the ISO 9000 categories are examined. These guidelines are oriented towards systems and are used to probe relationships that reach across departments and disciplines, with the goal of achieving and maintaining total quality service management. **Credit 4**

0625-895 **SLI Comprehensive Exam**
A written comprehensive exam is one of the non-thesis options available to complete the MS degree. Students will take a written examination and must receive a passing grade of at least 80% to be successful. Students failing the course will receive an incomplete and have one opportunity to retake the exam. Students have access during the quarter they are registered for the exam to self-directed learning resources covering the fundamental theories, foundation principles, and applications of each of the core subjects. Policy details and further information about the comprehensive examination is available from the department of service systems. (GPA of 3.0 or higher; faculty adviser approval) **Credit 4**

0625-896 **Graduate Project**
The course number is used to fulfill the graduate paper requirement under the non-thesis option for the MS degree in Service Leadership and Innovation. The candidate must obtain the approval of the Graduate Coordinator and if necessary, an appropriate faculty member to supervise the paper before registering for this course. A formal written paper and an oral presentation of the project results are required. **Credit variable 1–4**

0625-898 **Research Thesis**
Thesis based on experimental evidence obtained by the candidate in an appropriate topic demonstrating the reduction of theory into practice. The candidate must obtain the approval of the Graduate Coordinator and if necessary, an appropriate faculty member to supervise the paper before registering for this course. A formal written paper and an oral presentation of the project results are required. **Credit variable 1–6**

0625-899 **Independent Study**
An opportunity for the advanced student to undertake independent investigation in a special area under the guidance of a faculty member. A written proposal is to be forwarded to the sponsoring faculty member and approved by the Graduate Coordinator prior to registering for this course. The independent study must seek to answer questions outside the scope of regular course work. **Credit variable 1–6**

Human Resource Development

0626-701 **Business Acumen**
This course provides students with an understanding of how different business types create wealth and helps them build literacy in key business terms and concepts. Students in this course examine different business models, research industry trends, and explore the impact of human resource decisions on business strategy, costs and results. The course is designed for individuals in non-financial roles. It prepares them to collaborate effectively with senior leaders to make sound human capital decisions utilizing economic, financial, and organizational data. **Credit 4**

0626-702 **Leveraging Technology**
Knowledge of HR technology (how to leverage technology for HR practices and use e-HR/ Web-based channels to deliver value to customers) has become an increasingly important competency for HR practitioners. As companies strive to reduce costs, improve performance, align employee development efforts with business strategy, and adapt more quickly to changes in the marketplace, literacy with technology becomes more essential. Students in this course review the effective application of technology to improving HR efficiency. They are given hands on experience with software tools ranging from performance management, assessment, and competency development to electronic job postings and employee self-serve. Students learn to collaborate effectively with IT professional and senior executives to make technology-related decisions. **Credit 4**

0626-703 **Facilitation Skills**
Facilitation skills rank among the most critical competencies for HR practitioners today. HR practitioners are required to facilitate a variety of events from meetings and strategic planning sessions to new employee orientations and conflict mediation discussions. This course provides the HR practitioner with the skills required to effectively plan for and facilitate a variety of events. Individuals in other disciplines will benefit from this course as well. **Credit 4**

0626-704 **Competitive Staffing and Selection**
This course examines how to create a large, diverse and qualified pool of applicants that meet an organization's work force plans and which the organization can quickly tap into should an opening occur. In addition, the course provides a highly effective model for selection to ensure right fit and explores effective strategies to aid engagement and retention of newly hired employees. Students in this course learn to use technology and other tools to improve the quality of hiring and selection process outcomes. They evaluate best practices in staffing and selection and learn to address typical business problems in these areas. **Credit 4**

0626-705 **Competency-Driven Organization**
Without specific employee capabilities, organizations cannot achieve their strategic goals. These capabilities, often referred to as competencies, are the unique mix of skills, knowledge, experience, and personal characteristics necessary to perform effectively today and be prepared for future challenges. By defining those competencies necessary to drive the mission and strategy of an organization, HR practitioners and others can attract and hire the right people, reward the right behaviors, and invest in developing talent where there are competency gaps. Students in this course learn to define organization-wide and job specific-competencies. They apply those competency definitions to a range of employee practices from hiring and selection to performance management and succession planning. They evaluate best practices in competency modeling and application. **Credit 4**

0626-710 **Theories of Organization Development**
This course introduces the student to organization development theories and their application in an organizational setting. Consideration is given to the psychological, sociological, and historical constructs upon which the field is based. Students will be come familiar with the philosophical foundations for the key theories as well as the practical work of key theorists. This course will also examine how theories of organization development are being applied in organizations to foster change, innovation, and the revitalization of the organization. (Completion of at least 24 hours of study including the following four courses: Human Capital Strategies, Business Acumen, Strategic Employee Development, and Human Performance Management Practices plus any two electives) **Credit 4**

0626-720 **Theories of Career Development**
This course introduces students to traditional and emerging career development theory and its application to workplace issues. Theories such as trait and factor, type, developmental, psychodynamic, work adjustment, life span, social learning, and career decision-making are covered using a systems theory approach. Additional topics include organizational and strategic career development, application of theory to modern problems and issues, and contemporary issues in career development. The course is participative and draws heavily on case studies, role-playing, self assessment and groupwork to understand the theory and workplace application issues. **Credit 4**

0626 727 **HR Metrics**
This is an introductory-level survey course on performance measurement in human resource management. The course focuses on identifying the financial impact of human resource programs and practices. We examine concepts, principles, and techniques of measurement used in various areas of human resource management, including absenteeism, employee separation, employee health, wellness, and welfare, work-life programs, employee engagement and job performance, workforce planning, recruitment and selection, training and career development, and employee engagement and productivity. (12 credits of human resource management and/or human resource development course work or permission of the instructor) **Credit 4**

0626-730 **Strategic Employee Development**
This course provides individuals with a framework needed to successfully design learning interventions that drive performance improvements in their organizations. They examine adult learning principles and learning styles as well as best practices in organizational learning, employee development, and alternative delivery strategies. They identify how to link learning initiatives with corporate strategy and gain commitment to those initiatives from senior leaders. **Credit 4**

0626-735 **Human Capital Strategies**
This course examines how to develop a human capital strategy to acquire, retain, and engage the best available talent required for current and future success. It examines tools and techniques for human capital planning, sourcing, retention, and development. Students in this four-credit course examine benchmark practices from all industry types to derive effective strategies for their own organizations. They develop a human capital strategy and complete an integrated set of projects to implement selected components of the strategy. **Credit 4**

0626-755 **Graduate Writing Strategies**
This course in taught in conjunction with Research Methods/Data Analysis. Students will become articulate in a variety of business and research communication methodologies. These methods will include writing a research proposal, a white paper, and a grant proposal. The search of the literature for the research proposal will include an annotated bibliography to support the references used in the research proposal. In addition, students will research the requirements for submission of a professional journal in their field and write a research article which could be submitted for publication in the identified journal. **Credit 4**

0626-782 **Human Performance Management Practices**
This course focuses on Human Performance Management, or the effective use of human resources in order to enhance organizational performance and drive business results. The elements necessary to become a "high performance" organization and the unique role of the HR professional in performance management are important elements of study. Students in the course explore a range of Human Resource Management practices that are drawn from many disciplines including, behavioral psychology, instructional systems design, organizational development, and human resources management. They learn to design and manage a variety of performance management interventions and work collaboratively with managers and employees. **Credit 4**

0626-877 **Internship**
The internship is an opportunity to gain relevant skills for those that have limited work experience. This course consists of two parts: at least 140-200 hours of professional accomplishments in an appropriate setting participation in an online a seminar, and completion of assignments relevant to the on-site internship experience. . Students will work with their advisers to complete all necessary arrangements. Students should plan to meet with their advisers at least two months before planning to take the internship. Proposals for the internship must be approved and on file before registration. **Credit 1–6**

0626-890 **Independent Study**
Provides for independent study or research activity in subject matter areas not included in any existing course in the degree program, but having specialized value to students. Proposals approved by a supervising faculty member and the program chairperson are required prior to registration. This course may be taken more than once, but for no more than a total of six credit hours. **Credit 1–6**

0626-891 **Selected Topics**
Selected Topics are innovative courses not reflected in the curriculum. Titles will appear in the course listing each quarter. The course may be taken more than once as topics change. **Credit 4**

Environmental, Health and Safety Management

0630-710 **Special Topics**
This course permits students to pursue certain advanced undergraduate course work at a graduate level. Examples include contaminant hydrology, wetland delineation and remedial investigation/corrective action. **Credit 1–4**

0630-711 **Occupational Health**
This course is an intensive foundation course that provides students with an overview of the fundamentals of Industrial Hygiene. Emphasis will be placed on a) the toxicological effects of various industrial substances on the body; b) monitoring and personal sampling for these substances and c) personal protection against such substances. (Graduate students who have completed Biology (1004-212 or 1101-201) and Chemistry (1011-208 or 1011-211) or by permission of department. Students who have completed 0630-450 or 0630-610 may not take this course.) **Class 4, Credit 4**

0630-712 **Occupational Safety**
This course is an overview of the safety management tools utilized in today's industry. Students are expected to have a foundational knowledge of safety management techniques upon completion of this course. Topics examined include recordability and safety indices; incident investigation; guarding; electrical and material handling; welding, fire prevention; excavation; medical surveillance and worker's compensation; inspection and techniques and auditing; committees; incentives, and voluntary programs. Students will be required to research a leading edge safety topic. (Open to all graduate students. Students who have completed 0630-454 or 0630-611 may not take this course.) **Class 4, Credit 4**

0630-713 Solid and Hazard Waste Management
This is an intensive foundation course for students who lack academic preparation or practical experience in solid and hazardous waste management. Introduces principles, strategies, technologies and regulations for reducing, recycling, handling, treating, storing and disposing of solid and hazardous waste. (Permission of department. Students who have completed 0630-350 or 0630-620 Solid and Hazardous Waste Management may not take this course.) **Class 4, Credit 4**

0630-714 Industrial Wastewater Management
An intensive foundation course for students who lack academic preparation or practical experience in wastewater management. Identifies and characterizes the sources of industrial wastewater and examines the related environmental impacts, regulatory implications, and technical and cost considerations of treatment and disposal methodologies. (General chemistry (1011-211) or permission of instructor. Open to all graduate students. Students who have completed 0630-352 or 0630-622 may not take this course.) **Class 4, Credit 4**

0630-715 Air Emissions Management
This intensive foundation course will present an overview of industrial air emissions management. The course will teach students how to identify and categorize industrial air pollutants and their sources. Applicable state and federal laws and regulations will be covered. Air emissions reduction strategies will be covered, along with control technologies, testing, monitoring, and reporting requirements. By the end of the course, students will be able develop a comprehensive facility air emissions management plan. Students who have completed 0630-354 or 0630-622 may not take this course. **Class 4, Credit 4**

0630-720 Environmental Health and Safety Management
This course presents an overview of environmental, health and safety management, and provides students with an introduction to management systems for EHS operations. Explores the motivations and strategies for environmental, health and safety management, identifies EHS management components and presents the fundamentals of developing EHS visions and policies. This course includes an on campus executive leader session. **Class 4, Credit 4**

0630-725 EHS Accounting and Finance
Pollution and accidents impose costs-not just remedial costs, but also time, lost opportunities, long term liabilities and even company image. These costs are often overlooked by current accounting practices. This course will train students to make good business decisions when all the EHS costs of economic decision, as well as the economic of EHS decisions, are taken in consideration. The course will focus on decisions made at the company level. Methods will be taught to identify and quantify the full-costs of projects and activities. A more accurate approach towards EHS accounting will result in a safer environment and increased competitiveness. **Class 4, Credit 4**

0630-740 EHS Management System Design
This course examines the design and development of environmental, health and safety management systems to implement an organization's vision, mission and policies. Provides strategies for determining what needs to be measured in order to assess performance and ensure continual improvement. Discusses metrics and EHS management system intervention; significant team project work as well as individual work (0630-720 or permission of instructor.) **Class 4, Credit 4**

0630-750 EHS Project Management
This course focuses on unique factors in environmental, health and safety project management. It covers the nine major areas of project management: integration, scope, time, cost, quality, human resources, communication, risk and procurement. Discusses modern project management techniques, including program evaluation and review techniques (PERT), critical path method (CPM), and various budgeting and resource allocation techniques. Includes an introduction to Microsoft Project for Windows software. Applies project management concepts and software to simulated EHS projects. **Class 4, Credit 4**

0630-755 Research Methods
This course prepares students to plan and conduct research using methodologies commonly employed in the environmental, health and safety management disciplines. Included are: literature reviews; case studies; in-depth interviews; and quasi-experimental design. Students will be instructed in the requirements that must be met in order to comply with the Department of Health and Human Services (DHHS) regulations for the protection of human research subjects. This course will also prepare students to identify common approaches to the use of the works of others, and introduce them to associated resources. Students will learn to use the Chicago Manual of Style formats for citing references. (Open only to EHS Management students) **Class 4, Credit 4**

0630-760 Integrating EHS into Business Management
This course examines strategies for integrating EHS systems and processes into business management. Using case studies, the course explores the interrelationships between EHS and total quality management, reporting, financial value, and approaches for sustainable business development. Students will be prepared to select appropriate quality tools to improve EHS processes; identify opportunities, strategies and tools for integrating EHS into business management; and identify best practices in EHS/business integration. (0630-720 or permission of the instructor) **Class 4**, **Credit 4**

0630-765 Product Stewardship
This course examines the principles of product stewardship. The ethical, legal, liability and economic issues which product manufacturers face will be covered. In addition, students will be exposed to the methods used to identify and manage product environmental, health and safety (EHS) in today's world. The concept of sustainability will be covered and students will learn the principles of product life cycle assessment. Students will also learn and use specific EHS analysis techniques. Case studies will also be reviewed and students will complete a group or individual capstone project. This course is open to all graduate engineering technology, packaging, and environmental, health and safety management students or with permission of the instructor. **Class 4, Credit 4**

0630-770 Environmental Risk Management and Communication
This course presents an overview of risk assessment methodologies and history, along with current practices and developing trends. It takes a close look at strategies for reducing and managing EHS risks, and provides an introduction to the elements of internal and external risk communication. Students will gain skills in evaluating risk assessment and identifying associated strengths and weaknesses with respect to the EHS management needs of their respective organizations. They will be prepared to design and implement risk reduction and management plans for EHS-related activities and be able to identify essential risk-related elements that need to be communicated internally and externally. (0630-720 and course work in occupational health or permission of instructor) **Class 4, Credit 4**

0630-780 Practical EHS Law
This course provides a detailed examination of the EHS legal and regulatory framework, with emphasis on developing compliance strategies. It addresses strategies for advocating and negotiating flexible permits, enforcement matters and other legal requirements. Students will be prepared to discern the intent and applicability of EHS laws and regulations, prepare summary documents incorporating legal concerns and concepts, understand different approaches to negotiations, and work effectively with attorneys to achieve desired objectives. (0630-720 or permission of instructor) **Class 4, Credit 4**

0630-790 EHS Internal Auditing
This course addresses establishing and maintaining EHS auditing systems to examine how environmental, health and safety aspects are being managed relative to voluntary and regulatory standards. Students will be prepared to design, implement and evaluate auditing programs, and will practice auditing skills. (0630-740 and all required foundation courses, or permission of instructor) **Class 4, Credit 4**

0630-799 Independent Study
Students will have the opportunity to pursue relevant environmental, health and safety topics related to their work or professional interests at an advanced level. Students will gain added depth and/or specialized skill in a specific EHS area. **Credit 1–4**

0630-810 Special Topics
This course discusses new and developing EHS topics in selected areas, such as Workers Compensation, environmental economics, incident management, design for the environment, life-cycle assessment, industrial hygiene monitoring and measurement, regulatory strategy and compliance alternatives. **Credit 1–4**

0630-999 Graduate Co-op
Students will have the opportunity to gain appropriate work experience and applied knowledge of the profession working in one or more EHS areas. The graduate committee determines whether enrollment for one or more co-op quarters will be required. **Credit 0**

0630-890 Thesis Planning
In this course EHS Management graduate students will rigorously develop their thesis research ideas, conduct literature reviews, prepare bibliographies, identify and plan methodologies, identify deliverables, prepare schedules, become familiar with report formats and the proper use of literary guides, and gain a clear understanding of the expectations of the faculty and the discipline. Each student will be required to prepare a complete committee approved thesis research proposal as the final requirement of this course. (0630-755 Research Methods) **Credit 4**

0630-891 **Graduate Project**
Graduate projects are an applied research project, reflecting the student's ability to utilize professional skills to design, develop and/or evaluate a project and/or management decision. A formal written paper, and/or a draft article suitable for publication in an appropriate journal and an oral presentation are required. (Permission of adviser) **Credit 1–4**

0630-899 **Graduate Thesis**
The graduate thesis is a formal research document that empirically relates theory with practice. A formal written thesis and oral defense are required.(0630-890) **Credit 1–8**

Facility Management

0632-700 **Principles and Practice in Facility Management**
Presents the overall practical methodology of facility management including organizational, managerial, ethical, and legal principles for the delivery of facility services. Topics discussed include: relationship, between the facility unit and the overall corporate structure; history of FM; regulatory and legal issues; corporate culture; contracts; purchasing and procurement; and management of projects and personnel. **Credit 4**

0632-720 **Environmental Health and Safety Management for Facility Management**
According to the International Facility Management Association the primary goal of facility managers is the management of safe, humane and functional work environments in the context of sound ecological practices. This course will provide students with a solid foundation in environmental, health and safety management which will enhance their ability to develop and implement practices that promote and protect health, safety, security, the quality of work life, the environment and organizational effectiveness pertaining to facilities. Topics examined include: EHS moral, legal and economic issues, EHS related laws and regulations (OSHA, EPA, ADA), principles of accident causation and prevention, EHS management systems, fire protection and life safety codes, emergency preparedness, ergonomics, indoor air quality, mold, solid and hazardous waste, recycling, sustainable design, other environmental related issues, environmental psychology and impacts of facilities on individual, group and organizational performance, comfort and satisfaction. (This course is open to all facilities management graduate students or by permission of department.) **Class 4, Credit 4**

0632-760 **Space Planning in Facility Management**
This course provides the technical and strategic tools for space planning in a facility. Topics such as knowledge of long range planning, organization of sites/structures/interiors, building types, cost estimating techniques, contracts and specifications, construction management and documentation, and relocation management will be covered. **Class 4, Credit 4**

0632-800 **Operation and Maintenance I**
This is a first course in operations and maintenance of facilities and provides a basic understanding of the physical plant. Students will learn about common systems within facilities including HVAC, communications, building's structural components, and exterior elements. **Class 4, Credit 4**

0632-810 **Operation and Maintenance II**
This is the second course in the O&M sequence and involves the activities and functions that support the facility. **Class 4, Credit 4**

0632-830 **Real Estate of Facilities**
Managing Property assets as an investment and profit center is an important aspect of facility management. Emphasis will be placed on: real estate master planning; properly acquisition and disposal; leasing practices and management; real estate marketing and analysis; feasibility analysis; taxation; real estate finance; urban planning and development; site evaluation and selection; occupancy and use constraints; regulations and incentives. **Class 4, Credit 4**

0632-850 **Digital Communication and Analysis Tools in Facility Management**
Information Technology systems are critical to supporting an organization's business. This course will clover the basic logistical requirements for operating and supporting local area networks as well as internet connections, digital security, common application software, and CAD systems. In addition, instruction will be provided on FM software for energy management, project management, asset management, and space planning. **Class 4, Credit 4**

0630-891 **Graduate Project**
Graduate projects are an applied research project, reflecting the student's ability to utilize professional skills to design, develop and/or evaluate a project and/or management decision. A formal written paper, and/or a draft article suitable for publication in an appropriate journal and an oral presentation are required. (Permission of adviser) **Credit 1–4**

Environmental Health and Safety Management

0633-712 **Fire Protection**
This course introduces fundamentals concepts in protection of industrial workers and property from fire and explosion. Fire chemistry, control of ignition sources in industry, and properties of combustible materials are discussed. A major facility review project is completed. Fire detection and extinguishments are covered along with building construction for fire prevention, life safety, fire codes and related topics. (EHS graduate students or engineering technology, industrial engineering graduate students only) **Class 4, Credit 4**

0633-726 **Exposure Assessment and Analysis**
This course focuses on industrial hygiene applications and hands on participation. Particular attention will be given to sampling strategies from similar exposure grouping, actual sampling experiences with a wide range of industrial hygiene instruments, and sampling analysis using statistical protocols. Field experience with instrumentation, as well as professional written and oral communication of results is emphasized. There are several out of classroom learning experiences required (team based). This course also explores environmental health engineering applications including ventilation systems, process safety and inspection/audit protocol skill building for many different types of processes, including: laboratories, machining centers, painting and solvent usage. This course culminates in a one week block of emerging issues in occupational health—the content of which is expected to change **Class 4, Credit 4**

0633-730 **Mechanical and Electrical Controls and Standards**
Discussion of machinery safety with emphasis on hazard analysis, risk estimation, safeguarding techniques and electrical considerations. Particular attention will be paid to applicable OSHA regulations, ANSI, NFPA and EN standards as they relate to wood, metal, films and automation. A portion of the course will change regularly to reflect emerging issues in industry. (EHS graduate students or engineering technology, industrial engineering graduate students only) **Class 4, Credit 4**

Health Systems Administration

0635-712 **Library Research Methods**
This course is to instruct the learner how to conduct research using the tools the RIT library can provide. Fundamentals include use of on-line search engines and databases. (Required for HSA graduate students, available for HSM graduate students) **Credit 1**

0635-715 **Information Systems in Health Administration**
Theory and use of computers and information systems in health care delivery and administration is covered in depth. The information needs of clinical and administrative personnel are examined with an emphasis on developing and evaluating comprehensive information systems for health care organizations. **Credit 4**

0635-714 **Data Analysis**
This course will allow the learner to read and evaluate statistical information presented in evaluation reports used in health care management. (Required for HSA students, available for HSM graduate students) **Credit 2**

0635-716 **Law Policy Senior Retirement Living Options**
Retirement living in the United States has evolved to be a significant industry. Legislation and regulations govern the continuum of care for the independent as well as corporate organizations that provide senior living. The purpose of this course is to review the federal and state regulations governing senior retirement living, discussion of senior living models and the leadership requirements to operate and manage such facilities. **Credit 4**

0635-718 **Writing Research**
In preparation for writing a capstone project this course provides guidelines and practice in producing researched writing for analysis, definition, comparison and/or benchmarking. (Required for HSA Students, available for HSM graduate students) **Credit 1**

0635 723 Lean Sigma Applications in Health Care
This course teaches the principles of Lean-Sigma and the application of its process improvement methodologies (and tools) in a health care environment. The history of lean and key principles of six sigma will be discussed. The merging of these two powerful process improvement methodologies will be examined in the context of health care. The Toyota Production System (TPS) and its key leadership principles will be analyzed. The curriculum examines the current challenges encountered in the healthcare industry and the application of Lean Sigma to improve overall performance specifically in the clinical, administrative and service segments.(Elective for HSA graduate students) **Credit 4**

0635-752 Clinical Information Systems
This course will present an overview of several of the evolving clinical information systems present in the healthcare marketplace. A sampling of computerized systems including those found in the hospital, payer, nursing home, physician office, and other healthcare settings will be explored. Emphasis will be placed on the understanding of the changes involved in transitioning from manual systems to computerized systems in each of the above named areas. In particular, the student will be exposed to a variety of current technologies, which are being deployed in these areas. The benefits of the use of such technology will be analyzed and the requirements for planning and deployment of such systems will also be studied. (Health care information systems 0635-715-90, introductory technology/systems course or relevant experience. Computer systems hardware and software in health care recommended)

0635-753 Health Administration Applications
This course presents an overview of the various types of application used in the health administration arena. Emphasis will be placed on understanding the terminology and functionality of the basic software components that make collect and utilize health care data for administrative support and decision-making as well as insurance, billing and reimbursement. Students will examine the software infrastructure needed to support health care enterprises such as hospitals and smaller health care entities. The goal of this course is to provide students with a sufficient application familiarity so they can make meaningful IT and IT decisions. **Class 4, Credit 4**

0635-754 Ehealth
This course will give students a broad overview of essential concepts in, and applications of, web based technologies in healthcare. EHealth topics covered will include review, discuss and analyze industry trends explore emerging ECare solutions and investigate EHealth ethical guidelines and governmental regulations established to ensure privacy, standardization and health content reputability. **Credit 4**

0635-777 Health Systems Administration Internship
This is a health systems administration internship. Consists of a professional placement in an appropriate health care organization of at least 240 hours. Required for students without health care work experience. Can be taken in place of electives. Students will arrange with their program chair or assigned adviser, negotiate any arrangement necessary for on-site supervision and develop a written proposal. Students will present an oral evaluation of their experiences at the final course seminar. **Variable credit 2–8**

0635-796 Risk Management in Health Systems
This course identifies the risk inherent within health care- institutions, organizations, agencies and for individual providers. The management of risk is explored as part of a strategic response of an organization or individual within health care. Specifically the risk inherent within health care organizations; in communications and sharing of data; in the embracing of new technologies and drug treatment therapies; and the expectations of corporate compliance will be discussed. The role of quality assurance will be reviewed as a strategy to control risk. **Credit 4**

0635-798 Special Topics
Experimental courses are offered under this number. Titles appear in each quarter's course listing. **Credit 1–5**

0635-815 Finance for Operation
This course is an introductory course that examines the responsibilities of the finance function in health care entities and its relations to the operating responsible centers (or departments). Subject matter is broad enough to include both not-for-profit and for profit organizations in the allied health field. While this is a distance learning course, students are invited to participate in the first two on-campus lectures (attendance is optional, and those not attending will receive a videotape of the campus sessions). Topics include terminology and measurement, cost finding and allocation, budgeting and the budgeting process, report, reimbursement, interpretation of financial statements, and facilities and materials management. Students must be matriculated in the health systems masters program or have permission of the department chairperson. **Credit 4**

0635-820 Health Systems Economics and Finance
Investigation of the efficiency, effectiveness and equity of the economics of health care and a conceptual and practical knowledge of health care finance. Reviews sources of funding, the accounting and reporting process, and the influence of third-party payers on the provision of health care through applied exercises. Provides an integrated overview of managerial economics, financial management, and product management for distinct health care organizations composing the overall health care system. (Accounting Concepts for Managers) **Credit 4**

0635-830 Health Systems Planning
A review of the methodology of planning effectively for health care systems. The use of data systems, forecasting, and identifying and analyzing problems is explored, along with the process of strategic planning, setting priorities, developing projects, and allocating resources. Students will prepare actual business plans and applications for new health care programs to regulatory agencies. (Permission of program chair) **Credit 4**

0635-840 Health Systems Policy and Law
An examination of the roles and responsibilities of policy makers on the health care system. Compares and contrasts the regulatory functions of varying levels of government and the political process as it relates to health care systems. Examination of control issues and regulatory dynamics, the legislative process, and regulatory trends in the United States. Assessment of health systems' strategies and responses to regulatory oversight. An overview of legislation as it applies to health facilities and administrative law using case studies. **Credit 4**

0635-881 Health Insurance Reimbursement
An in-depth look at characteristics of successful managed care plans. The course will familiarize the student with all essential elements of managed care, using the tools needed to model and compare various managed care structures. **Credit 4**

0635-882 Bioethics
An overview of what ethics means, the principal ethical theories, and their application to specific bioethical issues. The course will familiarize students with ethics and ethical principles, the role of ethics in professional life, what is bioethics and an appreciation of ethical issues and arguments surrounding contemporary bioethical issues such as death, rationing health care and managed care. **Credit 4**

0635-890 Health Systems Administration Independent Study
Provides for independent study or research activity in subject areas not included in any existing course in the degree program, but having special value to students. Proposals approved by a supervising faculty member and the program chair are required prior to registration. This course may be taken more than once. **Variable credit 4–8**

0635-896 Health Systems Administration Thesis
An independent research project on a specific health system administration topic or problem, developed by the student with input from a faculty thesis adviser. The research must culminate in a formal written thesis and oral defense. Approval by the program chair and a faculty thesis adviser is required for this course. **Variable Credit 4–8**

E. Philip Saunders College of Business

Ashok Rao, Dean
http://saunders.rit.edu/

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Online learning option available

Success in the 21st century business environment requires leadership and management attuned to rapid changes in technology and increasingly vigorous global competition. Astute problem solvers who have gained a systems perspective must be able to convert product development and management challenges into competitive advantages. The E. Philip Saunders College of Business offers a portfolio of comprehensive, vigorous programs of study. Our innovative, multidisciplinary curriculum—embedding an international perspective and current technology throughout—produces graduates able to convert managerial learning into pragmatic business applications.

Admission requirements

The college offering the program makes all decisions on graduate admission. Please refer to each individual program for information regarding specific admission criteria. For general graduate admission information, please refer to the Admission section of this bulletin.

Financial aid and scholarship

Please refer to the Financial Aid and Scholarship section of this bulletin for information regarding financial aid, scholarships, grants, loans, and graduate assistantships.

Faculty

Our faculty members combine teaching excellence, innovative research, and personalized attention to meet student needs. Our setting, in a technological university embarked on creative business partnering and entailing joint programs across colleges, opens unique opportunities for all partners—industry leaders, faculty, and students.

Facilities

RIT is a national leader in incorporating computer technology into the classroom. Saunders College students have access to extensive resources and utilize the same business software used by Fortune 100 companies worldwide. The college's classrooms and study areas all feature wireless access.

Accreditation

The Saunders College is accredited by the Association to Advance Collegiate Schools of Business (AACSB International).

Business Administration–Traditional MBA

http://saunders.rit.edu/graduate/mba_program.php

Program overview

The master of business administration degree provides students with the capabilities for strategic and critical thinking needed for effective leadership in a global economy where creative management of both people and technology is vital. The curriculum begins with a solid grounding in the functional areas of business and combines that foundation with the flexibility that allows students to specialize in one or two areas of expertise. In the classroom, students learn the latest theories and concepts, and how they can be immediately applied to solve problems in the workplace.

The MBA program requires 72 credit hours and consists of 18 courses, nine of which are devoted to core functional areas and nine available in concentration areas and as electives. All courses in the Saunders College carry four credit hours.

Curriculum

All MBA students take the following nine foundation courses:

COURSE		QTR. CR. HRS.
0101-703	Accounting for Decision Makers*	4
0102-735	Strategic Management of Technological Innovation	4
0102-740	Organizational Behavior and Leadership*	4
0103-705	Economics for Managers*	4
0104-721	Financial Analysis for Managers*	4
0105-761	Marketing Concepts*	4
0106-743	Operations and Supply Chain Management*	4
0106-782	Statistical Analysis for Decision Making*	4
0102-759	Competitive Strategy	4

*Up to six of these courses can be waived, thus reducing the number of courses required to graduate.

All full-time students are required to complete Professional Skills Seminar I and II (0102-070, 071). These noncredit courses give students the skills to successfully complete their graduate degree and prepare them to obtain a job or co-op position.

Concentrations

Students have the option of choosing one or two concentration areas. A concentration is a sequence of four courses in a specialized area of business, thus giving students in-depth knowledge in a particular field.

Students with one concentration area will complete:

- Nine foundation courses
- Four courses in a concentration area
- Five electives, outside the selected concentration area (no more than four of these can be taken in any one discipline). Electives must be selected from approved Saunders College graduate courses or from graduate courses outside the Saunders College that are part of an approved MBA concentration.

Students with two concentration areas will complete:

- Nine foundation courses
- Four courses in a concentration area
- Four courses in a second concentration area (in a different discipline)
- One elective, outside the selected concentration areas

Notes:

- Students cannot complete more than two concentration areas.
- No course can be counted in more than one concentration.
- No more than four electives can be completed in any one discipline.
- Students taking two concentration areas must meet with an adviser.
- Finance is a five-course concentration.

Students select a concentration area and choose a four-course sequence in a particular area of specialization. Concentrations are available both through the Saunders College and from departments within RIT's other colleges.

Accounting

Designed for students planning to enter corporate accounting. This concentration is also an excellent complement to a concentration in finance or management information systems.

COURSE		QTR. CR. HRS.
0101-704	Corporate Financial Reporting I	4
0101-705	Corporate Financial Reporting II	4
0101-706	Cost Management	4
Choose one from the following:		
0101-707	Advanced Accounting	4
0101-708	Auditing	4
0101-709	Basic Taxation	4

Digital Marketing

One of the most significant forces to affect marketing since the emergence of mass media, the Internet has introduced a global electronic marketplace that has caused a dramatic shift in standard business practices. This has given rise to an enormous need to understand the implications of these shifts for strategic initiatives in marketing and advertising.

COURSE		QTR. CR. HRS.
0105-772	Internet Marketing: Strategy and Tactics	4
0105-775	Business to Business E-marketing	4
Choose two from the following:		
0105-762	Advanced Marketing Management	4
0105-763	Buyer Behavior	4
0105-767	Advertising and Integrated Marketing Communications	4

Entrepreneurship

The entrepreneurship concentration is designed to enable students to recognize and commercialize attractive business opportunities—either by new independent ventures or by established firms seeking growth or rejuvenation. It involves integrating all

functions of business (strategy, marketing, innovation, finance, accounting, etc.) within one concerted value-creating initiative.

The concentration requires an applied entrepreneurial learning experience that may be satisfied through either the Field Experience in Business Consulting (0102-753) course or an approved commercialization project. These projects may involve students developing their own businesses or working with RIT incubator companies, local startup firms, or RIT multidisciplinary commercialization projects. Students interested in high-technology initiatives are encouraged to enroll in Technology Management (0102-742) as the fourth course in the concentration.

COURSE		QTR. CR. HRS.
0102-720	Entrepreneurship and New Venture Creation	4
0102-753	Field Experience in Business Consulting*	4
0105-776	Product and Brand Management	4
Choose one from the following:†		
0101-709	Basic Taxation	4
0102-742	Technology Management	4
0104-722	Financial Management II	4
0105-763	Buyer Behavior	4
0105-772	Internet Marketing: Strategy and Tactics	4
0110-730	Business Legal Concepts	4

* Or an approved entrepreneurial field experience.
† Or a management course, with approval of graduate adviser.

Environmentally Sustainable Management

With a goal of familiarizing students with environmentally sustainable business practices, this concentration is attractive to students with an overall interest in understanding how firms can manage social and political demands for more environmentally sustainable products and operations. It may be of particular interest to those students in industries with a significant environmental impact such as the automotive, chemical, energy, transportation, or agricultural industries, where environmental issues are central to operational and strategic decision making.

COURSE		QTR. CR. HRS.
0102-710	Managing for Environmental Sustainability	4
0102-745	Social and Political Environment of Business	4
Choose two from the following:		
0102-775	Business Ethics	4
0303-790	Fundamentals of Sustainable Engineering	4
0303-791	Lifecycle Assessment/Costing	4
0521-751	Energy Policy	4
0630-720	Environmental Health and Safety Management*	4
0630-750	EHS Project Management	4
0630-765	Product Stewardship	4
5001-803	Economics of Sustainability	
5001-804	Industrial Ecology	
5001-805	Technology, Policy, and Sustainability	

*Online course. As a part of this class, students are required to attend a four-day executive leader session held on campus at RIT. Contact the instructor for more information on the dates for this session.

Finance

This concentration is designed to provide a foundation of knowledge in finance and allow students to choose courses appropriate for a career in investments or corporate finance. Students interested in investments will acquire advanced skills in securities evaluation and portfolio management. Those interested in corporate finance will acquire advanced skills in budgeting, planning, global financing and operations, and corporate risk management. *Note:* Finance is a five-course concentration.

COURSE		QTR. CR. HRS.
0104-722	Financial Management II	4
0104-725	Securities and Investments Analysis	4
Plus one of the following courses:		
0103-711	Microeconomics	4
0103-712	Macroeconomics	4
Choose two from the following:		
0104-732	Portfolio Management	4
0104-740	Options and Futures	4
0104-742	Financial Modeling and Analysis	4
0104-744	Innovation in Financial Markets and Securities	4
0104-760	Finance in a Global Environment	4

Global Information Technology Management

Successful organizations rely upon information systems to integrate cross-functionally within organizations, to integrate with other business and to integrate directly with customers. The global information technology management concentration prepares students for diverse careers in commercial, government, and not-for-profit organizations where information is key to the organization's success. Within this concentration, students will learn about emerging technological trends, acquire technical skills such as Web systems development and data modeling, and examine managerial issues such as the strategic management of information technology and the global impacts of information technology outsourcing.

COURSE		QTR. CR. HRS.
0112-720	Information Systems Design	4
Choose three from the following:		
0112-715	Information Technology and Globalization	4
0112-725	Data Management	4
0112-740	Managing Information Technology Outsourcing	4
0112-745	Information Systems Development	4
0112-755	Information Technology and Strategy Management	4

International Business

This concentration prepares graduates for today's global business environment. Large, medium, and small enterprises all operate globally: sourcing, producing, researching, and marketing worldwide. Suppliers and competitors are not only across the street, they are all around the globe. To balance the needs of local, regional, and national communities and the benefits attained

from global competition and cooperation requires an understanding of the international dimensions of business. Managers and professionals must be able to think, market, negotiate, and make decisions designed for the diversity, complexity, and dynamism that are the hallmarks of global business.

COURSE		QTR. CR. HRS.
0113-710	Global Business Environments	4
Choose three from the following:		
0104-760	Finance in a Global Environment	4
0113-730	Managing in a Global Business	4
0113-750	Marketing in a Global Environment	4
0113-780	Global Issues and Strategies	4

Management and Leadership

Managers need to combine effective leadership with analytical reasoning. The management and leadership concentration provides students with the leadership skills needed to be successful managers in business, nonprofit, and public organizations. Students will develop the essential analytical and decision-making skills for today's rapidly changing world. They will learn why change is difficult, when to initiate change, and how to introduce and manage change in the workplace. These courses also will prepare students for the demands of managing people and projects.

COURSE		QTR. CR. HRS.
0102-741	Managing Organizational Change	4
Choose three from the following:		
0102-720	Entrepreneurship and New Venture Creation	4
0102-742	Technology Management	4
0102-745	Social and Political Environment of Business	4
0102-750	Human Resource Management	4
0102-756	Power and Influence	4
0102-758	Seminar in Management	4
0102-763	Behavioral Skills for Managers and Professionals	4
0102-775	Business Ethics	4
0110-745	Legal and Ethical Issues in Technology Intensive Environments	4

Managing Service Systems

Services are playing an increasing role in many economies and information technology is a critical element in supporting, managing and innovating services. The managing service systems concentration provides students with interdisciplinary perspectives on the concepts of service delivery and management, and the role of information technology in the design, management, delivery, and evaluation of services required to improve and innovate in service-focused organizations. The concentration prepares students for diverse careers in IT-intensive service organizations and industries, such as health care, information technology, and financial services. Students taking this concentration are encouraged to focus on a specific industry, such as the health care industry, the information technology industry, or the financial services industry.

COURSE		QTR. CR. HRS.
0112-711	Managing Service Systems	4
0112-712	Service-Oriented Information Systems	4
Choose two from the following:		
0112-725	Data Management	4
0112-755	Information Technology Strategy and Management	4
0112-760	Integrated Business Systems	4
0112-761	Business Process Analysis and Workflow Design	4

Marketing

The overall process of entering markets, creating value for customers, and developing profit for the firm are the fundamental challenges for today's marketing manager. Effective marketing must consider the target audience, along with the changing business environment and competitive pressures of technological and global challenges. These marketing basics apply to governmental agencies, not-for-profit organizations, and profit-making firms.

COURSE		QTR. CR. HRS.
0105-762	Advanced Marketing Management	4
Choose three from the following:		
0105-758	Seminar in Marketing*	4
0105-763	Buyer Behavior	4
0105-765	Professional Sales Management	4
0105-767	Advertising and Integrated Marketing Communications	4
0105-771	Marketing Research Methods	4
0105-772	Internet Marketing: Strategy and Tactics	4
0105-773	Database Marketing	4
0105-776	Product and Brand Management	
0105-778	Commercialization and Marketing of New Products	4
0113-750	Marketing in a Global Environment	4

*Topics may vary.

Marketing Research

How do you identify your customers' needs and wants, and respond with the most profitable product or service? Marketing research analysts take a leading role in identifying and defining marketing problems. Relying on communication as well as analytical and conceptual skills, a market researcher can evaluate the market, generate product ideas, refine the delivery process, monitor marketing performance, and improve the company's profitability. Increasing numbers of specialized research firms add more opportunities to the traditional marketing profession.

COURSE		QTR. CR. HRS.
0307-717	Design/Analysis of Experiments I	4*
Choose one from the following:		
0105-770	Business Research Methods	4
0105-771	Marketing Research Methods	4
Choose two from the following:		
0105-762	Advanced Marketing Management	4
0105-772	Internet Market Strategy and Tactics	4
0307-818	Design/Analysis of Experiments II*	4

COURSE		QTR. CR. HRS.
0307-831	Multivariate Analysis Applications*	4
0307-841	Regression Analysis*	4

* Student must register for the four credit hour option of these courses.

Operations Management

This concentration is designed to enhance the student's understanding of manufacturing and service functions as they exist in modern business. In addition to key courses covering project management, quality control, and improvement and manufacturing strategy, an extensive set of electives allow students the ability to broaden their knowledge base.

COURSE		QTR. CR. HRS.
0106-744	Project Management	4
0106-745	Quality Control and Improvement	4
Choose two from the following:		
0102-741	Managing Organizational Change	4
0102-742	Technology Management	4
0307-721	Statistical Process Control*	4
0307-731	Statistical Acceptance Control*	4
0307-781	Quality Management*	4
0307-782	Quality Engineering*	4

* Student must register for the four credit hour option of these courses.

Product Commercialization

This concentration is targeted to students who are interested in developing expertise in managing the marketing-related activities required to move new products and services through the prelaunch business stages to a successful launch. The commercialization of new corporate offerings is increasingly important as product life cycles get shorter.

COURSE		QTR. CR. HRS.
0105-776	Product and Brand Management	4
0105-778	Commercializing and Marketing of New Products	4
Choose one from the following:		
0102-770	Business Research Method	4
0105-771	Marketing Research Methods	4
Choose two from the following:		
0102-762	Managing New Process and Product Development	4
0105-762	Advanced Marketing Management	4
0105-763	Buyer Behavior	4
0105-767	Advertising and Integrated Marketing Communications	4
0106-744	Project Management	4
0113-750	Marketing in a Global Environment	4

Quality and Applied Statistics

This concentration is for those students who would like to study the technical aspect of managing quality, i.e., statistical quality control. Students will gain an understanding of the basics of statistical process control, quality improvement, acceptance sampling, and off-line quality control techniques such as the design of experiments.

COURSE		QTR. CR. HRS.
Choose four of the following:		
0106-745	Quality Control and Improvement	4
0307-721	Statistical Process Control*	4
0307-731	Statistical Acceptance Control*	4
0307-782	Quality Engineering*	4
0307-801	Design of Experiments I*	4
0307-802	Design of Experiments II*	4

*Student must register for the four credit hour option of these courses.

Quality and Organizational Improvement

This concentration is designed for students who would like to learn more about the organizational and managerial (i.e., "soft") aspects of quality. The courses offered help students lead organizational change and manage quality improvement projects.

COURSE		QTR. CR. HRS.
0102-741	Managing Organizational Change	4
0106-745	Quality Control and Improvement	4
Choose one from the following:		
0102-770	Business Research Methods†	
0105-771	Marketing Research Methods†	4
Choose one from the following:		
0106-744	Project Management	4
0307-721	Statistical Process Control*	4
0307-731	Statistical Acceptance Control*	4
0307-782	Quality Engineering*	4
0625-841	Benchmarking and the Process of Continuous Improvement	4

*Student must register for the four credit hour option of these courses.
†Students may choose either Marketing Research Methods (0105-771) or Business Research Methods (0102-770), but not both.

Technology Management

In a constantly changing environment, the ability of an organization to innovate and renew itself is critical if it is to survive and prosper. Technology managers, who typically are responsible for the innovation and application of new technology, are central to the long-term strategy and success of their companies. To manage these processes well, managers need to understand both business and technological perspectives. Co-op or internship experience in high-technology settings may be helpful to students pursuing a specialty in technology management.

COURSE		QTR. CR. HRS.
0102-742	Technology Management	4
Choose one or both of the following†:		
0102-761	Managing Research and Innovation	4
0102-762	Managing New Process and Product Development	4
Choose one or two courses from the following:		
0102-741	Managing Organizational Change	4
0105-776	Product and Brand Management	4
0106-744	Project Management	4
0110-745	Legal and Ethical Issues in Technology Intensive Environments	4

†If students choose both Managing Research Innovation (0102-761) and Managing New Process and Product Development (0102-762), students are required to take only one additional course.

Additional Concentrations

In addition to the business-related concentrations, several additional concentrations are available to MBA students from outside the Saunders College. Customized concentrations are also available and require the approval of a graduate adviser. To register for courses in the following concentrations, students must see a graduate adviser.

Communication and Media Technologies

Communication, and the technologies for message creation and dissemination, is at the center of dramatic economic, social, and cultural changes occurring as a result of technological development and global connectedness. This concentration, offered by the College of Liberal Arts, prepares students for careers as communication experts in commerce, industry, education, entertainment, government, and the not-for-profit sector.

Health Systems Administration

This concentration is specifically designed for those students who are employed in the health care environment. Offered by the College of Applied Science and Technology, courses introduce up-to-date, industry-relevant content that is continually developed in response to the changing health care environment. All courses in this concentration are offered online.

Human Resource Management

The field of human resource development has grown in both size and importance over the past decade, leading to a high demand for educated and skilled human resource professionals. This concentration, offered by the College of Applied Science and Technology, provides education in training, human resource management, and career and organizational development.

Industrial and Systems Engineering Management

Organizations need individuals who possess a blend of technical and business skills, as well as the integrated systems perspective needed to commercialize complex products and services. This concentration, offered by the Kate Gleason College of Engineering, may be significantly interdisciplinary.

Information Technology

Corporations are aware of the cost savings and performance improvement possible when information technology is applied in a systematic manner, improving organizational information flow, employee learning, and business performance. Information technology includes a mixture of computers and multipurpose devices, information media, and communication technology. Students may choose from the following areas of specialization: Web programming/multimedia, software project management, programming, and telecommunications. This concentration is offered by the B. Thomas Golisano College of Computing and Information Sciences.

Print Media

Leadership and management in the print media industry require an understanding of the cutting-edge technology and emerging markets to articulate a corporate vision that encompasses new opportunities and directions. This concentration, offered by the College of Imaging Arts and Sciences, is designed to provide a solid technical background in cross-media digital workflow processes and a keen understanding of the issues and trends in the print media industry.

Public Policy

Formulating public policy and understanding its impact are critical, whether you work in government, not-for-profit, or the private sector. This concentration, offered by the College of Liberal Arts, gives students the skills to effectively formulate public policy and evaluate its impact, particularly as related to science and technology issues. The courses focus on policy formation, implementation, and analysis.

Admission requirements

To be considered for admission to the MBA program, candidates must fulfill the following requirements:

- Hold a baccalaureate degree from an accredited institution,
- Have a working knowledge of algebra and statistics,
- Submit official transcripts (in English) of all previously completed undergraduate and graduate course work,
- Submit scores from the Graduate Management Admission Test (GMAT) or Graduate Record Exam (GRE) (GMAT preferred for international applicants and those applying for scholarships),
- Submit a personal statement,
- Submit a current resume, and
- Complete a graduate application.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language (TOEFL). Minimum scores of 580 (paper-based), 237 (computer-based), or 92 (Internet-based) are required. Scores from the International English Testing Language System (IELTS) are accepted in place of the TOEFL exam. The minimum acceptable score is 7.0. The TOEFL or IELTS requirement is waived for native speakers of English and for those submitting transcripts and diplomas from accredited American institutions. For additional information on the IELTS, visit www.ielts.org.

Applications are accepted for all four academic quarters. Most full-time students begin their program of study in the fall. Students may complete their studies on a full or part-time basis.

Completed applications for admission should be on file in the Office of Graduate Enrollment Services at least four weeks prior to registration for the next academic quarter for students from the United States, and up to 10 weeks prior for international students applying for student visas.

Additional information

Nonmatriculated status

Students with strong undergraduate records are permitted to take two graduate courses on a nonmatriculated basis. To become a

matriculated student and admitted formally to the MBA program, the regular admissions process should be followed. Graduate credits earned as a nonmatriculated student may be applied to the student's degree program.

Academic standards
Graduate students must maintain a grade of B (3.0) or better for all courses. Grades of all repeated MBA courses will be counted in the GPA computation. The policy on probation and suspension is explained in the Registration and Degree Requirements section of this bulletin.

Maximum time limit
University policy requires that graduate programs be completed within seven years of the student's initial registration for courses in the program.

Orientation
All new students are required to attend an orientation session prior to beginning their studies. Course selection, career planning, program planning, and academic advising are discussed during orientation.

Waiver policy/transfer credit
The MBA normally requires 72 credit hours, however, students may be able to waive up to six MBA foundation courses. Prior academic preparation must be from an institution accredited by AACSB International and the course work must be equivalent to MBA foundation courses. Prior course work must be completed within the last five years, with a grade of B (3.0) or better. Foundation courses may be waived either outright or through an examination.

A maximum of 12 credit hours may be awarded as transfer credit from other graduate programs. The courses must be relevant to the MBA program, taken within the last five years at an institution accredited by AACSB International, and the student must have earned a grade of B or better.

Credits for waiver, transfer, or undergraduate courses are not counted in the GPA computation. Students must apply for transfer/waiver credit.

Placement
Preparation for professional placement begins early in the student's program with the completion of Professional Skills Seminar II (0102-071). The Office of Cooperative Education and Career Services offers individualized career counseling, provides critical job leads, coordinates employers' annual campus recruiting visits, maintains an extensive online job listing, and sponsors two career fairs annually.

Cooperative education
Cooperative education in the MBA program is optional. Co-op experience affords students the opportunity to obtain a paid position for three to six months and gain valuable work experience. Academic credit is not granted, but formal recording of the co-op experience is made on the student's transcript. Students in good academic standing are eligible for co-op after completing the foundation courses, Professional Skills Seminar I and II (0102-070, 071), and a substantial portion of their concentration courses. They also must attend a series of co-op and career services workshops. RIT does not guarantee co-op placements.

Deferment
Accepted students can defer enrollment for up to one year. After one year, a new application must be submitted and will be re-evaluated based on the most current admission standards.

Business Administration–Executive MBA

http://saunders.rit.edu/executive/index.php

Donald O. Wilson, Director of EMBA Program
(585) 475-6798, dwilson@saunders.rit.edu

Program overview

The executive MBA is an integrated, 15-month, five-quarter, cohort-based program designed to develop future leaders and general managers in organizations serious about improving customer satisfaction, product quality, and organizational success.

A team of faculty and executives from all sectors of business and industry designed the program for professionals with substantial career experience. Through the use of practical approaches to improving business results and increasing personal productivity, participants in the program will:

- strengthen their leadership and interactive skills by collaborating with teams of professional peers and faculty;
- develop strategic perspectives consistent with the needs of customers, stockholders, employees, the community, and other organizational stakeholders;
- apply cross-functional approaches to enhance their analytical and decision-making capabilities; and
- obtain a solid foundation in the functional areas of business.

Students must have a minimum of six years of professional work experience. Courses are conducted all day Friday and Saturday on alternating weekends. Participants work in teams, studying a curriculum that focuses on developing general management skills with a strategic focus. The program is structured in an interactive fashion, with an emphasis on cross-functional integration.

Curriculum

The program consists of six weekends per quarter, for a total of 30 weekends over a 15 month period, two one-week on-campus sessions, and a one-week international study trip.

The first two quarters of the curriculum focus on core business concepts, providing fundamental skills, knowledge, and perspectives in accounting, statistics, leadership, finance, and economics. The remaining three quarters of the program extend that foundation and develop cross-functional analysis skills, with an emphasis on strategy, marketing, technology, and international business. Interdisciplinary examples, case analyses, and an applied orientation are key components of the program.

The program also includes practical experience obtained through capstone consulting projects; ongoing support for career-oriented

skills such as career development planning, communications, and team building; the application of a cross-functional business simulation model; and a week-long international business trip.

Typical course schedule

Mid-August

0102-806	Team Building and Business Ethics (one week)

Quarter One, Fall

0101-801	Accounting and Organizational Goals
0101-802	Managerial Accounting
0102-800	Leadership Development Skills I
0102-810	Leadership
0106-810	Statistical Analysis for Managers

Quarter Two, Winter

0102-862	Power and Influence
0103-840	Microeconomics
0104-845	Valuation and Capital Budgeting
0104-846	Financial Planning and Analysis

Quarter Three, Spring

0102-818	Strategic Thinking I
0102-819	Strategic Thinking II
0103-841	Macroeconomics
0105-851	Marketing Strategy

Late May

0102-801	Leadership Development Skills II
0106-875	Business Simulation: Consulting Skills (one week)

Quarter Four, Summer

0102-861	Managing Technology, Innovation and Research
0102-889	Capstone Consulting Project I
0106-864	Systems Support for Operations
0105-865	Managing New Product Commercialization

Quarter Five, Fall

0113-820	International Business
0113-825	International Seminar
0102-860	Executive Leadership
0102-890	Capstone Consulting Project II
0104-850	International Finance

Late Fall

0102-802	Leadership Development Skills III

Admission requirements

To be considered for admission to the executive MBA program, candidates must fulfill the following requirements:

- Have a minimum of six years of professional work experience,
- Hold a baccalaureate degree from an accredited program,
- Submit transcipts (in English) of all previously completed undergraduate and graduate course work,
- Participate in an interview with a representative of the executive MBA team, and
- Complete a graduate application.
- International applicants, whose native language is not English, must submit the scores from the Test of English as a Foreign Language (TOEFL).

Additional information

Sponsorship

Employer sponsorship includes several dimensions. The sponsor must permit the candidate to attend scheduled Friday/Saturday classes, two required one-week sessions, and one required one-week international study trip. The weeklong sessions will occur in the summer and spring, and the one-week international study trip will occur in the student's final quarter. Business owners or individuals may sponsor themselves.

Business Administration–Online Executive MBA

http://embaonline.rit.edu

Kristi Dempski, Graduate Program Director
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Marty Lawlor, Director of Online EMBA Program
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Program overview

The rigorous online executive MBA program covers the same topics as the on campus program. The online EMBA is a challenging and demanding degree program designed to accelerate the careers of mature, high-performance professionals with significant business experience, unlike traditional MBA programs which are geared primarily toward a less experienced audience.

The program is ideal for creative, innovative individuals who have gained their experience in the workforce and not just the classroom. Participants in this program have established careers and are looking for proven and effective methods and strategies to propel them even further up the career ladder. Online EMBA students master executive skills such as strategic and cross–functional thinking and leadership. They learn not only from their knowledgeable and professional instructors but also from their successful, motivated, diverse peer group as well.

The online executive MBA encourages students to think outside the box and places a strong emphasis on group networking. Students will leave the program with a strong network of influential peers.

Curriculum

Typical curriculum based on a student beginning in the fall quarter:

Mid-August

0102-806	Team Building and Business Ethics (one week)

Quarter One, Fall

0101-801	Accounting and Organizational Goals
0101-802	Managerial Accounting
0102-800	Leadership Development Skills I

0102-810	Leadership
0106-810	Statistical Analysis for Managers

Quarter Two, Winter

0102-862	Power and Influence
0103-840	Microeconomics
0104-845	Valuation and Capital Budgeting
0104-846	Financial Planning and Analysis

Quarter Three, Spring

0102-818	Strategic Thinking I
0102-819	Strategic Thinking II
0106-864	System Support for Operations
0105-851	Marketing Strategy

Late May

0102-801	Leadership Development Skills II
0106-875	Business Simulation: Consulting Skills (one week)

Quarter Four, Summer

0102-861	Managing Technology, Innovation and Research
0102-889	Capstone Consulting Project I
0103-841	Macroeconomics
0105-865	Managing New Product Commercialization

Quarter Five, Fall

0113-820	International Business
0113-825	International Seminar
0102-860	Executive Leadership
0102-890	Capstone Consulting Project II
0104-850	International Finance

Late Fall

0102-802	Leadership Development Skills III

Admission requirements

To be considered for admission to the online executive MBA program, candidates must fulfill the following requirements:

- Have a minimum of six years of professional work experience,
- Hold a baccalaureate degree from an accredited program,
- Submit transcipts (in English) of all previously completed undergraduate and graduate course work,
- Participate in an interview with a representative of the executive MBA team, and
- Complete a graduate application.
- International applicants, whose native language is not English, must submit the scores from the Test of English as a Foreign Language (TOEFL).

Accounting, MBA

http://saunders.rit.edu/graduate/mba_accounting.php

Program overview

In addition to the educational preparation for a career leading to top management, the master of business administration—accounting program fulfills the education requirements that allow students to sit for the New York State Certified Public Accountancy exam. The program also stresses the skills necessary for the design, operation, and control of accounting information systems.

Curriculum

The program requires students to complete foundation courses, accounting courses, and business courses. The program offers two tracks, one for students with an undergraduate degree in accounting and one for students who have an undergraduate degree in a field other than business or accounting.

Track 1: For students with an undergraduate degree in accounting

Students with an undergraduate degree in accounting may be able to complete the program with as few as 12 graduate courses totaling 48 credit hours. Full-time students starting in the fall quarter may be able to complete the degree in three quarters. With some required courses only offered once a year, additional completion time may be required for full-time students entering in other quarters. The program also is available on a part-time basis for practicing professionals. Typical course work for students with an undergraduate degree in accounting is as follows:

Foundation courses:

0102-740	Organizational Behavior and Leadership
0102-759	Competitive Strategy
0105-761	Marketing Concepts

Accounting courses:

0101-707	Advanced Accounting*
0101-722	Advanced Cost Management
0101-738	Information Systems Auditing and Assurances Services
0101-795	Financial Accounting Theory and Research

Business courses:

0110-731	Commercial Law*
0112-725	Data Management
or	
0112-745	Information Systems Development
0112-760	Integrated Business Systems
or	
0101-737	Accounting and Enterprise Information Systems
	Two non-accounting professional electives

*Students taking these courses as part of their undergraduate program may substitute electives or other courses to fulfill the education requirements for the CPA exam.

Track 2: For students without undergraduate business course work

For students without undergraduate business course work, but with an undergraduate degree meeting CPA liberal arts and science requirements, the program consists of 27 courses that may be completed in seven quarters (two academic years) of full-time study. Because of the length of required prerequisite courses, seven-quarter completion for full-time students is based on fall quarter entry. Variations will likely extend the time needed to

complete the program. Typical course work for a student without undergraduate business course work is as follows:

Foundation courses:

0101-703	Accounting for Decision Makers
0102-735	Strategic Management of Technological Innovation
0102-740	Organizational Behavior and Leadership
0102-759	Competitive Strategy
0103-705	Economics for Managers
0104-721	Financial Analysis for Managers
0105-761	Marketing Concepts
0106-743	Operations and Supply Chain Management
0106-782	Statistical Analysis for Decision Making

Accounting courses:

0101-704	Corporate Financial Reporting I
0101-705	Corporate Financial Reporting II
0101-706	Cost Management
0101-707	Advanced Accounting
0101-708	Auditing
0101-709	Basic Taxation
0101-710	Advanced Taxation
0101-722	Advanced Cost Management
0101-738	Information Systems Auditing and Assurances Services
0101-795	Financial Accounting Theory and Research
0101-745	Accounting Information Systems
	Accounting elective

Business courses:

0110-730	Business Legal Concepts
0110-731	Commercial Law
	Finance elective
	Two non-accounting professional electives
Choose one of the following:	
0112-760	Integrated Business Systems
0101-737	Accounting and Enterprise Systems

Admission requirements

To be considered for admission to the MBA—accounting program, candidates must fulfill the following requirements:

- Hold a baccalaureate degree from an accredited institution,
- Have working knowledge of algebra and statistics,
- Submit official transcripts (in English) of all previously completed undergraduate and graduate course work,
- Submit scores from the Graduate Management Admission Test (GMAT) or Graduate Record Exam (GRE) (GMAT preferred for international applicants and those applying for scholarships),
- Submit a personal statement,
- Submit a current resume, and
- Complete a graduate application.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language (TOEFL). Minimum scores of 580 (paper-based), 237 (computer-based), or 92 (Internet-based) are required. Scores from the International English Testing Language System (IELTS) will be accepted in place of the TOEFL exam. The minimum acceptable score is 7.0. The TOEFL or IELTS requirement is waived for native speakers of English and for those submitting transcripts and diplomas from American institutions. For additional information on the IELTS, visit www.ielts.org.

Accepted students can defer enrollment for up to one year. After one year, a new application must be submitted and will be re-evaluated based on the most current admission standards.

Completed applications for admission should be on file in the Office of Graduate Enrollment Services at least four weeks prior to registration for the next academic quarter for students from the United States, and up to 10 weeks prior for international students applying for student visas.

Finance, MS

http://saunders.rit.edu/graduate/ms_finance.php

Program overview

The master of science degree in finance is designed to prepare students for managerial careers in corporate finance, investment analysis and portfolio management, financial consulting, and financial institutions. The courses will prepare students to sit for the Certified Financial Analyst exam. To complete the program in one year, full-time students must begin their studies in the fall quarter.

Curriculum

The program consists of 12 courses and a comprehensive exam. The candidate must successfully complete a comprehensive field exam based on the required finance courses completed.

0101-703	Accounting for Decision Makers
0103-705	Economics for Managers
0104-721	Financial Analysis for Managers
0104-722	Financial Management II
0104-725	Securities and Investment Analysis
0104-740	Options and Futures
0104-742	Financial Modeling and Analysis
0104-760	Finance for Global Business
0106-782	Statistical Analysis for Decision Making
	One finance elective
	Two free electives

Admission requirements

To be considered for admission to the MS program in finance, candidates must fulfill the following requirements:

- Hold a baccalaureate degree from an accredited institution,
- Submit transcripts (in English) of all previously completed undergraduate and graduate course work,
- Submit scores from the Graduate Management Admission Test (GMAT) or Graduate Record Exam (GRE) (GMAT preferred for international applicants and those applying for scholarships),

- Submit a personal statement,
- Submit a current resume, and
- Complete an application for graduate study.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language (TOEFL). Minimum scores of 580 (paper-based), 237 (computer-based), or 92 (Internet-based) are required. Scores from the International English Testing Language System (IELTS) are accepted in place of the TOEFL exam. The minimum acceptable score is 7.0. The TOEFL or IELTS requirement is waived for native speakers of English and for those submitting transcripts and diplomas from accredited American institutions. For additional information on the IELTS, visit www.ielts.org.

Completed applications for admission should be on file in the Office of Graduate Enrollment Services at least four weeks prior to registration for the next academic quarter for students from the United States, and up to 10 weeks prior for international students applying for student visas.

Additional information

Deferment

Accepted students may defer enrollment for up to one year. After one year, a new application must be submitted and will be re-evaluated based on the most current admission standards.

Innovation Management, MS

http://saunders.rit.edu/graduate/ms_innovation_management.php

Program overview

The master of science degree in innovation management supports the development of technology workers as they move into leadership roles in the high-technology domains in the world economy. Graduates of the program will have a unique combination of technical and business expertise and will be able to communicate at all levels of an organization. The program is designed to be interdisciplinary, including courses from a number of academic departments and colleges. The degree is offered by the Saunders College in collaboration with the B. Thomas Golisano College of Computer and Information Sciences and the College of Science.

Curriculum

The program requires students to complete 46-48 credit hours consisting of:

- six required business core courses designed to increase a student's knowledge of accounting, organizational behavior and leadership, technology management, entrepreneurship, marketing, and product commercialization.
- Two innovation courses that allow students to pursue organizational, research, product, or project management expertise.
- One two-course sequence from a technology specialization area.
- A capstone experience, which serves as an opportunity for students to integrate their business and technology expertise through a full-quarter applied project or research paper.

Required business courses (32 credit hours):

0101-703	Accounting for Decision Makers
0102-720	Entrepreneurship and New Venture Creation
0102-740	Organization Behavior and Leadership
0102-742	Technology Management
0105-761	Marketing Concepts
0105-778	Commercialization and Marketing of New Products
0102-794	Innovation Management Capstone Preparatory
0102-795	Innovation Management Capstone

Innovation courses (8 credit hours):

Choose two from the following:	
0102-741	Managing Organizational Change
0102-761	Managing Research and Innovation
0105-776	Product and Brand Management
0106-744	Project Management

Technology specialization area (6-8 credit hours):
Two graduate courses directly related to a previously approved capstone project. These courses may be from other RIT colleges.

Admission requirements

To be considered for admission to the MS program in innovation management, candidates must fulfill the following requirements:

- Hold a baccalaureate degree from an accredited institution,
- Submit transcripts (in English) from all previously completed undergraduate and graduate course work,
- Submit the results of the Graduate Management Admission Test (GMAT) or Graduate Record Exam (GRE) (GMAT preferred),
- Submit a personal statement,
- Submit a current resume,
- Submit a capstone project proposal (see below), and
- Complete an application for graduate study.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language. Minimum scores of 580 (paper-based), 237 (computer-based), or 92 (Internet-based) are required. Scores from the International English Language Testing System (IELTS) will be accepted in place of the TOEFL exam. The minimum acceptable score is 7.0. The TOEFL or IELTS requirement is waived for native speakers of English and for those submitting transcripts and diplomas from American institutions. For additional information on the IELTS, visit www.ielts.org.

Completed applications for admission should be on file in the Office of Graduate Enrollment Services at least four weeks prior to registration for the next academic quarter for students from the United States, and up to 10 weeks prior for international students applying for student visas.

Accepted students can defer enrollment for up to one year. After one year, a new application must be submitted and will be re-evaluated based on the most current admission standards.

Capstone project proposal

Candidates for admission must also submit a 1-2 page proposal outlining a proposed capstone project. The proposal should cover the following:

- Identify and explain a proposed capstone project.
- Explain the innovation used in the project along with the qualifications of the applicant to manage the innovation.
- If the candidate partners with a company, explain the company and the individuals who will work on/support the project. Candidates should provide a letter of support from the company contact on official letterhead.
- If the project requires a team, identify team members and their qualifications.

Management, MS

http://saunders.rit.edu/graduate/ms_management.php

Program overview

The master of science in management is a specialized program designed to provide students with the knowledge and problem-solving skills needed to function effectively in a variety of management positions in complex organizations that are impacted by technological change and globalization. Students choose between two tracks of study: global management or technology management. After taking several courses in research tools, the program culminates with a two-course thesis or practicum. In place of a thesis or practicum, the candidate may successfully pass a comprehensive exam based on the courses in the track completed by the student.

Full-time students must begin the program in the fall quarter in order to complete the program in 12 months. Part-time students may enter the program in any quarter.

Curriculum

The program consists of 12 courses, which includes a thesis, practicum, or comprehensive exam.

Global management track

Required courses:

0113-710	Global Business Environments
0113-780	Global Issues and Strategy

Choose two of the following:

0104-760	Finance in a Global Environment
0113-730	Managing in a Global Environment
0113-750	Marketing in a Global Environment

Two courses in research tools

Four breadth-of-field courses*

Two courses in a thesis or practicum**

Technology management track

Required courses:

0102-742	Technology Management
0102-762	Managing New Process and Product Development

Choose two from the following:

0102-741	Managing Organizational Change
0102-761	Managing Research and Innovation
0105-776	Product and Brand Management
0106-744	Project Management
0113-710	Global Business Environments

Two courses in research tools

Four breadth-of-field courses*

Three additional management courses*

Two courses in a thesis or practicum**

*See graduate adviser before choosing these courses.
**In place of a thesis, the candidate may successfully complete a comprehensive field examination.

Admission requirements

To be considered for admission to the MS program in management, candidates must fulfill the following requirements:

- Hold a baccalaureate degree from an accredited institution,
- Submit transcripts (in English) of all previously completed undergraduate and graduate course work,
- Submit the results of the Graduate Management Admission Test (GMAT) or Graduate Record Exam (GRE) (GMAT preferred),
- Submit a personal statement,
- Submit a current resume, and
- Complete an application for graduate study.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language. Minimum scores of 580 (paper-based), 237 (computer-based), or 92 (Internet-based) are required. Scores from the International English Language Testing System (IELTS) will be accepted in place of the TOEFL exam. The minimum acceptable score is 7.0. The TOEFL or IELTS requirement is waived for native speakers of English and for those submitting transcripts and diplomas from American institutions. For additional information on the IELTS, visit www.ielts.org.

Completed applications for admission should be on file in the Office of Graduate Enrollment Services at least four weeks prior to registration for the next academic quarter for students from the United States, and up to 10 weeks prior for international students applying for student visas.

Additional information

Deferment

Accepted students may defer enrollment for up to one year. After one year, a new application must be submitted and will be re-evaluated based on the most current admission standards.

**See graduate adviser before choosing courses*

Graduate Faculty

Ashok Rao, BTech, Indian Institute of Technology; MS, Ph.D., University of Iowa—Dean

Donald O. Wilson, BS, Oklahoma State University; MS, MPA, University of Southern California; Ph.D., University of California at Irvine—Associate Dean for Teaching and Curriculum; Director, EMBA Program; Assistant Professor

Jerry H. Curnutt, AB, William Jewell College; MS, Ph.D., University of Illinois—Assistant Dean for Administration; Minors Adviser

Accounting

Mithu Dey, BBA, Howard University; MBA, Ph.D., George Washington University; CPA, Maryland—Assistant Professor

William H. Dresnack, BS, Long Island University; MS, Binghamton University; JD, University of Buffalo—Professor

William T. Evans, BS, Rensselaer Polytechnic Institute; MBA, University of Rochester—Senior Lecturer

Roberta L. Klein, BS, State University College at Brockport; MBA, Rochester Institute of Technology; CPA, New York—Lecturer

Bruce L. Oliver, BBA, MBA, University of Cincinnati; Ph.D., University of Washington—Professor

Qian Song, B.Sc., M.Sc., Qingdao University; Ph.D., Washington State University—Assistant Professor

Daniel D. Tessoni, BBA, St. John Fisher College; MS, Clarkson University; Ph.D., Syracuse University; CPA, New York—Benjamin Forman Chair for Teaching Excellence; Assistant Professor

Decision Science

John Angelis, BE, Youngstown State University; Ph.D., Case Western Reserve University—Assistant Professor

John E. Ettlie, BS, MS, Ph.D., Northwestern University—Benjamin Forman Chair for Research; Professor

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Brian F. O'Neil, BS, Syracuse University; MS, Ph.D., Purdue University—Distinguished Lecturer

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Finance and Economics

Steven C. Gold, BA, BS, Rutgers University; MA, Ph.D., State University of New York at Binghamton—Professor

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Management

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A. Clyde Hull, BA, Yale University; MB, MBA, Ph.D., Indiana University—Associate Professor

Shalini Khazanchi, BS, South Gujarat University; MBA, University of Pune; Ph.D., University of Cincinnati—Associate Professor

Martin Lawlor, BA, State University of New York at Buffalo; MBA, Rochester Institute of Technology—Director, Online EMBA; Lecturer

Steven Luxmore, BA, MA, University of Guelph; Ph.D.; University of Toronto—Assistant Professor

Joy Oguntebi, BS, Georgia Institute of Technology; MS, Ph.D., University of Michigan—Assistant Professor

Michael Palanski, BS, Grove City College; MA, Covenant Theological Seminary; Ph.D., Binghamton University—Assistant Professor

Sandra L. Rothenberg, BS, Syracuse University; MS, Ph.D., Massachusetts Institute of Technology—Director, Institute for Business Ethics and Corporate Social Responsibility; Associate Professor

Delmonize Smith, BBA, Faulkner University; MS, Troy University; Ph.D., University of Alabama—Assistant Professor

Zhi Tang, BA, Shandorun University; MA, Fudon University; Ph.D., University of Alabama—Assistant Professor

Donald O. Wilson, BS, Oklahoma State University; MS, MPA, University of Southern California; Ph.D., University of California at Irvine—Associate Dean for Teaching and Curriculum; Director, EMBA Program; Assistant Professor

Management Information Systems

A. James Baroody, BS, University of Richmond; MS, College of William and Mary; MS, Ph.D., University of Wisconsin at Madison—Distinguished Lecturer

Sean William Hansen, BA, Harvard University; MBA, Ph.D., Case Western Reserve University—Assistant Professor

Manlu Liu, BS, Jiangsu University; MS, Zhejiang University; MBA, The Hong Kong University of Science & Technology; Ph.D., University of Arizona—Assistant Professor

Victor J. Perotti, BS, MS, MA, Ph.D., The Ohio State University—Associate Professor

Quiang (John) Tu, BS, MS, Xian Jiaotong University; Ph.D., University of Toledo—Professor

Marketing

Robert B. Boehner, BA, MA, Siena College; JD, University of North Carolina at Chapel Hill—Senior Lecturer

Adriana M. Boveda-Lambie, BS, University of Maryland at College Park; MA, University of Texas at Austin; Ph.D., University of Rhode Island—Assistant Professor

Deborah Colton, BA, State University of New York at Buffalo; MBA, Rochester Institute of Technology; Ph.D., University of South Carolina—Associate Professor

Neil Hair, BS, University of Wales; MS, Sheffield Hallam University; Ph.D., Cranfield University—Associate Professor

Joseph C. Miller, BA, Grand Valley State University; MBA, Wayne State University; Ph.D., Michigan State University—Assistant Professor

Rajendran Sriramachandra Murthy, BE, University of Madras; MBA, Ph.D., Southern Illinois University—Assistant Professor

John Ward, BS, Georgia Institute of Technology; MS, Purdue University—Lecturer

Accounting

0101-703 Accounting for Decision Makers
An introduction to accounting concepts and the use of accounting information by decision makers. Topics include financial statements; measurement of assets, liabilities, equities, and income; financial statement analysis, cost behavior and measurement; profitability analysis; relevant costs for special decisions; budgeting; and responsibility accounting. Consideration is given to the role of information technology in the development and use of accounting information. **Credit 4**

0101-704 Corporate Financial Reporting I
A comprehensive exposure at an intermediate level to accounting theory and practice. Emphasis is placed on applying underlying accounting theory to complex accounting measurement problems. The effects of alternative methods are considered throughout the entire course. (0101-703) **Credit 4**

0101-705 Corporate Financial Reporting II
Continuation of Corporate Financial Reporting I with emphasis on equity and special measurement and reporting problems. Topics include statement of cash flows, pensions, leases, revenue recognition and investments. (0101-704) **Credit 4**

0101-706 Cost Management
The development and use of cost data for external reporting and internal cost management (planning and control). Topics include job costing, process costing, joint product costing, cost reassignments, standard costs, activity based costing, decentralization and transfer pricing, and cost variances. Consideration is given to manufacturing, service and retail organizations. (0101-703) **Credit 4**

0101-707 Advanced Accounting
Investigates the application of generally accepted accounting principles and international financial reporting standards to business enterprises, including corporations with investments in subsidiaries, domestic and international, and partnerships. Issues involving consolidated financial statements, including international topics, are considered. Also examined are objectives for not-for profit and governmental entities, and how these objectives affect their financial accounting and reporting. (0101-705 or equivalent) **Credit 4**

0101-708 Auditing
The theory and practice of auditing is examined. Auditing procedures and standards governing current practice are reinforced by case studies. Audit reports and legal liability issues are discussed. The course is designed for students planning to enter public accounting upon graduation and become CPAs. (0101-705) **Credit 4**

0101-709 Basic Taxation
A basic introductory course in federal income taxation. Emphasis is on taxation of individuals and sole proprietorships. Topics include income measurement and deductibility of personal and business expenses. (0101-703) **Credit 4**

0101-710 Advanced Taxation
A continuation of Basic Taxation. Emphasis is on the tax treatment of property transactions and the taxation of business entities. Also covers the use of technology to prepare complex returns and to research tax issues. (0101-709) **Credit 4**

0101-722 Advanced Cost Management
A study of alternative approaches to identifying and proactively managing the costs of providing services and/or manufacturing and distributing products. The focus is on the development of cost data in ambiguous situations to assist managers in decision-making about future activities. Current issues in cost management receive special attention. (0101-706 or permission of instructor) **Credit 4**

0101-738 Information Systems Auditing and Assurance Services
An examination of the unique risks, controls, and assurance services resulting from and related to auditing financial information systems with an emphasis on enterprise resource systems. (0101-708 or equivalent) **Credit 4**

0101-745 Accounting Information Systems
Emphasis is on developing a conceptual understanding of accounting information systems. Combines information systems concepts, computer technology, and accounting issues. Topics include computer security, information privacy, accounting cycles, specialized journals, systems development, computer crime, database applications, e-commerce, and other information systems issues. Includes discussion of current literature and use of a computerized accounting system. Students analyze accounting information systems topics through problem solving, essays, presentations, exams and case studies. (0101-703) **Credit 4**

0101-758 Seminar in Accounting
Special topics seminars offer an in-depth examination of current events, issues and problems unique to accounting. Specific topics will vary depending upon student and faculty interest and on recent events in the business world. Seminar topics for a specific quarter will be announced prior to the course offering. These seminars may be repeated for credit since topics normally vary from quarter to quarter. (Depends upon topic) **Credit 4**

0101-794 Cost Accounting in Technical Organizations
A first course in accounting for students in technical disciplines. Topics include the distinction between external and internal accounting, cost behavior, product costing, profitability analysis, performance evaluation, capital budgeting, and transfer pricing. Emphasis is on issues encountered in technology intensive manufacturing organizations. This course is not intended for Saunders College of Business students. **Credit 4**

0101-795 Financial Accounting Theory and Research
This course examines the theoretical concepts, definitions, and models espoused in the accounting literature and relevant to analyzing various contemporary issues in financial accounting and reporting. (0101-705 or equivalent) **Credit 4**

Management

0102-710 Managing for Environmental Sustainability
Environmental sustainability means satisfying today's ecological needs without compromising the ability to meet tomorrow's needs. This course will examine how firms can use sustainable practices, such as pollution prevention and green design, and still be successful in a competitive marketplace. The course will look at the concept of environmental sustainability and the current state of social and political pressures for more sustainable business practices. It will also explore successful sustainable business strategies, and the management processes needed to support them. **Credit 4**

0102-720 Entrepreneurship and New Venture Creation
This course studies the process of creating new ventures with an emphasis on understanding the role of the entrepreneur in identifying opportunities, seeking capital and other resources, and managing the formation and growth of a new venture. Students will typically write a business plan in this course. **Credit 4**

0102-735 Strategic Management of Technological Innovation
This course addresses the management of global sustainable technological innovation. The course integrates two major themes: The management of innovation and the management of technology. Emphasis is on the role of both innovation and technology in creating global competitive advantage. The course also addresses the responsibility of businesses related to sustainability. (Must have completed at least four MBA core courses.) **Credit 4**

0102-740 Organizational Behavior and Leadership
This course examines why people behave as they do in organizations and what managers can do to improve organizational performance by influencing people's behavior. Students will be exposed to the impact of organizations on leaders, individuals, groups, and cultures, and to different frameworks for diagnosing and dealing with problems in organizational settings. Topics include leadership, motivation, team building, conflict resolution, organizational change, and managing organizational cultures, creativity and ethical leadership. **Credit 4**

0102-741 Managing Organizational Change
This course examines various theories and approaches currently used to assist organizations in achieving planned change. The features of successful change in organizations will be discussed, with an emphasis on the structural, motivational, interpersonal, and social aspect of organizational change. Topics include the processes of envisioning and implementing change, as well as, the roles and perspectives of change agents and change recipients. (0102-740) **Credit 4**

0102-742 Technology Management
This course is an introduction to the technological process in organizations and the factors, both internal and external, which influence the rate, timing and success of industrial innovations. The interrelationship between science and technology and the importance of these two disciplines to the process of technological innovation is examined. Also discussed is the process of R&D management, the strategic management of technology, the dynamics of technology life cycles and organizational influences on engineering and manufacturing processes. **Credit 4**

0102-745 Social and Political Environment of Business
This class focuses on the interactions among business, government and society. The course illuminates the role of ethics, social ideology and government policy in guiding business decisions and in providing the conditions for successful competitive activity. Attention is given to understanding the reason for government regulation, as well as the pros and cons of various regulatory approaches. The class also looks at current debates on corporate social responsibilities with regard to stakeholders, including government, consumers, employees, communities and the environment. **Credit 4**

0102-750 Human Resource Management
This course focuses on the importance of managing human resources with an awareness of the legal and regulatory environment. Attention is given to the increasing importance of cooperation among top management, HR managers, line managers and employees. Students will become familiar with workplace planning and employment, human resource development, compensation and benefits, employment and labor relations, occupational health and safety, and managing diversity. (0102-740) **Credit 4**

0102-753 Field Experience in Business Consulting
Students work in consulting teams to assist startup ventures and/or small businesses. Problems are isolated and solutions are then developed. Affiliated course projects may focus on a number of areas. For example, they may seek to develop commercialization plans for specific technologies, products or services; focus on unique problems associated with small businesses, and develop growth strategies. Recommended for students nearing the completion of their program. (0101-703, 0104-721, 0105-761 for business majors; permission of instructor for other colleges) **Credit 4**

0102-756 Power and Influence
Power and influence processes are pervasive and an important part of organizational life. This course has as its objectives enhancing the understanding of these processes and increasing the student's skills in using them. Topics covered include the conditions under which power and politics are more likely to dominate decision processes, assessing the relative power of various actors, understanding the basis for their positions on issues, the sources of both individual and departmental power, power and influence strategies and tactics, and some functional and dysfunctional aspects of organizational politics for both individuals and the organizations involved. (0102-740) **Credit 4**

0102-758 Seminar in Management
Special topics seminars offer an in-depth examination of current events, issues and problems unique to management. Specific topics will vary depending upon student and faculty interest and on recent events in the business world. Seminar topics for a specific quarter will be announced prior to the course offering. These seminars may be repeated for credit since topics will normally vary from quarter to quarter. (Prerequisite depends on topic) **Credit 4**

0102-759 Competitive Strategy
This course reviews the techniques and tools firms use to create a sustainable competitive advantage in the global economy. Cross functional analysis is a core element in the course. Topics covered include the mission and vision of the firm, analysis of the external environment, analysis of internal resources and capabilities, the role of innovation in strategy development, analysis of global business trends, developing business level and corporate level strategies, strategy implementation, and the role of ethics in strategy development and execution. (All other required core courses) **Credit 4**

0102-761 Managing Research and Innovation
This course deals with the responsibilities of, and operating problems faced by managers responsible for the research function within high-technology firms. Topics will include: internal technology assessments, the acquisition of technology, domestic and international technology transfer, and the selection and management of R&D projects. Particular attention will be given to motivating and managing creative individuals, organizational alternatives for R&D, and techniques for overcoming barriers to innovation. (0102-742 or 0102-735 or permission of instructor) **Credit 4**

0102-762 Managing New Process and Product Development
The course deals with the internal organizational challenges faced by managers of technology-intensive companies. Particular attention is given to management techniques for successfully developing and introducing into the marketplace new products and services. Also discussed is the management of technical groups and project teams, cross-functional integration, organizational support of innovation and creativity and organizational alternatives such as matrix management and skunk works. (0102-742 or 0102-735 or permission of instructor) **Credit 4**

0102-763 Behavioral Skills for Managers and Professionals
This course provides the opportunity to develop individual and interpersonal skills that enhance managerial performance in today's high-performance organization. Each student will perform in each of the major skill dimensions and will be given evaluative feedback and the opportunity to incorporate the implications of that feedback into additional performance opportunities. Course participants are also provided with the opportunity to assess their career work preferences and to compare them with the performance expectations of managerial positions. The management styles of each participant are also assessed, and the impact is clarified of the behaviors that flow from each style on the perceptions and performance of others in the organization. (0102-740) **Credit 4**

0102-765 Applied Venture Creation
This project oriented course enables students to gain multi- disciplinary experience in entrepreneurship, venture creation, or product/service commercialization through a number of alternative venues. Student teams gain applied and practical knowledge by participating in an actual entrepreneurial or commercialization project. These projects could include: advancing/maturing a student originated business concept through the RIT Student Business Development Laboratory, developing commercialization plans in partnership with various RIT college product/service development projects, or creating commercial business plans for RIT generated intellectual property. Students meet with supervising faculty on a weekly basis. (Faculty permission is required to enroll in the course. See a COB graduate advisor for details.) **Credit 4**

0102-770 Business Research Methods
This course concerns the development, presentation and use of research in managerial decision making. Included are the processes by which meaningful research problems are generated, identification of the relevant literature, rationalizing of the research design and interpretation of findings. Students typically work in small groups to execute a research project in one of the functional areas of business. (0106-782 or equivalent) **Credit 4**

0102-775 Business Ethics
This course examines business ethics from both an organizational and managerial perspective. Students will examine the goal of business organizations, as well as individual conduct in business settings. Ethical reasoning and ethical leadership will guide debate on topics such as: creating an ethical climate in an organization, honesty, affirmative action, environmental ethics, ethics in advertising and sales, financial management, personnel management, and the role of character and virtues in effective leadership. **Credit 4**

0102-794 Innovation Management Capstone Preparation
This is the first of two courses (0102-794 and 0102-795) that must be taken in consecutive quarters. The course is limited to students in the Master of Science in Innovation Management program only. Students will begin to analyze an innovation issue and develop a plan to commercialize the innovation. Students will further define the innovation and the project, collect and analyze relevant data and information, develop alternative solutions, and make recommendations to the professor and outside experts as appropriate. Students will develop skills in both the technical and business aspects of managing innovation. NOTE: Students will be required to write and have approved by the Program Director a one-page description of their proposed innovation before they register for the class. (Four program classes and permission of program director; corequisite: three additional program classes)

0102-795 Innovation Management Capstone
In this MS in Innovation Management capstone course, students work with faculty and industry advisors to integrate their business and technology learning through an applied project. In these projects, real-world business problems will be identified, and solutions will be planned and developed. These projects may be entrepreneurial in nature, or they may be carried out within an existing company. Projects will be conducted under the supervision of the course instructor and other advisors as appropriate. Learning from the applied project will be generalized so that the importance of the work in a broader business context will be clear. NOTE: Students will be required to write and have approved by the Program Director a one-page description of their proposed innovation before they register for the class. (0102-794 and seven other program courses, permission of program director; corequisite: any remaining courses for MS)

Economics

0103-705 **Economics for Managers**
The course focuses on the fundamental economic theories most useful for the management of a firm in a global environment. Microeconomic theories and current events are used to explain the performance of the market system and help managers formulate effective pricing and business decisions. Macroeconomic theories and current events are used to explain the direction of the domestic and global economy to help managers understand the implications, including foreign direct investment, for their companies. Students will learn to explain and predict changes in economic growth, inflation, interest rates, international trade and foreign exchange rates. (0106-066 algebra or equivalent) **Credit 4**

0103-711 **Microeconomics**
Microeconomics introduces the principles of economic analysis as applied to micro decisions to determine how an organization can achieve its aims most efficiently. This course applies statistical and quantitative tools and the methodological approaches commonly used by economists to business problems such as demand estimation, product pricing, profit maximizing level of output, cost minimizing level of input use, and forecasting. (0103-705 or two economics courses, one in microeconomics and one in macroeconomics with a grade of B or better) **Credit 4**

0103-712 **Macroeconomics**
This is an intermediate macroeconomics course with a focus on the global environment. A framework of product and money market equilibrium is developed that recognizes all economies are linked through international markets for goods, services and capital. Open economy models are developed to explain economic growth, inflation, interest rates, foreign exchange rates and trade balances. (0103-705 or two economics courses, one in microeconomics and one in macroeconomics with a grade of B or better) **Credit 4**

Finance

0104-721 **Financial Analysis for Managers**
An examination of basic financial theories, techniques, and practices. Topics include: time value of money, valuation, capital asset pricing, risk and diversification, cost of capital, capital budgeting techniques. (Corequisites 0101-703, 0106-782) **Credit 4**

0104-722 **Financial Management II**
This advanced course in corporate finance focuses on financing policies, financial planning/control, and other advanced corporate topics. Specific topics include the financing process, alternative financing instruments, restructuring, cost of capital, corporate applications involving options, working capital management and the use of financial budgets/forecasts. (0104-721) **Credit 4**

0104-725 **Securities and Investment Analysis**
Study of securities and other investment media and their markets. Analysis of investment values based on fundamental analytic procedures, technical analytic procedures, and the impact that modern portfolio theory has on the value of financial assets. Topics include return, growth, risk, accounting procedures, tax considerations and the impact of various institutional arrangements on value determination. (0104-721) **Credit 4**

0104-732 **Portfolio Management**
This course extends the knowledge of risk and return in a portfolio context to active portfolio management. The measurement and evaluation of portfolio performance are analyzed. The importance of asset allocations, international diversification, pension fund management and the use of a wide range of derivative securities to manage risk are explored. (0104-721) **Credit 4**

0104-740 **Options and Futures**
This course focuses on financial derivative securities. Their role in financial management is becoming increasingly important, especially in portfolio management. This course covers valuation of various options and futures as well as their use in risk management. Specific topics include option and futures pricing models, option strategies and contemporary topics such as index arbitraging. (0104-721) **Credit 4**

0104-742 **Financial Modeling and Analysis**
Students apply computer technology to solve finance-related problems using a variety of analytical methods. Analytical methods include spreadsheet modeling, mathematical optimization, regression, decision tree analysis and Monte Carlo Simulation. Typical topics covered are financial forecasting, pro-forma financial statements, equity valuation, cash budget forecasts, and portfolio analysis. This is a hands-on course that focuses on collecting, managing and analyzing financial data. (0104-721, 0104-725; corequisite 0104-722) **Credit 4**

0104-744 **Innovation in Financial Markets and Securities**
Advanced course exploring the twin-issue of (a) innovation in market structures and security design and (b) use of complex securities by market participants. Topics include financial engineering, market microstructure, debt and equity market innovations, securitization, interest rate/credit derivative applications, hedging methods. (0104-721, 0104-725; corequisite 0104-740) **Credit 4**

0104-760 **Finance in a Global Environment**
This course has a specific focus on international business problems that are financial in nature. Topics include an examination of the international environment the firm operates in, international investment, exchange rates and the management of risks arising from shifting exchange rates, and the problems of short and long term asset and liability management. (0104-721) **Credit 4**

Marketing

0105-761 **Marketing Concepts**
An introduction to contemporary principles and practices of marketing. The course is structured around the process of marketing planning leading to the development of successful marketing strategies, including the commercialization of products and services in domestic and international environments. Focus is on environmental scanning techniques, setting and evaluating measurable objectives, innovating and controlling the interrelated components of product/service offering, planning and executing the marketing mix (channels of distribution, price, and promotion), and enhancing customer relationships through the delivery of customer value. **Credit 4**

0105-762 **Advanced Marketing Management**
A course designed to give the student an in-depth knowledge of middle-and upper-level marketing problems and processes. Topics include the tools used by marketing managers in the development, implementation, and control of marketing plans and strategies. (0105-761) **Credit 4**

0105-763 **Buyer Behavior**
The course reviews the major theories that frame the understanding of both consumer (end-user) and business buying behavior. Topics include the buying decision process, the impact of emotion, product knowledge and product involvement on purchasing decisions. In addition, behavioral and social psychology perspectives will be discussed. All perspectives will be applied to designing marketing strategy. (0105-761; co-requisite 0106-782) **Credit 4**

0105-767 **Advertising and Integrated Marketing Communications**
An in-depth view of tools of advertising, sales promotion, public relations, personal selling, direct marketing and internet marketing. Basic concepts of advertising using print, broadcast, Internet and outdoor media are studied. Planning, budgeting and the roles of advertising agencies are also covered. Students develop a comprehensive promotion plan beginning with the marketing strategy and ending with implementation and evaluation. The project, in which the student plans and prepares a promotion/advertising campaign for a product or service in consultation with the instructor is an integral part of the course. (0105-761) **Credit 4**

0105-771 **Marketing Research Methods**
This course provides an overview of marketing research and practice especially the methods of measuring, examining, and predicting factors that affect the marketing process. Students will learn about the process of conducting surveys and experiments that includes the following: determining customer requirements, questionnaire design, telephone, mail and electronic surveys, sampling plan design and data analysis. (0105-761, 0106-782 or equivalent) **Credit 4**

0105-772 **Internet Marketing: Strategy and Tactics**
This course examines the impact that the Internet has on traditional and contemporary business-to-consumer marketing activities. It explores these implications in both strategic and tactical terms to enhance organizations' levels of competitiveness. The course identifies the use of the Internet in enhancing value for consumers and considers the leverage of: the latest technologies, trends, e culture and innovation through the medium of the Internet. (0105-761) **Credit 4**

0105-775 **Business-to-business e-marketing**
The focus of this course is on the effective integration and coordination of various business to business marketing operations within the realm of e-commerce. The course explores from a marketing perspective factors critical to the success of e-business operations and examines the strategies and tactics that organizations can use to build and/or enhance their business to business relationships using electronic tools. (0105-761) **Credit 4**

0105-776 **Product and Brand Management**
An essential element of corporate success is the management of products and brands. Firms in both consumer and commercial industries often manage their marketing strategies and tactics through the activities of their product and brand managers. This course will examine the role of product and brand managers in the development and execution of strategies that deliver value to targeted customers and grow the business. The role of product and brand managers will be examined through all phases of the firm's product and brand life cycle. The course emphasizes the decisions that firms expect product and brand managers to make to achieve market share and financial objectives. (0105-761) **Credit 4**

0105-778 **Commercialization and Marketing of New Products**
This course emphasizes the marketing and product strategy-related activities required to create, develop and launch successful new products. Topics covered include identifying the market opportunity for new products, defining the product strategy, understanding customer requirements, developing and updating the product business plan, marketing's role in the firm's product development process, developing the marketing plan for launching new products, and managing the product life cycle. The course emphasizes best practices in marketing-related activities required for successful new product commercialization. (0105-761) **Credit 4**

Decision Science

0106-743 **Operations and Supply Chain Management**
Study of the management of operations and supply chain management. Encompasses both manufacturing and services. Topics include operations and supply chain strategy, ethical behavior, forecasting; work systems, inventory management, capacity and materials planning, lean operation, supply chain design and closed-loop supply chains, global operations, quality management, quality control, and quality improvement, project management; and current issues. (0106-782 or equivalent) **Credit 4**

0106-744 **Project Management**
A study in the principles of project management and the application of various tools and techniques for project planning and control. This course focuses on the leadership role of the project manager, and the roles and responsibilities of the team members. Considerable emphasis is placed on statements of work and work breakdown structures. The course uses a combination of lecture/discussion, group exercises, and case studies. **Credit 4**

0106-745 **Quality Control and Improvement**
Study of total quality management (TQM), including Deming's philosophy, quality planning, quality cost principles, problem solving methods and tools, the use of statistical methods for quality control and improvement, supplier relations, reliability concepts, and recent developments in quality. The course focus is on the management and continuous improvement of quality and productivity in manufacturing and service organizations. (0106-782 or equivalent) **Credit 4**

0106-782 **Statistical Analysis for Decision Making**
This is a course in applied statistics emphasizing an understanding of variation and inference (estimation and testing). Topics to be covered include: review of descriptive statistics, normal distribution, sampling distributions, estimation, test of hypothesis for single and two populations, analysis of variance (ANOVA), linear regression, multiple regression and model building. Students will apply these concepts using mini-cases and problem sets that involve both structured and unstructured data sets. The application of appropriate tools will be required. **Credit 4**

Business Legal Studies

0110-730 **Business Legal Concepts**
This course provides an introduction to legal procedure and the substantive laws that govern businesses. The course explores the background and origin of the U.S. legal system as well as its legal and regulatory agencies. Representative topics will include review of the U.S. Constitution and the U.S. court system, basics of civil and criminal procedures, torts, contracts, criminal law, bankruptcy, antitrust, intellectual property, and business and consumer protection. **Credit 4**

0110-731 **Commercial Law**
Explores the impact of the Uniform Commercial Code on business operations. Emphasis on topics included on certified public accounting exam. Topics covered include sales, commercial paper, corporations, partnerships, joint ventures, sole proprietorships, bailment and agency. Topical cases and examples are used to help the student grasp the business implications of the law and its nomenclature. A research project on legal issues is an important aspect of this course. (0110-730 or equivalent) **Credit 4**

0110-745 **Legal and Ethical Issues Technology Intensive Environments**
The course confronts graduate students with a wide variety of legal and ethical issues in organizational environments that are technologically intensive, such as information technology and the life sciences. Impacts of intellectual property legislation and legal cases in national and international venues are investigated. Legal and social issues involving individual privacy are argued. This exposure to legal and ethical dilemmas is an important tool as the graduates encounter such situation throughout their careers. Coupled with technical proficiency the ability to deal with legal and ethical issues shapes professional successes and failures. Not available to students who have completed 0102-775. **Credit 4**

Management Information Systems

0112-710 **Information Systems Concepts**
This course is an introduction to the conceptual and theoretical foundations of management information systems and their role in modern organizations. The course will provide students with the concepts, tools, and techniques needed to understand and interpret information management issues, such as how to best incorporate information technology into an organization, from a managerial perspective. **Credit 4**

0112-711 **Managing Service Systems**
Service science is a new, interdisciplinary field that addresses the shift to the service and information-based economy. Students in this course investigate the nature of services and the need for interdisciplinary approaches to services innovation. Students will explore the role of information technology in the design, management, delivery and evaluation of services and apply these concepts to a specific industry, such as health care, IT services or financial services.

0112-712 **Service-oriented Information Systems**
Recent advances in service-oriented IT, such as web services, are playing an increasing role in implementation and innovation with service systems. This course provides an overview of these technologies and their role in service systems. Students will explore web services and service-oriented architectures and examine their usage in service systems to implement business processes and to develop, deliver, manage and innovate in services.

0112-725 **Data Management**
This course discusses issues associated with data capture, organization, storage, extraction, and modeling for planned and ad hoc reporting. Enables student to model data by developing conceptual and semantic data models. Techniques taught for managing the design and development of large database systems including logical data models, concurrent processing, data distributions, database administration, data warehousing, data cleansing and data mining. **Credit 4**

0112-755 **Information Technology and Strategy Management**
Information systems increasingly have a strategic role in organizations, both public and private. Information technology has changed the ways organizations interact internally and externally, the management of production processes and how organizations compete. Students examine how IT is used to support the management of and to support the firm's core business processes. Topics include the nature of IT, its role in supporting business strategy, the impacts of information systems to organizations, IT governance processes and the strategic use of information technology in leading organizations. **Credit 4**

0112-760 **Integrated Business Systems**
This course emphasizes the concepts and technologies associated with Integrated Business Information Systems and the managerial decisions related to their implementation and application in managing organizations. Students gain an understanding of the scope of these integrated systems that reach across organizational boundaries and how they can change how a company does business. Topics covered include business integration, business processes, systems integration, enterprise resource planning systems and the role of real-time information in business management. Hands-on experience with enterprise systems, such as SAP R/3, is used to enable students to demonstrate concepts related to integrated business systems. **Credit 4**

0112-761 **Business Process Analysis and Workflow Design**
A common theme held in business today is identifying opportunities for improvement. By analyzing, redesigning and where possible, automating business processes, companies look to add value, improve operating efficiencies and reduce costs. Students explore approaches to analyzing and designing processes and apply graphic modeling techniques that allow for clear and simple definition, analysis and improvement of processes. Systems used for automating process workflow are introduced, such as workflow tools or SAP's R/3 workflow application. **Credit 4**

B. Thomas Golisano College of Computing and Information Sciences

Andrew L. Sears, Dean
www.gccis.rit.edu

Programs of study

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Medical Informatics	56
Networking and System Administration	60
Software Engineering	63

Advanced Certificates in:	
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Interactive Multimedia Development	57
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Online learning option available

The B. Thomas Golisano College of Computing and Information Sciences is one of the most comprehensive computing colleges in the United States. The college offers 17 bachelor's, master's, and doctoral degrees in computing. With its focus on interdepartmental and intercollege cooperation, the college addresses computing in the broadest sense.

The college's programs address the growing need for experts in the fields of computational science, gaming, simulation, computer security and forensics, edutainment, management of complex information technology infrastructures, and software engineering. These programs offer the most current thinking in computing and information sciences and technology, and are supported by extensive laboratory facilities.

Admission requirements

The college offering the program makes all decisions on graduate admission. Please refer to each individual program for information regarding specific admission criteria. For general graduate admission information, please refer to the Admission section of this bulletin.

Financial aid and scholarships

Please refer to the Financial Aid and Scholarship section of this bulletin for information regarding financial aid, scholarships, grants, loans, and graduate assistantships.

Faculty

The college's faculty is a dedicated group of teacher-scholars and scholar-teachers, performing scholarly work with an emphasis on student involvement and career preparation. Faculty members provide leadership by implementing innovative teaching techniques and anticipating and meeting the needs of students and our industrial partners. Many have significant industrial experience in addition to outstanding academic credentials.

Research

The Golisano College supports learning and research across disciplines through our Center for Computational Research and Innovation, where students, faculty, and industry converge to develop and advance cutting-edge computing technology and innovative applications of computing across science, engineering, business, and even the social sciences. Project teams, often multi-disciplinary, are formed consisting of faculty and students of complementary computing and domain expertise. The center serves as the laboratory for the college's doctorate program.

Facilities

The college houses extensive laboratories containing powerful state-of-the-art, leading-edge computing devices and workstations, as well as appropriate, up-to-date software. Labs are available to students 16 to 18 hours a day. Network, wireless, and Web access also are available throughout the college, ensuring that

students have the tools necessary to complete their assignments and projects.

The college is equipped with more than 2,000 workstations and more than 50 classrooms, labs, and studio labs, all with the latest technology for both general and specialized-use. There are labs and studios dedicated to networking, security, entertainment technology, human-computer interaction, computer vision, and robotics. Students and faculty also have access to the Center for Computational Research and Innovation facilities.

Study options

Courses are available during the day and evening, allowing for full- or part-time study. Several master's degrees and advanced certificate programs are available online. Please refer to each individual program for more information.

Computing and Information Sciences, Ph.D.

http://phd.gccis.rit.edu/

Pengcheng Shi, Program Director
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Program overview

The doctoral program in computing and information sciences is designed to produce independent scholars, well-prepared educators, and cutting-edge researchers poised to excel in their work in computing and interdisciplinary academic, industrial, or government environments. The degree highlights two of the most unique characteristics of the Golisano College: its breadth of program offerings and its scholarly focus on discovering solutions to real-world problems by balancing theory and practice.

The program focuses on the theoretical and practical aspects of cyberinfrastructure as applied to specific problems across multiple domains. It is a blend of intra-disciplinary computing knowledge areas and inter-disciplinary domain areas.

Cyberinfrastructure

Cyberinfrastructure (CI) is a comprehensive infrastructure integrating hardware, data, networks, and digitally-enabled sensors to provide secure, efficient, reliable, accessible, usable, and interoperable suites of software and middleware services and tools. Our doctorate program plays a leadership role in CI research by providing human-centered tools for the science and engineering communities. These tools and services focus on such areas as high performance computing, data analysis and visualization, cyberservices and virtual environments, and learning and knowledge management.

Intra-disciplinary knowledge

There are three intra-disciplinary computing knowledge areas: interaction, informatics, and infrastructure.

Interaction

Interaction refers to topics related to the combined action of two or more entities (human or computational) that affect one another and work together when facilitated by technology. It encompasses several subtopics relating to how people and technology interact and interface. Several common threads weave through all of these areas, many of which rely heavily and build upon foundations in the social and behavioral sciences with an emphasis on understanding human and social/organizational phenomena. To some extent, these fields follow an engineering approach to the design of interactions in which solutions are based on rules and principles derived from research and practice, but require analyses that go beyond the analytical approach. From this perspective, solutions can be measured and evaluated against goals and intended outcomes. However, while efficiency and effectiveness are often the watchwords of these fields in practice, this is also where science meets art in computing. Creative design and sensitivity to human needs and aesthetics are critical. Some of the specialties available in this area are human-computer interaction, computer-based instructional systems, and access technologies.

Informatics

Informatics is the study of computational/algorithmic techniques applied to the management and understanding of data-intensive systems. It focuses on the capture, storage, processing, analysis, and interpretation of data. Topics include algorithms, complexity, and discovery informatics. Data storage and processing require investigation into tools and techniques for modeling, storage, and retrieval. Analysis and understanding require the development of tools and techniques for the symbolic modeling, simulation, and visualization of data. The increased complexity of managing vast amounts of data requires a better understanding of the fundamentals of computation. These fundamentals include complexity, theory to determine the inherent limits of computation, communication, cryptography, and the design and analysis of algorithms to obtain optimal solutions within the limits identified. Some of the specialties available in this area are core informatics, discovery informatics, and intelligent systems.

Infrastructure

Infrastructure comprises aspects related to hardware, software (both system software and applications), communications technology, and their integration with computing systems through applications. The focus is on the best organization of these elements to provide optimal architectural solutions. On the hardware side it includes system-level design (e.g., for system-on-a-chip solutions) and their building block components. On the software side it covers all aspects of systems and applications software development, including specification and design languages and standards; validation and prototyping, and multi-dimensional Quality-of-Service management; software product lines, model-driven architectures, component-based development, and domain-specific languages; and product estimation, tracking, and oversight. The communications subtopic includes sensor networks and protocols; active, wireless, mobile, configurable, and high speed

networks; and network security and privacy, quality of service, reliability, service discovery, and integration and internetworking across heterogeneous networks. At the system level there are issues related to conformance and certification; system dependability, fault tolerance, verifiable adaptability, and reconfigurable systems; real-time, self adaptive, self-organizing, autonomic systems. Some of the specialties available in this area are networks and security, digital systems and VLSI, software design and productivity, and systems software.

Interdisciplinary domains

The program focuses on domain-specific computing, or the interaction between computing and non-computing disciplines, in the areas of science, engineering, medicine, arts, humanities, and business. By incorporating domain-specific computing, the research conducted in this program applies computing and information science principles to the solution of problems in application domains that lie outside of the scope of the traditional computing discipline. The research requirement incorporates fundamental concepts in cyberinfrastructure that are necessary for understanding the problems commonly encountered in advancing scientific discovery and product development in cross-disciplinary domains.

Active research areas

Computing technology

- Algorithm and Theory
- Grid and Cloud Computing
- Communication and Networking
- Computer Vision and Pattern Recognition
- Database and Data Mining
- Graphics and Visualization
- Human-Computer Interaction
- Machine Learning
- Security and Cryptology
- Software Engineering

Domain applications

- Access Technology
- Biomedical Computing
- Computational Astrophysics
- Environmental Informatics
- Green Computing
- Imaging and Image Informatics
- Service Sciences
- Social Computing

Curriculum

The program requires a minimum of 99 quarter credit hours beyond the baccalaureate level. These credit hours are comprised of graduate-level course work, including seminar attendance and research credits.

Required courses (24 quarter credit hours)

4040-810	Research Methods
4040-811	Introduction to Research
4040-820	Discovery
4040-830	Connectivity
4040-840	Security and Trust
4040-850	Design
4040-896	Cyberinfrastructure Colloquium

Teaching skills courses (3 quarter credit hours)

4040-807	Teaching Skills Workshop I
4040-809	Teaching Skills Apprenticeship

Electives (40 quarter credit hours)

Elective courses provide foundation support of the student's dissertation research area. These courses will come from the computing courses (interaction, informatics, infrastructure), domain courses, and other electives.

Dissertation and research (32 quarter credit hours)

Students are required to conduct original research involving two of the three knowledge areas of interaction, informatics, and infrastructure, and applied to a domain.

Residency requirement

One year of full-time residency (minimum of 12 credits per quarter for three consecutive quarters, not including summer) is a requirement of the program.

Assessments

Each student must pass three assessment examinations in the following order:

Research potential assessment

Completed after the first year, this assessment evaluates the research tasks students have worked on in their first year in the program. Passing this assessment will qualify students to continue in the doctoral program.

Thesis proposal defense

This is an oral qualifying examination completed after the thesis proposal is written. Formal admission to candidacy will be granted after successfully passing the research potential assessment requirement and having a research proposal approved by the dissertation committee. The dissertation committee will have a minimum of four members including the student's adviser.

Dissertation defense

This is the final examination. The dissertation defense includes the dissertation committee and an external reader from outside RIT. The exam consists of a formal, oral presentation of the thesis research by the student, followed by questions from the audience.

Admission requirements

To be considered for admission to the doctorate program in computing and information sciences, candidates must fulfill the following requirements:

- Hold a baccalaureate degree or its equivalent,*

- Submit official transcripts (in English) of all previously completed undergraduate and graduate course work,
- Submit scores from the Graduate Record Examination (GRE) (basic exam score; taken within last 5 years),
- Submit a statement of purpose, containing, but not limited to, research experiences and interests, motivation to pursue doctorate, and long-term goals,
- Submit a recent curriculum vitae or resume,
- Submit two recommendations from individuals who are well qualified to assess the student's potential for doctoral study,
- Submit professional or research paper sample(s), if available, and
- Complete a graduate application.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language (TOEFL). A minimum score of 570 (paper-based), 230 (computer-based), or 88 (Internet-based) is required.

* Since the program encompasses a wide variety of disciplines, students with diverse backgrounds (e.g., engineering, science, humanities, fine arts, business, and disciplines with sufficient computing backgrounds) are encouraged to apply. Applicants should have the following minimum course work requirements: one full year of study in programming and computing concepts; strong mathematical background in subjects such as discrete mathematics, and probability and statistics; and aptitude, vision, and experience (if applicable) in computing and information sciences related research.

Interview

An interview by one or more of the doctoral program faculty and/or admissions committee may be required for candidates considered for admission prior to final selection. This interview may be conducted via telephone.

Additional information

Transfer credit

Students with previous graduate course work, or a master's degree in a computing and information sciences discipline or in a related domain-specific discipline, may be granted up to 28 quarter credit hours towards the degree requirements. The transfer credit evaluation will not be made until after the first year of study. Consideration for transfer credit will include the appropriateness to the student's intra- and inter-disciplinary program of study and research interests.

Assistantships

Assistantships, which include tuition and stipend, are available and awarded on a competitive basis. Students working on funded research projects are required to be available during the day for project commitments.

Department of Computer Science

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www.cs.rit.edu

The MS program in computer science consists of a core curriculum, a diverse set of clusters, and a number of electives. The core curriculum provides students with a solid background in the theoretical principles underlying computer science, which ensures that students acquire the intellectual tools necessary to keep up-to-date in this rapidly evolving discipline. The clusters provide students with the opportunity to obtain depth in a computer science discipline and the electives add the necessary breadth of knowledge required by industry. This combination prepares students to engineer modern computing systems and contribute in all aspects of systems life cycles. The program helps students prepare for academic or research careers in computer science or a related discipline.

Clusters are offered in a variety of areas, such as computer graphics and visualization, data management, distributed systems, computational vision and acoustics, intelligent systems, languages and tools, and security and theory. Certain pre-approved courses from other departments also may be counted toward the degree.

Faculty members in the department are actively engaged in research in the areas of artificial intelligence, wireless networks, pattern recognition, computer vision, visualization, data management, combinatorics, and distributed computing systems. There are many opportunities for graduate students to participate in these activities toward thesis or project work and independent study.

Computer facilities

The computer science department provides extensive facilities for students and faculty. The hardware associated with these facilities represents current technology, including:

- a graduate lab with more than 15 Mac's and a graduate library;
- specialized labs in graphics, computer vision, pattern recognition, security, wireless networks, database, and artificial intelligence;
- six general purpose computing labs with more than 100 workstations, running Solaris, Linux, Windows, and Mac OS X;
- campus-wide wireless access; and
- a networking/distributed systems lab equipped with dual-processor Pentium workstations and its own internal network.

Computer Science, MS

http://www.cs.rit.edu/

Program overview

The MS in computer science is designed for students who have an undergraduate degree (or minor) in computer science, as well as those who have a strong background in a field in which computers are applied, such as engineering, science, or business. Students can concentrate in intelligent systems, languages and tools, distributed systems, security, theory, databases/data mining, or graphics.

The degree is offered on a full- or part-time basis. Courses are generally offered in the afternoon and evening to accomodate part-time students. A full-time student, one who takes three courses per quarter, may be able to complete the course work in one year; part-time students may finish in two to four years. The time required to complete a master's thesis or project varies according to the student and the scope of the project; two quarters is typical.

Curriculum

The program consists of 45 credit hours. There are two tracks to the degree, the thesis track and the project track.

Core courses

4005-800	Theory of Computer Algorithms
4005-893	Graduate Seminar

Thesis track

- Four courses from a cluster (16 credits)
- Four electives (16 credits)
- Master's thesis (seven credits)

Project track

- Four courses from a cluster (16 credits)
- Five electives (20 credits)
- Master's project (three credits)

The topic of the master's project must be in the cluster domain. Only the graduate program director can approve an exception to this rule.

For either track, students with a strong background in a core area may receive permission from the graduate program director to replace a core course with another course, generally in the same area. Only the graduate program director can approve changes to a student's program of study.

Clusters and electives

- Computational vision and acoustics
- Computer graphics and visualization
- Data management
- Distributed systems
- Intelligent systems
- Languages and tools
- Security
- Theory

In addition, a student is allowed to design his or her own cluster, with the consent of an adviser and the graduate program director.

A subset of electives is shown below.

4005-704	Complexity and Computability
4005-705	Cryptography
4005-709	Combinatorial Computing
4005-706	Crytography II
4005-709	Privacy and Security
4005-710	Programming Language Theory
4005-711	Compiler Construction
4005-713	XML-Arch, Tools and Techniques
4005-714	Programming Skills
4005-719	Topics in Programming Languages
4005-720	Computer Architecture
4005-729	Topics in Computer Architecture
4005-730	Distributed Systems I
4005-731	Distributed Operating Systems II
4005-735	Parallel Computing I
4005-736	Parallel Computing II
4005-739	Topics in Operating Systems
4005-740	Data Communications and Networks I
4005-741	Advanced Computer Networks
4005-742	Ad-Hoc Networks
4005-747	Intelligent Security Systems
4005-750	Introduction to Artificial Intelligence
4005-753	Biologically Inspired Intelligent Systems
4005-755	Neural Networks and Machine Learning
4005-756	Genetic Algorithms
4005-757	Introduction to Computer Vision
4005-758	Advanced Computer Vision
4005-761	Computer Graphics I
4005-762	Computer Graphics II
4005-769	Topics in Computer Graphics
4005-771	Database Systems
4005-772	Database System Implementation
4005-774	Secure Database Systems
4005-775	Data Mining
4005-779	Topics in Data Management
4005-784	Privacy and Security

Electives provide breadth of experience in computer science and applications areas. Students who wish to include courses from departments outside of computer science need prior approval of the graduate program director. Refer to the course descriptions in the departments of computer science, engineering, mathematical, and imaging science for possible elective courses.

A program of study must be designed in cooperation with the graduate program director.

Master's thesis or project

A thesis paper or project forms the capstone of the MS program. In order to register for either, a student must complete the graduate seminar and submit an acceptable proposal to the computer science faculty.

Requirements for the degree must be completed within seven years of the date of the first course counted toward the student's program. Bridge courses are excluded.

Admission requirements

To be considered for admission to the MS in computer science, candidates must fulfill the following requirements:

- Hold a baccalaureate or equivalent degree from an accredited institution,
- Submit transcripts (in English) of all previously completed undergraduate and graduate course work,
- Have a minimum grade point average of 3.0 (B), and
- Complete a graduate application.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language. A minimum score of 213 (computer-based) is required. Graduate Record Exam scores are also required. GRE scores also will be considered for applicants whose undergraduate grade point average is lower than 3.0.

Prerequisites

Applicants must satisfy prerequisite requirements in mathematics (differential and integral calculus, probability and statistics, discrete mathematics, and computer science theory) and computing (experience with a modern high-level language [e.g., C++, Java], data structures, assembly language programming, software design methodology, introductory computer architecture and digital logic, operating systems, and programming language concepts).

Bridge program

If an applicant lacks any of the above prerequisites, bridge courses may be recommended to provide students the required knowledge and skills needed for the program. Generally, formal acceptance into the master's program is deferred until the applicant has made significant progress through these necessary courses.

If any bridge courses are indicated in a student's plan of study, the student may be admitted on the condition that he or she will successfully complete the bridge program courses with a grade of B or better (courses with lower grades must be repeated). The bridge program courses are not part of the 45 quarter credits required for the master's degree.

A bridge program can be designed in different ways. Often, other courses can be substituted, and courses at other colleges may be applied. (See the Computer Science Graduate Studies Handbook for more details.) All programs must be approved in advance by the graduate program director.

Additional information

Faculty

Faculty members in the department are actively engaged in research in the areas of artificial intelligence, wireless networks, pattern recognition, computer vision, visualization, data management, combinatorics, and distributed computing systems. There are many opportunities for graduate students to participate in these activities toward thesis or project work and independent study.

School of Interactive Games and Media

Andrew Phelps, Director
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The study of media-centric computing has recently emerged as a unique academic discipline that focuses on creating new technology as a means of expression and as a tool for the conveyance of message. Students entering programs in the School of Interactive Games and Media typically arrive with questions such as: How can I create video games? How can I build experiences/entertainment I can share with others online? Can I impact the way people communicate with each other online? How can I express myself with a computer?

The school's programs are designed to look for new ways of using games, multimedia, social connections, etc., for a wide range of applications and uses. The programs focus on more than just the technology, but on systems that drive messages and deliver content. The goal is to create highly technical applications and installations to establish a meaningful, memorable, and entertaining experiences.

Game Design and Development, MS

http://games.rit.edu/

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Program overview

The master of science degree in game design and development allows students to explore the entertainment technology landscape, along with other related areas of software development. The program has its technical roots in the computing and information science disciplines, while simultaneously covering the breadth of the game development field through course work in topics such as computer graphics design, human-computer interaction, interactive narrative, and game design. The degree is specifically for students whom aspire to careers within the professional games industry or a related field such as simulation, edutainment, or visualization.

This is a two-year, on-campus, cohort-based program in which students are admitted through a portfolio review process. Upon completion of their course work, students form development teams that construct a working game engine and software title as the program capstone experience. This requirement includes both individual and group expectations. The capstone culminates in a private defense before program faculty, as well as a public

exhibition. Combined, these requirements provide a unique and comprehensive educational experience for individuals who aspire to a career in the game development industry.

Curriculum

The program's curriculum consists of a core course sequence, a minor, a seminar sequence, and a capstone experience.

Core course sequence

Students choose one of the following core course sequences:

COURSE		QTR. CR. HRS.
Game engine development		
4005-761	Computer Graphics I	4
4005-762	Computer Graphics II	4
4085-834	2D Graphics Programming	4
4085-835	3D Graphics Programming	4
4005-763	Computer Animation: Algorithms and Techniques	4
4085-836	Game Engine Design and Development	4
Artificial intelligence and simulation		
4005-750	Introduction to Artificial Intelligence	4
4085-891	Advanced AI: Evolutionary Computing	4
4005-752	Artificial Intelligence for Interactive Environments	4
4005-759	Topics in Artificial Intelligence	4
4005-756	Genetic Algorithms	4
4005-755	Neural Networks and Machine Learning	4

Minor

Students will complete a minor (three courses) in one of the areas shown below. Students also may create a minor from three courses selected from the major area that they have not studied or they may request approval for a special-topic minor.

COURSE		QTR. CR. HRS.
Asset creation and management		
2014-721	3DDG Modeling	4
Plus two courses from the following:		
2014-722	3DDG Interactive Motion	4
2014-731	3DDG Lighting	4
2014-732	3DDG Shading	4
2014-733	3DDG Character Design	4
2014-747	3DDG Rendering	4
2014-798	Production Pipeline	4
Content authoring for games		
4085-728	Interactive Narrative	4
4085-732	Game Design	4
4085-744	Building Online Communities	4
Human-computer interaction		
4004-745	Foundations of Human Computer Interaction	4
4004-748	Usability Engineering	4
4004-749	Usability Testing	4
Database architecture and design		
4002-720	Data Object Development	4
4002-784	Foundations of Database Client/Server Connectivity	4
4002-785	Fundamentals of DBMS Architecture and Implementation	4

Seminar sequence

Students will complete the game design and development seminar sequence, designed to bring students of various cohorts together to investigate industry issues.

COURSE		QTR. CR. HRS.
4085-791	History and Critical Analysis of Computer Games and Interactive Entertainment	4
4085-794	Online Identity, Social and Community Behavior	4
4085-790	Emerging Themes in Entertainment Technology	4
4085-792	Development Processes in the Games Industry	4
4085-793	Business and Legal Aspects of Game Development	4

Capstone experience

During the winter and spring semesters of the second year, students complete a 20-week, team-based capstone experience which concludes with a presentation and defense of their work. This presentation includes a private faculty review, which constitutes the capstone defense, a public presentation, and a demonstration.

COURSE		QTR. CR. HRS.
4085-887	Capstone Design	4
4085-888	Capstone Development*	2

All requirements for the degree must be completed within seven years of the date of the oldest course counted toward the student's program. Prerequisite courses are excluded.

* The number of capstone credits does not fully represent the expected level of effort and work involved (i.e. more than 6 credits of course work) in successfully completing the development of a game.

Admission requirements

To be considered for admission to the MS in game design and development, candidates must fulfill the following requirements:

- Hold an undergraduate degree in a relevant field, such as information technology, computer science, software engineering, or computer graphics. Students with undergraduate degrees in related disciplines such as computer animation or human computer interaction may be considered.
- Submit official transcripts (in English) of all previously completed undergraduate and graduate course work.
- Have a minimum GPA of 3.25 or a first-class international degree with distinction.
- Submit a portfolio that includes evidence of individual and group projects (clearly marked as such) relevant to the area that the individual wishes to study within the degree program.

- Complete a graduate application.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language (TOEFL). A minimum score of 230 (computer-based), 570 (paper-based), or 88 (Internet-based) on the TOEFL is required. Scores from The Graduate Record Exam (GRE) must also be submitted.

Due to the cohort nature of the program, students are admitted in the fall quarter only. Admission to the program is highly competitive and applicants are selected in a manner that ensures balance among the various curricular tracks and specialties. Students may use GRE scores to strengthen their application. Students with a GPA below 3.25 are required to submit GRE scores.

Additional information

Prerequisites

Students are expected to have at least one year of significant programming experience in a current object-oriented language—preferably C++ or Java—and a solid working knowledge of website development and interactive multimedia concepts. If students do not have these prerequisites, additional course work may be recommended to bridge any educational gaps.

School of Informatics

Department of Information Sciences and Technologies

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Dianne Bills, Graduate Program Director
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The information sciences and technologies department offers master of science degrees in human-computer interaction, information technology, and medical informatics; as well as an advanced certificate in interactive multimedia development. Graduate courses are available to accomodate both full- and part-time graduate students—morning, late afternoon, and evening. Programs typically take at least one and a half to two years to complete. The advanced certificate may be accomplished in one calendar year or less.

Human-Computer Interaction, MS

http://www.ist.rit.edu/

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Program overview

Human-computer interaction (HCI) is a professional discipline that addresses the design, evaluation, and implementation of interactive computing and computing-based systems for the benefit of human use. HCI research is driven by technological advances and the increasing pervasiveness of computing devices in our society. With an emphasis on making computing technologies more user-friendly, HCI has emerged as a dynamic, multifaceted area of study that merges theory from science, engineering, and design–as well as concepts and methodologies from psychology, anthropology, sociology, and industrial design–with the technical concerns of computing.

The master of science in human-computer interaction provides the knowledge and skills necessary for conceptualizing, designing, implementing, and evaluating software applications and computing technologies for the benefit of the user, whether the user constitutes an individual, a group, an organization, or a society. Throughout the curriculum human, technological, and organizational concerns are interwoven and addressed in team- and project-based learning experiences.

This 52 quarter credit hour program is comprised of five required core courses, four advanced electives, two application domain courses, and an 8 credit capstone experience. The core courses provide knowledge and skills in the conceptual and methodological frameworks of HCI and HCI research. Emphasis is on understanding human cognition as it applies to information systems and on interface design, prototyping, and evaluation. Upper-level electives expose students to cutting-edge research and applications in the HCI discipline. The application domain courses provide foundational knowledge in a computing or computing-related domain to which HCI theories and practices may be applied during the capstone experience.

Curriculum

Core courses

All students are required to complete the following five core courses.

COURSE		QTR. CR. HRS.
4002-726	Research Methods	4
4004-745	Foundations of Human-Computer Interaction	4
4004-748	Usability Engineering	4
4004-749	Usability Testing	4
4002-765	User-centered Design Methods	4

Advanced elective courses

To gain depth in this technical field, students select four upper-level electives within the domains of interface and interaction design, usability engineering, or interface architecture.

COURSE		QTR. CR. HRS.
Choose four from the following:		
4002-823	Agent-Based Modeling	4
4002-892	CSCW and Groupware	4
4004-755	Advanced Topics in HCI	4
4004-744	Eye Tracking: Theory, Methodology and Applications	4
4004-781	Usability Economics	4

COURSE		QTR. CR. HRS.
4085-757	Graphical Elements of the User Experience	4
4085-855	Innovation and Invention	4
0514-785	* Advanced Perception	4
0514-787	* Advanced Cognition	4

* Course offered by the department of psychology.

Application domain options

To gain breadth in a technical area to which HCI concepts are applied, students complete two courses in any of the following application domain areas:

- Website development
- Interactive multimedia development
- Computer game design
- Application development
- Learning and human performance
- Bioinformatics
- Ergonomics and safety†
- Special topics‡

† Course is offered by the industrial and systems engineering department.
‡ Other graduate courses offered by the IT department or from graduate-level course work offered by other departments at RIT or other universities with faculty approval.

Capstone thesis/project

The multi-term, 8 credit capstone thesis or project completes the requirements for the degree. The capstone may be completed as a thesis, which is an empirical study of a HCI problem, or as a project, which can be the development of a software product through user-centered design processes. The results are either published in a peer-reviewed journal or publically disseminated in an appropriate professional venue.

COURSE		QTR. CR. HRS.
4004-897	MS HCI Thesis	8
4004-898	MS HCI Project	8

All requirements for the degree must be completed within seven years of the date of the oldest course counted toward the student's program of study. Bridge courses are excluded.

Admission requirements

To be considered for admission to the MS program in human-computer interaction, candidates must fulfill the following requirements:

- Hold a baccalaureate (or equivalent) degree from a regionally accredited institution,
- Have a minimum cumulative GPA of 3.0 (B average),
- Submit transcripts (in English) of all previously completed undergraduate and graduate course work, and
- Have prior study or professional experience in computing; however, study in other disciplines will be given consideration.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language. Minimum scores of 570 (paper-based), 230 (computer-based), or 88 (internet-based) are required.

Applicants with a GPA that is less than 3.0 may be considered, but are required to submit standard Graduate Record Exam (GRE) scores.

Additional information

Prerequisites

This program requires both strong technical and social science skills. Knowledge of quantitative statistical methodologies is important since students review research studies in the literature as well as analyze the results of their own usability evaluations. Students are also expected to have a solid background in computer programming and interactive multimedia development. These competencies may be demonstrated by previous course work, technical certifications, or comparable work experience. Courses are available that may be used to bridge areas where gaps occur in an applicant's qualifications. Applicants will be made aware of any areas where additional course work may be necessary.

Information Technology, MS

http://www.ist.rit.edu/

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Program overview

The master of science degree in information technology is a unique and flexible program that allows students to craft their own program of study within the broad range of the IT computing discipline. Students build upon a core requirement in current information technology directions and opportunities. The specialty areas include website design and interactive multimedia development, application development, usability and interface design, database theory and practice, software project management, eLearning technologies, and computer networking. In addition, students have the option of choosing courses from among the wide variety of fields offered within RIT, such as computer animation, computer graphics design, telecommunications technology, and business.

Curriculum

The program consists of 48 quarter credit hours of graduate study and includes one core course, concentrations, an elective, and a capstone experience. Some of the courses are available online. Please consult the course descriptions for more information on availability and prerequisites.

Core course (4 credits)

COURSES		QTR. CR. HRS.
4002-718	Current Themes in Information Technology	4

Concentrations (36 credits)

COURSES		QTR. CR. HRS.
Web development		
4004-737	Website Design and Technology	4
4004-736	Web Client-Side Programming	
4004-739	Programming for the World Wide Web	4
4004-751	Web-Database Integration	4
XML data management		
4002-770	Introduction to XML	4
4002-771	XML Programming	4
4002-772	XML Transformation and Presentation	4
Multimedia application development		
4085-727	Digital Audio and Computer Music	4
4004-730	Interactive Media Implementation	4
4085-746	Programming for Interactive Multimedia	4
4085-738	Multi-User Media Spaces	4
Human-computer interaction		
4004-745	Foundations of Human-Computer Interaction	4
4004-748	Usability Engineering	4
4002-749	Usability Testing	4
4004-755	Advanced Topics in HCI	4
4002-765	User-Centered Design Methods	4
4002-892	CSCW and GroupWare	4
Media and interaction		
4085-757	Graphical Elements of the User Experience	4
4085-744	Building Online Communities	4
4085-794	Online Identity and Community Behavior	4
4085-855	Innovation and Invention	
Application development		
4002-710	Object Technologies	4
4002-720	Data Object Development	4
4002-725	Component Development	4
4002-784	Fundamentals of Database Client/Server Connectivity	4
4002-542	/890 Native App Mobile Development	4
eLearning technologies		
4002-722	Fundamentals of Instructional Technology	4
4002-723	Interactive Courseware	4
4002-724	Performance Support Systems Design	4
4002-823	Agent-Based Modeling	4
Project management		
4002-830	Project Management	4
4002-831	Process Management	4
4002-820	Economics of Software Development	4
Databases and data management		
4002-720	Data Modeling and Database Implementation	4
4055-744	*NIX Fundamentals for the Application Domain	4
4002-774	Information Assurance Fundamentals	4
4002-784	Fundamentals of Database Client/Server Connectivity	4
4002-785	Fundamentals of DBMS Architecture and Implementation	4
4002-787	Database Performance and Tuning	4
4002-789	Data Warehousing	4
Bioinformatics		
4002-762	Introduction to Bioinformatics Computing	4
4002-763	Computing in Functional and Translational Bioinformatics	4
Networking		
4055-761	Principles of System Administration	4
4055-755	Secure Wireless and Wired Data Networks	4
4055-815	Introduction to Routing and Switching	4
Systems administration		
4055-721	Perl for System Administration	4
4055-761	Principles of System Administration	4
4055-780	Computer System Security	4
System survivability		
4055-761	Principles of System Administration	4
4055-780	Computer System Security	4
4055-755	Secure Wireless and Wired Data Networks	4

Concentrations offered by other RIT departments

With the permission of the graduate program director, students are permitted to complete one concentration (a maximum of 12 graduate credits) from another department at RIT. Concentrations are available in the following areas:

- Technology management
- Information systems
- e-Commerce
- Telecommunications technology
- Automated manufacturing
- Health systems administration
- Computer graphics

Special topics

Students can use the special topics option to design a concentration with approval from the graduate program director.

Elective (up to 4 credits)

Electives are typically chosen from information technology, computer science, computer engineering, electrical engineering, or business. Graduate courses from other departments also may be appropriate, with the prior approval of the graduate program director.

Capstone experience (4 or 8 credits)

A required master's project or thesis is required and should build upon the student's concentrations and electives. Students register for either 4 or 8 quarter credits for the capstone experience, depending on the depth and scope of their investigations. Students who choose the 8-credit capstone option do not take an elective.

Capstone options

COURSES		QTR. CR. HRS.
4002-897	MS IT Thesis	4
4002-898	MS IT Project	4

All requirements for the degree must be completed within seven years of the date of the oldest course counted toward the student's program of study. Bridge courses are excluded.

Admission requirements

To be considered for admission to the MS program in information technology, candidates must fulfill the following requirements:

- Hold a baccalaureate degree from an accredited institution,
- Have a minimum cumulative GPA of 3.0 (B),
- Submit official transcripts (in English) for all previously completed undergraduate and graduate course work,
- Submit a resume,
- Submit two letters of recommendation, and
- Complete a graduate application.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language. Minimum scores of 570 (paper-based), 230 (computer-based), or 88 (Internet-based) are required. Applicants with a lower TOEFL score may be admitted conditionally and may be required to complete a prescribed program in English, along with a reduced program course load.

Applicants from foreign universities must submit Graduate Record Examination (GRE) scores. These scores may also be required for applicants whose undergraduate grade point average is less than 3.0.

Additional information

Prerequisites

It is expected that students wishing to enter the program will have a background in fundamental information technology concepts, including object-oriented programming, computer hardware and software architecture, networking, website design, and interactive multimedia concepts.

Students without the necessary background should complete the prerequisites before applying to the program. Bridge courses are available to satisfy the prerequisites.

Bridge program

Students whose undergraduate preparation or employment experience does not satisfy the prerequisites can make up these deficiencies by completing bridge courses as prescribed by the graduate program coordinator.

The bridge program's courses are not part of the 48 quarter credit hours required for the master's degree. Grades for bridge courses are not included in a student's graduate GPA if the courses are taken before matriculation; they are included if they are taken after matriculation.

Bridge programs can be designed in a variety of ways. Other courses can be substituted, or courses at other colleges can be applied. Contact the graduate program director for approval.

Medical Informatics, MS

http://www.ist.rit.edu/medinfo

Dianne Bills, Graduate Program Director
(585) 475-2700, Dianne.Bills@rit.edu

Program overview

Medical informatics studies the nature of medical information and the use of information technology to manage health-related records and content in medical practice, education, and research. With increases in the application and uses of information technology to the medical industry, there is an unprecedented need for professionals who can use their knowledge of both information technology and health care to improve the safety and quality of health care delivery and to control its costs.

Medical informatics is an emerging profession in which the power of information technology is creatively applied to the information needs of health care. This includes the acquisition, storage, and retrieval of patient data, as well as access to electronically maintained medical knowledge for use in patient care, research, and education. This field requires computing expertise; understanding formal medical terminology, clinical processes, and guidelines; and the application of information and communication systems that can successfully delivery patient information in a number of healthcare settings.

The medical informatics program is offered jointly by RIT and the University of Rochester's School of Medicine and Dentistry. Students choose to matriculate at one of the universities, where they will earn their degree and recieve a diploma bearing the seals of both institutions.

The program is offered on a full- or part-time basis. The full-time program may be completed in approximately two years. For part-time students, competition may take three to four years.

Curriculum

The medical informatics degree is a 14-course program comprised of nine required core courses, a three-course concentration for depth, plus a two-course capstone experience. Students may choose from a set of pre-approved concentrations or, with the pre-approval of the faculty, define a specialized concentration. Depending upon the student's background, some of the program's core courses may be replaced. For example, a physician may be allowed to replace a course such as The Practice of Health Care (4006-704/MFI 404) with one that will be more beneficial. Similarly, a database professional may be allowed to replace the foundation database course.

Students take courses at both universities. The University of Rochester has an academic calendar based upon 15-week semesters, while RIT has 10-week academic quarters. However, all courses are scheduled so that students can attend courses offered by at each university without conflict. All requirements for the degree program must be completed within seven years of the date of the oldest course counted toward the student's program of study. Bridge courses are excluded.

Core courses

RIT COURSE #	UR COURSE #	COURSE TITLE
4002-726	MFI 406	Research Methods†
4006-701	MFI 400	Introduction to Medical Informatics‡
4006-735	MFI 403	Clinical Information Systems (EHR)†
4006-702	MFI 402	Perspectives of Health Informatics‡
4006-704	MFI 404	Practice of Health Care‡
4006-707	MFI 407	Clinical Decision Support‡
4002-720	MFI 430	Data Modeling and Database Implementation†
4006-780	MFI 405	Design, Development, and Deployment of Applications†
4002-820	MFI 401	Economics of Software Development†

† Course offered at RIT.
‡ Course offered at UR.

Concentrations

All students complete a three-course concentration for depth. The six pre-approved concentration options are:

- Electronic health record development*
- Database systems†
- Clinical systems integration†
- Web applications for medicine†
- Management†
- Public health‡

* This concentration includes courses from both RIT and UR.
† Courses for this concentration are available at RIT only.
‡ Courses for this concentration are available at UR only.

With the approval of the faculty, the student may create a customized concentration by selecting courses from the existing concentrations or from related areas, such as bioinformatics or computer systems security.

Capstone

The capstone is a two-course experience, for a total of four academic credits, and is completed in two consecutive academic terms.

RIT COURSE #	UR COURSE #	COURSE TITLE
4006-887	MIF 408A	Capstone in Medical Informatics I†
4006-888	MIF 408B	Capstone in Medical Informatics II†

† Course offered at RIT.

Admission requirements

To be considered for admission into the MS in medical informatics, candidates must fulfill the following requirements:

- Hold a baccalaureate degree from a regionally accredited institution (with a minimum GPA of 3.0), a graduate degree, MD, RN, or other professional degree,
- Submit transcripts (in English) of all previously completed undergraduate and graduate course work,
- Submit a professional essay describing relevant employment or other experience and career plans. Recent undergraduate students without extensive employment experience should discuss their career plans as well as any courses they have completed that are relevant to medical informatics, health care, or information technology.
- Submit three letters of recommendation from individuals who are able to assess the applicant'ss potential for success in the program,
- Have completed at least one year of computer programming in a current object-oriented language or equivalent work experience,*
- Have knowledge of the medical terminology/vocabulary, clinical processes, and information systems that are used to support health care activities and processes,*
- Have a familiarity with anatomy and physiology, including the major systems of the human body, including: the skeletal system, muscle tissue physiology, muscular system, nervous system, cardiovascular system, respiratory system, urinary system, and histology,*
- Have completed the equivalent of one statistics course that covers the fundamental statistical principles necessary to interpret data and present results, including: descriptive statistics, random sampling, normal distribution, confidence intervals, and hypothesis testing. (This prerequisite may be completed post-admission if necessary.)*
- Submit a current resume.
- Complete a graduate application.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language (TOEFL). Minimum scores of 570 (paper-based), 230 (computer-based), or 88 (Internet-based) are required.

* These competencies may be demonstrated through previous course work, technical certifications, or comparable employment experience. RIT and UR offer courses that may be used to bridge areas where gaps occur in an applicant's background. Prerequisite study must be completed with at least a 'B' grade to continue in the program. Contact the graduate coordinator for assistance.

Applicants without previous graduate study and with an undergraduate GPA that is less than 3.0 may be considered for admission, but will be required to submit Graduate Record Exam (GRE) scores. Applicants from international universities are required to submit GRE scores.

An interview with the program's admissions committee may also be required. This program may be started in fall terms only.

Interactive Multimedia Development, Adv. Cert.

http://www.ist.rit.edu/

Dianne Bills, Graduate Program Director
(585) 475-2700, Dianne.Bills@rit.edu

Program overview

As interactive technologies advance, the forms and approaches to human communication change—and the importance of enhancing the communication experience within electronic environments increases. This certificate provides an opportunity for students to gain firsthand knowledge and expertise in the art and science of interactive multimedia design. In this program,

students explore the theories of interactive computing, the fundamentals of interactive multimedia, programming in an authoring language, multimedia design, and the impact of networked technologies in such areas as the Internet.

Curriculum

Projects include the development of websites and interactive multimedia applications. The curriculum consists of six courses:

COURSE		QTR. CR. HRS.
4004-741	Fundamentals of Web-based Multimedia	4
4004-730	Interactive Media Implementation	4
4004-737	Website Design and Technology	4
4004-745	Foundations of Human-Computer Interaction	4
	Two Web, interactive multimedia, or related electives	8

The curriculum can be completed in as few as three quarters. Students have at their disposal a variety of computer, video, and digitizing equipment in our state-of-the-art interactive media laboratories.

All requirements for the certificate must be completed within the seven years of the date of the oldest course counted toward the degree. Bridge courses are excluded.

Prerequisites

Due to continuing advances in the technologies used for interactive multimedia, knowledge of programming is necessary in this field. Students must have object-oriented programming skills equivalent to at least one, but preferably two, undergraduate courses. Bridge courses are available to complete any requirements missing from the applicant's credentials.

Admission requirements

To be considered for admission to the advanced certificate in interactive multimedia development, candidates must fulfill the following requirements:

- Hold a baccalaureate (or equivalent) degree from an accredited institution,
- Have a minimum cumulative GPA of 3.0 (B),
- Submit official transcipts (in English) of all previously completed undergraduate and graduate course work,
- Submit two professional recommendations, and
- Complete a gradute application.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language (TOEFL). Minimum scores of 570 (paper-based), 230 (computer-based), or 88 (Internet-based) are required. Applicants with a lower TOEFL score may be admitted conditionally and may be required to complete a prescribed program in English, along with a reduced program course load. Since this is a part-time program, RIT cannot issue I20 forms to international students.

Department of Networking, Security and Systems Administration

Sylvia Perez-Hardy, Chair
(585) 475-6179, Sylvia.Perez-Hardy@rit.edu
Dianne Bills, Graduate Program Director
(585) 475-6179, Dianne.Bills@rit.edu

Industry today is experiencing two opposing trends. We live in a world of increasingly complex networks and systems recognizing that these technologies are a strategic enabler of corporate adaptation. In opposition to this we see industry reducing their staffing levels while expecting increased efficiency and management oversight in the provision of information technology services. These trends can only coexist through a reliance on a highly educated and technologically proficient networking, security, and system administration staff that understands both the technology and the application of that technology to business issues and opportunities.

To support student learning, most networking, security, and system administration courses are laboratory-based. The computing facilities of the department are driven solely by curricular and research needs and are comprised of five physical lab spaces designed to support different facets of the curriculum. Students use these facilities to investigate concepts, and design and develop systems to meet the needs of the ever-evolving information age. The department also provides access to a remotely accessible virtualization environment known as RLES (Remote Laboratory Emulation System) for both distance and local students to complete laboratory-based courses. Many of our students also work as lab or graduate assistants, adding an additional practical dimension to their educational experiences.

Computing Security and Information Assurance, MS

http://www.nssa.rit.edu/

Dianne Bills, Graduate Program Director
(585) 475-2700, Dianne.Bills@rit.edu

Program overview

Developers and practitioners need to understand the importance of building security and survivability into systems, rather than trying to add it once systems are installed.

The MS in computing security and information assurance includes a foundation of seven core courses designed to give students a better understanding of the technological and ethical roles of computer security in society. Students then develop a specialization in one of several areas by selecting four related elective courses under the guidance of a faculty adviser. Students conclude their program of study with a thesis, completed under the guidance of the faculty. This program enables students to develop a strong foundation, preparing them for leadership positions

in both the private and public sectors in the computer security industry, or for an advanced degree. Students also can prepare for academic or research careers in computer security and information assurance, as well as further academic study.

The program is designed for students who have an undergraduate degree in computer science, information technology, or software engineering, as well as those who have a strong background in a field in which computers are applied, such as computer or electrical engineering.

Graduate courses are generally offered in the afternoon and evening. Some of our students are employed and are pursuing the degree on a part-time basis. A full-time student, one who takes three courses per quarter, may be able to complete the course work in five quarters; part-time students can finish in two to four years. The time required to complete a master's thesis varies according to the student and the scope of the thesis; however, two quarters is typical.

Curriculum

The graduate program of study is composed of core courses, electives, and a thesis for a total of 48 quarter credit hours. The thesis track consists of seven required core courses (28 credits), electives (16 credits), and a master's thesis (4 credits).

Core courses

COURSE		QTR. CR. HRS.
4055-726	Research Methods	4
4055-755	Secure Wireless and Wired Data Networks	4
4055-780	Computer System Security	4
4005-705	Cryptography I	4
4005-774	Secure Database Systems	4
4010-748	Secure Software Engineering: Requirements and Design	4
0110-745	Ethics in Technology	4

Electives

The following is a partial list of electives. Students must complete 16 credit hours of elective courses. Special topic and independent studies are available.

COURSE		QTR. CR. HRS.
4002-876	Secure e-Commerce	4
4055-760	Computer Viruses and Malicious Software	4
4055-841	Advanced Forensics	4
4002-882	Enterprise Security	4
4005-706	Cryptography II	4
4005-749	Topics in Data Communication	4
4005-800	Theory of Computer Algorithms	4

Students also may include elective courses from other RIT departments. Other departments' courses may have prerequisites that will not be approved for degree credit.

Electives provide breadth of experience in security-related areas within computer science, information technology, and software engineering. Students who wish to include courses from departments outside of the list of electives need prior approval of the graduate program director.

Master's thesis

A thesis forms the capstone of the program. In order to register, a student must complete Research Methods (4055-726) and submit an acceptable proposal to the program faculty.

COURSE		QTR. CR. HRS.
4055-897	Thesis	4

Admission requirements

To be considered for admission to the MS in computing security and information assurance, candidates must fulfill the following requirements:

- Hold a baccalaureate degree in computer science, software engineering, information technology, computer engineering, electrical engineering, applied mathematics, or computer engineering technology (exceptional students from other fields may be admitted on a contingent basis),
- Have a minimum grade point average of 3.0,
- Submit official transcripts (in English) of all previously completed undergraduate and graduate course work,
- Submit scores from the Graduate Record Exam (GRE). Minimum scores of 650 (quantitative), 500 (verbal), and 4.5 (analytical reasoning) are required,
- Submit a minimum of two recommendations from well-qualified individuals who are able to assess the applicant's potential for success, and
- Complete a graduate application.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language. Minimum scores of 570 (paper-based), 230 (computer-based), or 88 (Internet-based) are required.

Prerequisites

Applicants must satisfy prerequisite requirements in mathematics (integral calculus, discrete mathematics) and computing (experience with a modern high-level language [e.g., C++, Java], operating systems, OS scripting, software engineering, and computer networking).

Bridge program

If an applicant lacks any of the required prerequisites, bridge courses may be recommended to allow students to achieve the required knowledge and skills. Generally, formal acceptance into the master's program is deferred until the applicant has made significant progress through these necessary courses.

Students whose undergraduate preparation or employment experience does not satisfy the prerequisites may make up these deficiencies through up to a year of study, taking one or more of the following courses, as prescribed by the graduate program director:

Mathematics

1016-281, 282	Calculus
1016-265	Discrete Math I

Computing

4050-211	C++ for Networking and System Administration
4003-713	Operating Systems
4010-361	Software Engineering
4055-746	Telecommunications Network Protocols
4055-761	Principles of System Administration

If any bridge courses are indicated in a student's plan of study, the student may be admitted on the condition that he or she successfully completes the bridge program courses with a grade of B or better. All remaining bridge program courses must be completed with a grade of at least a B; courses with lower grades must be repeated. Bridge program courses are not part of the 48 credits required for the master's degree. These grades are not included in a student's graduate grade point average.

A bridge program can be designed in different ways. Often, other courses can be substituted, and courses at other colleges can be applied. All bridge course work must be approved in advance by the graduate program director.

Additional information

Faculty

Faculty members are actively engaged in consulting and research in the information assurance areas, including cryptography, databases, networking, and software engineering. There are many opportunities for graduate students to participate in research activities toward thesis or independent study work.

Maximum time limit

Requirements for the degree must be completed within seven years of the date of the oldest course counted toward the student's program. Bridge courses are excluded.

Networking and System Administration, MS

http://www.nssa.rit.edu/

Dianne Bills, Graduate Program Director
(585) 475-2700, Dianne.Bills@rit.edu

Program overview

Effective technical leadership in a modern enterprise relies on a combination of technical knowledge and an understanding of basic business concepts and processes. The master of science in networking and systems administration enables students to study, develop, and become proficient in the practices, methodologies, and techniques used in the management of a modern IT networking infrastructures. The focus is on enterprise-scale problems and solutions, addressing the needs of a medium to large organization.

Curriculum

The program consists of 11 courses, which include seven required core courses (28 credit hours), four elective courses (16 credit hours) (chosen from an approved list of electives), and a four-credit thesis or capstone project. Two quarters of cooperative education experience is optional.

Core courses

0102-740	Organizational Behavior and Leadership
0106-744	Project Management
4055-726	Research Methods
4055-755	Secured Wireless and Wired Networks
4055-817	Emerging Network Technologies
4055-850	Network Design and Performance
4055-882	Enterprise Security

Electives

0101-703	Accounting for Decision Makers
4055-760	Computer Viruses and Malicious Software
4055-780	Computer System Security
4055-818	Network Management
4055-841	Advanced Computer Forensics
4055-862	Advanced Routing Protocols
4055-883	Enterprise Networking
4055-884	Enterprise Service Provisioning

Thesis/Capstone

All students are required to complete a master's thesis or capstone project. The time required to complete the thesis varies according to its scope. However, two quarters is typical.

4055-896	Proposal Development (optional)
Choose one of the following options:	
4055-897	MS NSSA Thesis
4055-898	MS NSSA Project

Admission requirements

To be considered for admission to the MS program in networking and systems administration, candidates must fulfill the following requirements:

- Hold a baccalaureate (or equivalent) degree from an accredited institution,
- Have a minimum cumulative grade point average of 3.0 (B)*,
- Submit transcripts (in English) of all previously completed undergraduate and graduate course work,
- Submit two professional recommendations, and
- Complete a graduate application.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language (TOEFL). Minimum scores of 570 (paper-based), 230 (computer-based), or 88 (Internet-based) are required. Applicants with a lower TOEFL score may be admitted conditionally, but may be required to complete a prescribed program in English along with a reduced program course load.

- Applicants from foreign universities must submit Graduate Record Examination (GRE) scores. Visa forms cannot be issued by RIT for part-time or distance education.

* The GRE is recommended for those applicant's whose undergraduate grade point average is less than 3.0.

Additional information

Bridge program

Students wishing to enter the program must have a solid educational or employment record in networking, security, and systems administration. If a student does not have the necessary background, bridge courses may be recommended to allow students to meet these prerequisites. Formal acceptance into the master's program may be possible even though the applicant must complete bridge program courses.

Students whose undergraduate preparation or industrial experience does not satisfy the technical prerequisites of this degree can make up this deficiency through study, or taking one or more of the following RIT courses, as prescribed by the graduate program program director:

Technical prerequisites

4050-211	C++ for Networking and Systems Administration
Choose one of the following:	
4055-721	PERL for System Administration
4050-302	Scripting in Perl
4055-761	Principles of System Administration
4055-746	Telecommunications Network Protocols

The bridge program courses are not part of the 48 credit hours required for the master's degree. Grades for bridge courses are not included in a student's graduate GPA if the courses are taken before matriculation; courses that are competed after matriculation are included.

A bridge program can be designed in a variety of ways. Other courses can be substituted, or courses at other colleges can be applied. Contact the graduate program director for approval.

Study options

This program is designed for full- or part-time study through distance (online learning) or on-campus instruction. Students who take at least three courses per quarter are considered full-time and may be able to complete their course work in one year. Part-time students may take as few as one course per quarter, and may take up to four years to complete their course work.

Information Assurance, Adv. Cert.

http://nssa.rit.edu/

Dianne Bills, Graduate Program Director
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Program overview

This advanced certificate provides the fundamental knowledge and expertise in network security and forensics necessary to provide information assurance in networked environments. Students learn to make computers and networks resistant to attack by closing off vulnerabilities and by monitoring intrusions. The application of forensics allows successful attacks on computer systems to be detected. This involves gathering information on the nature and extent of the attack for presentation in court, as well as assessing the extent of the damage to an organization. Courses taken as part of this certificate can transfer into the MS in networking and systems administration or the MS in computing security and information assurance.

Curriculum

The advanced certificate in information assurance consists of a four-course sequence.

COURSE		QTR. CR. HRS.
4055-755	Secured Wireless and Wired Network	4
4055-780	Computer System Security	4
4055-841	Advanced Computer Forensics	4
4055-882	Enterprise Security	4

Admission requirements

To be considered for admission to the advanced certificate program in information assurance, candidates must fulfill the following requirements:

- Hold a baccalaureate degree from an accredited institution with course work or extensive work experience in networking, systems administration, programming (C++) and scripting (Perl preferred),
- Have a minimum grade point average of 3.0 (or a first class degree from a foreign university),
- Submit transcripts (in English) of all previously completed undergraduate and graduate course work,
- Complete a graduate application.
- International applicants, whose native language is not English, must submit scores from the Graduate Record Exam (GRE) and the Test of English as a Foreign Language. Minimum TOEFL scores of 570 (paper-based exam), 230 (computer-based exam), or 88 (Internet-based exam) are required.

While GRE scores are not required, they are strongly suggested for applicants with an undergraduate degree but with a lower GPA than required. Strong scores, or a proven record of achieving a grade of "B" or better in more recent course work, could strengthen a candidate's application for admission.

Networking and System Administration, Adv. Cert.

http://nssa.rit.edu/

Dianne Bills, Graduate Progam Director
(585) 475-2700, Dianne.Bills@rit.edu

Program overview

The advanced certificate in networking and system administration consists of five courses that provide students with the ability to identify and deploy tools and techniques used in the administration of computer networks and to assume leadership roles in the administration of these networks. These courses also ensure that graduates will be able to discuss and develop policies, procedures, and standards needed to enhance the security of the networks. These courses may be completed as a stand alone certificate or can be used towards the prerequisites (12 credits) and the requirements (8 credits) of the MS program in networking and systems administration.

Curriculum

COURSE		QTR. CR. HRS.
0102-740	Organizational Behavior	4
4055-721	PERL for System Administration	4
Choose one of the following:		
4055-746	Telecom Network Protocols	4
4055-815	Introduction to Switching and Routing	4
4055-761	Principles of System Administration	4
4055-882	Enterprise Security	4

Admission requirements

To be considered for admission to the advanced certificate in networking and system administration, candidates must fulfill the following requirements:

- Hold a baccalaureate degree from an accredited institution with course work or extensive work experience in networking, systems administration, and programming in C++; experience in scripting is beneficial,
- Have a minimum grade point average of 3.0 (or a first class degree from a foreign university),
- Submit official transcripts (in English) of all previously completed undergraduate and graduate course work, and
- Complete a graduate application.
- International applicants, whose native language is not English, must submit scores from the Graduate Record Exam (GRE) and the Test of English as a Foreign Language. Minimum TOEFL scores of 570 (paper-based exam), 230 (computer-based exam), or 88 (Internet-based exam) are required.

While GRE scores are not required, they are strongly suggested for applicants with an undergraduate degree but with a lower GPA than required. Strong scores, or a proven record of achieving a grade of B or better in more recent course work, could strengthen a candidate's application for admission.

Additional information

Study options

Students may complete the advanced certificate program on a full- or part-time basis. The courses in this program are available both online and on campus.

Network Planning and Design, Adv. Cert.

http://nssa.rit.edu/

Dianne Bills, Graduate Program Director
(585) 475-2700, Dianne.Bills@rit.edu

Program overview

The advanced certificate in network planning and design provides students with the knowledge and expertise needed to seek careers in project management, emerging network technologies, network design, and enterprise networking. Students completing this program will be able to design and implement project management plans for sophisticated network design projects; understand and work with emerging technologies in networking and system administration; develop, test, and implement a network model to simulate the performance of an enterprise scale network; and develop and implement the security policies and procedures that surround an enterprise scale network.

This program consists of four courses. The certificate may be completed separately or, at a later date, these courses may be applied to one of the following MS degrees: networking, security, and systems administration; computing security and information assurance; or information technology.

Curriculum

COURSE		QTR. CR. HRS.
0106-744	Project Management	4
4055-817	Emerging Network Technologies	4
4055-850	Network Design and Performance	4
4055-882	Enterprise Networking	4

Admission requirements

To be considered for admission to the advanced certificate in network planning and design, candidates must fulfill the following requirements:

- Hold a baccalaureate degree from an accredited institution with course work or extensive work experience in networking, systems administration, and programming in C++; experience in scripting (Perl preferred) is beneficial,
- Have a minimum grade point average of 3.0 (or a first class degree from a foreign university),
- Submit official transcripts (in English) of all previously completed undergraduate and graduate course work,
- Complete a graduate application.

- International applicants, whose native language is not English, must submit scores from the Graduate Record Exam (GRE) and the Test of English as a Foreign Language. Minimum TOEFL scores of 570 (paper-based), 230 (computer-based), or 88 (Internet-based) are required.

While GRE scores are not required, they are strongly suggested for applicants with a lower undergraduate GPA than required. Strong scores, or a proven record of achieving a grade of B or better in more recent course work, could strengthen a candidate's application for admission.

Additional information

Study options

Courses for this advanced certificate are available both on campus and online.

Department of Software Engineering

James Vallino, Chair
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Demand for quality software delivered on time and within budget has never been higher. According to recent studies, this trend will increase for years to come. The master of science degree in software engineering helps fulfill the industry need for qualified software engineers.

Software Engineering, MS

http://www.se.rit.edu/grad

Stephani Ludi, Graduate Program Director
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Program overview

The master of science in software engineering is designed to attract software professionals with a formal undergraduate background in software engineering, computer science, or computer engineering and at least one year of professional experience. The program's core content ensures that graduates will possess both breadth and depth of knowledge in software engineering. Specialization tracks in software quality and design provide the student with the opportunity to match their graduate education with their professional goals.

The MS in software engineering is available to professionals without a formal baccalaureate degree in computing, but who may otherwise have sufficient experience developing software professionally, and those who have earned an undergraduate computing degree and have at least one year of software development experience.

Curriculum

The program comprises 52 credit hours, anchored by a three-quarter (12 credit hour) practicum, where students work with peers and faculty on a long-term, moderately complex software development project. Initially students will serve in basic support and development roles, but as they progress through the practicum and accompanying course work, they will be assigned correspondingly greater responsibilities. The program combines fundamental and theoretical concepts taught in courses, with their application in a constrained but realistic setting.

Core courses

COURSE		QTR. CR. HRS.
4011-700	Software Engineering Practicum I	4
4011-701	Software Engineering Practicum II	4
4011-702	Software Engineering Practicum III	4
4011-710	Research Methods	4
4011-720	Software Evolution and Re-engineering	4
4011-730	Process Engineering and Environments	4
4011-740	Empirical Software Engineering	4
4011-750	Software Modeling	4
4011-780	Experience and Research Report	4

Electives

Track electives: Choose one track elective from the following courses:

- 4011-760 Software Quality Engineering (quality track)
- 4011-770 Software Architectures and Product Lines (design track)

Technical electives: Choose three graduate-level courses from any of the following programs:

- Computer science
- Software development and management
- Software engineering
- Computer engineering
- Business

Admission requirements

To be considered for admission to the MS program in software engineering, candidates must fulfill the following requirements:

- Hold a baccalaureate degree from an accredited institution,
- Have a cumulative grade point average of 3.0 or higher (Prospective students from institutions that do not use the GPA scale are expected to demonstrate an equivalent level of academic accomplishment. Formal academic background in software engineering, computer science, or computer engineering is a plus.),
- Submit official transcripts (in English) of all previously completed undergraduate and graduate course work,
- Submit a professional essay (1-4 pages) describing current job (if applicable), relevant experience, and career plans,
- Submit a current resume (including descriptions of significant software projects in which the candidate participated), and
- Complete a graduate application.

- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language (TOEFL). Minimum scores of 570 (paper-based), 230 (computer-based), or 88 (Internet-based) are required.

Prospective students without a bachelor's degree in software engineering, computer science, or computer engineering are expected to submit evidence of professional experience developing software. For these individuals, a minimum of three years of professional experience is required.

Additional information

Bridge courses

Based on the evaluation of academic and relevant experience, the program director may require some applicants to successfully complete bridge courses to fill in any gaps in their background. Successful completion of bridge courses is necessary for registration in graduate-level courses.

Graduate Faculty

Andrew L. Sears, BS, Rensselaer Polytechnic Institute, Ph.D., University of Maryland—Dean; Professor

Wiley McKinzie, BA, University of Wichita; MS, State University of New York at Buffalo—Vice Dean; Professor

Computer Science

Paul Tymann, BS, MS, Syracuse University—Department Chair; Professor

Peter G. Anderson, BS, Ph.D., Massachusetts Institute of Technology—Professor Emeritus

Reynold Bailey, BS, Midwestern State University; MS, Ph.D., Washington University—Assistant Professor

Ivona Bezakova, BS, Comenius University; Ph.D., University of Chicago—Assistant Professor

Hans-Peter Bischof, BS, MS, University of Ulm; Ph.D., University of Osnabrück—Graduate Program Director; Professor

Zack Butler, BS, Alfred University; Ph.D., Carnegie Mellon University—Associate Professor

Roxanne Canosa, BS, State University College at Brockport; MS, Ph.D., Rochester Institute of Technology—Associate Professor

Warren Carithers, BS, MS, University of Kansas—Associate Professor

Henry Etlinger, BS, University of Rochester; MS, Syracuse University—Undergraduate Program Coordinator; Associate Professor

Matthew Fluet, BS, Harvey Mudd College; Ph.D., Cornell University—Assistant Professor

Roger S. Gaborski, BS, MS, State University of New York at Buffalo; Ph.D., University of Maryland—Professor

Joe Geigel, BS, Manhattan College; MS, Stevens Institute of Technology; Ph.D., George Washington University—Associate Professor

James Heliotis, BS, Cornell University; Ph.D., University of Rochester—Professor

Edith Hemaspaandra, BS, MS, Ph.D., University of Amsterdam—Professor

Chris Homan, AB, Cornell University; MS, Ph.D., University of Rochester—Associate Professor

Trudy Howles, BS, MS, Rochester Institute of Technology; Ph.D., Nova Southwestern University—Associate Professor

Alan Kaminsky, BS, Lehigh University; MS, University of Michigan—Associate Professor

Fereydoun Kazemian, BS, Queen Mary College; MS, Pittsburgh State University; Ph.D., Kansas State University—Associate Professor

Mineseok Kwon, BS, MS, Seoul National University; Ph.D., Purdue University—Associate Professor

Xumin Liu, BE, Dalian University; ME, Jinan University; Ph.D., Virginia Polytechnic Institute—Assistant Professor

Stanislaw Radziszowski, MS, Ph.D., University of Warsaw—Professor

Rajendra K. Raj, BS, Indian University of Technology; MS, University of Tennessee; MS, Ph.D., University of Washington—Professor

Leonid Reznik, MS, St. Petersburg Aircraft Academy; Ph.D., St. Petersburg Polytechnic Institute—Professor

Axel Schreiner, MS, Northern Illinois University; Ph.D., University of Illinois—Professor

Walter A. Wolf, BA, Wesleyan University; MS, Rochester Institute of Technology; MA, Ph.D., Brandeis University—Professor

Richard Zanibbi, BA, MS, Ph.D., Queens University (Canada)—Assistant Professor

School of Interactive Games and Media

Andrew Phelps, BFA, Bowling Green State University; MS, Rochester Institute of Technology—Director; Professor

Jessica Bayliss, BS, California State University at Fresno; MS, Ph.D., University of Rochester—Associate Professor

Kevin Bierre, BA, State University College at Geneseo; MS, Cornell University and Rochester Institute of Technology—Associate Professor

John A. Biles, BA, MS, University of Kansas—Professor

Nancy Doubleday, BS, MS, Rochester Institute of Technology—Associate Professor

Chris Egert, BS, MS, Rochester Institute of Technology; Ph.D., University at Buffalo— Associate Director; Associate Professor

Kevin Gold, AB, Harvard University; MS, Ph.D., Yale University—Assistant Professor

Gordon Goodman, BS, State University of New York at Binghamton; MS (computer science), MS (information technology), Rochester Institute of Technology—Professor

W. Michelle Harris, BS, Carnegie Mellon University; MPS, New York University—Associate Professor

Tona Henderson, BS, Southwest Missouri State University; MS, University of Missouri—Associate Professor

Jay Alan Jackson, BS, MS, Ph.D., Florida State University—Associate Professor

Stephen Jacobs, BA, MA, New School for Social Research—Associate Professor

Anthony Jefferson, BS, State University College at Oswego; MS, Rochester Institute of Technology—Lecturer

Stephen Kurtz, BA, University of Miami; MS, MFA, Rochester Institute of Technology—Professor

Elizabeth Lane Lawley, AB, MLS, University of Michigan; Ph.D., University of Alabama—Professor

Elouise Oyzon, BFA, MFA, Rochester Institute of Technology—Associate Professor

Jonathan Schull, BS, Reed College; MA, Ph.D., University of Pennsylvania—Associate Professor

David I. Schwartz, BS, MS, Ph.D., University of Buffalo—Associate Professor

Erik Vick, BS, MS, Ph.D., University of Central Florida—Assistant Professor

Keith Whittington, BS, Rensselaer Polytechnic Institute; MS, Nova Southeastern University—Associate Professor

School of Informatics

Evelyn P. Rozanski, BS, State University College at Brockport; MS, Syracuse University; Ph.D., State University of New York at Buffalo—Director; Professor

Information Sciences and Technologies

Jeffrey A. Lasky, BBA, MBA, City College of New York; MS, University of Minnesota—Department Chair; Professor

Catherine I. Beaton, BA, BEd, MITE, Dalhousie University—Associate Professor

Dianne P. Bills, BA, University of Rochester; MS, Rochester Institute of Technology—Graduate Program Director; Associate Professor

B. Thomas Golisano College of Computing and Information Sciences

Sean Boyle, BS, MS, Rochester Institute of Technology—Lecturer

Daniel S. Bogaard, BFA, Indiana University; MS, Rochester Institute of Technology—Associate Professor

Deborah Coleman, AAS, Rochester Institute of Technology; BS, Empire State College; MS, Rochester Institute of Technology—Associate Professor

Michael Floeser, AAS, BS, MS, Rochester Institute of Technology—Lecturer

Anne Haake, BA, Colgate University; MS, Rochester Institute of Technology; MS, Ph.D., University of South Carolina—Associate Professor

Edward Holden, BA, State University College at Oswego; MBA, Rochester Institute of Technology—Associate Professor

Jai Kang, BS, Seoul National University; MA, Kent State University; MS, Georgia Institute of Technology; Ph.D., State University of New York at Buffalo—Associate Professor

Jim Leone, BS, University of Cincinnati; MA, Ph.D., Johns Hopkins University—Professor

Rayno Niemi, BS, MS, Ph.D., Rensselaer Polytechnic Institute—Professor

Ronald Perry, BS, MS, Rochester Institute of Technology—Professor

Evelyn P. Rozanski, BS, State University College at Brockport; MS, Syracuse University; Ph.D., State University of New York at Buffalo—Professor

Jeffrey Sonstein, BA, MA, New College of California—Assistant Professor

Brian Tomaszewski, BA, University at Albany; MA, State University of New York at Buffalo; Ph.D., Pennsylvania State University—Assistant Professor

Nicholas Thireos, BS, Wabash College; MS, Utah State University—Medical Informatics Program Director

Ronald P. Vullo, BS, LeMoyne College; Ed.M., Ph.D., University at Buffalo—Associate Professor

Elissa M. Weeden, BS, MS, Rochester Institute of Technology—Faculty Associate for Undergraduate Affairs; Associate Professor

Michael A. Yacci, BS, Ithaca College; MS, Rochester Institute of Technology; Ph.D., Syracuse University—Professor

Qi Yu, BS, Zhejiang University; ME, National University of Singapore; Ph.D., Virginia Polytechnic Institute—Assistant Professor

Stephen Zilora, BS, University of Rochester; MS, New Jersey Institute of Technology—Associate Professor

Networking, Security, and Systems Administration

Sylvia Perez-Hardy, BS, MBA, Cornell University—Department Chair; Associate Professor

George Barido, BS, State University College at Brockport; MS, Rochester Institute of Technology—Lecturer

Charles B. Border, BA, State University College at Plattsburgh; MBA, Ph.D., State University of New York at Buffalo—Associate Professor

Tina Chapman-DaCosta, BA, State University College at Brockport; MS, Rochester Institute of Technology—Senior Lecturer

Bruce H. Hartpence, BS, MS, Rochester Institute of Technology—Associate Professor

Lawrence Hill, BS, MS, Rochester Institute of Technology—Associate Professor

Daryl Johnson, BS, St. John Fisher College; MS, Rochester Institute of Technology—Associate Professor

Daniel Kennedy, BS, MS, Rochester Institute of Technology—Lecturer

Jim Leone, BS, University of Cincinnati; MA, Ph.D., Johns Hopkins University—Professor

Peter Lutz, BS, St. John Fischer College; MS, Ph.D., State University of New York at Buffalo—Professor

Sharon P. Mason, BS, Ithaca College; MS, Rochester Institute of Technology—Associate Professor

Sumita Mishra, BS, Patna University; BS, Ph.D., State University of New York at Buffalo—Assistant Professor

Tae (Tom) Oh, BS, Texas Tech University; MS, Ph.D., Southern Methodist University—Associate Professor

Yin Pan, BS, MS, Shanghai Normal University; MS, Ph.D., State University of New York at Binghamton—Associate Professor

Nirmala Shenoy, BE, ME, University of Madras; Ph.D., University of Bremen—Professor

William Stackpole, BS, Roberts Wesleyan College; MS, Rochester Institute of Technology—Associate Professor

Luther Troell, BS, MS, Texas A&M University-Kingsville; Ph.D., University of Texas at Austin—Professor

Harris Weisman, BS, Cornell University; MBA, Rensselaer Polytechnic Institute—Lecturer

Kaiqi Xiong, MS, Ph.D., Claremont Graduate University; MS, Ph.D., North Carolina State University—Assistant Professor

Bo Yuan, BS, Shanghai Teachers' University; Ph.D., State University of New York at Binghamton—Associate Professor

Software Engineering

James Vallino, BE, The Cooper Union; MS, University of Wisconsin; Ph.D., University of Rochester—Department Chair; Professor

J. Scott Hawker, BS, MS, Texas Tech University; Ph.D., Lehigh University—Assistant Professor

Stephanie A. Ludi, BS, MS, California Polytechnic State University at San Luis Obispo; Ph.D., Arizona State University—Graduate Program Director; Associate Professor

Michael J. Lutz, BS, St. John Fisher College; MS, State University of New York at Buffalo—Professor

Andrew Meneely, BA, Calvin College; Ph.D., North Carolina State University—Assistant Professor

Thomas Reichlmayr, BS, MS, Rochester Institute of Technology—Associate Professor

LihuaXu, BS, Nanchang University; MS, Ph.D., University of California—Assistant Professor

Computing and Information Sciences

Pengcheng Shi, BS, Shanghai Jiao Tong University; MS, M.Phil., Ph.D., Yale University—Doctorate Program Director; Professor

Justin Domke, BS, Washington University in St. Louis; MS, Ph.D., University of Maryland at College Park—Assistant Professor

Huafeng Liu, BS, MS, Ph.D., Zhejiang University—Associate Professor

Linwei Wang, BS, Zhejiang University; M.Phil., Hong Kong University of Science and Technology; Ph.D., Rochester Institute of Technology—Assistant Professor

Information Sciences and Technologies

4002-710 Object Technologies
This is a course in the principles and techniques of designing and implementing software objects. Current software environments are used to explore effective design methods and concepts. Topics include basic object design, class definition and syntax, object-oriented design, software quality and object evaluation. Software design and programming projects are required. (4002-714 or permission) **Class 4, Distance Format, Credit 4**

4002-714 Java for Programmers
An intensive survey of the Java programming language for experienced programmers. This course covers the creation of application programs. Topics include: basic language concepts (declaring and evaluation of data, statements, expressions, control flow, and input/output), object-oriented fundamentals, GUI interfaces, exception handling, debugging, threads, and the client/server environment. Programming projects will be required. (A two-course object-oriented programming sequence in a language other than Java) **Class 5, Distance Format, Credit 4**

4002-716 C++ Programming Workshop
A workshop in the C++ programming language intended for students to gain programming experience. This course will focus on modern programming concepts such as reusability, data abstraction, information hiding, exception handling and object-oriented design. Programming projects will be required. (4002-710 or permission of instructor) **Class 4, Distance Format, Credit 4**

4002-718 Current Themes in Information Technology
This course provides entering graduate students in Information Technology with an overview of current theory and issues in the field. Topics covered would include social and cultural impacts of technology, virtuality digital communication, and online communities. Using reading from a variety of books and periodicals, students will be presented with views on information technology in a socioeconomic context. (MS-IT Bridge) **Class 4, Distance Format, Credit 4**

4002-720 Data Model and Database Implementation
This course provides a theoretical and practical introduction to the design and development of relational database systems. Current software environments are used to explore effective database design and implementation concepts. Topics include data modeling, database design, data query and manipulation, and transaction management along with current topics. Database design and implementation projects are required. (A two-course object-oriented programming sequence) **Class 4, Distance Format, Credit 4**

4002-722 Fundamentals of Instructional Technology
The world of information technology offers the possibility of transforming the way that instruction is designed and delivered. However, few information technology professionals understand the methods and materials of instructional design. As a professional in information technology, a student may be responsible for designing instruction either in a business or an educational context. This course enables the student to be able to plan, organize, and systematically develop instructional materials. The course uses an Instructional Systems Design (ISD) model to analyze, design, deliver, and evaluate instruction. (4002-770) **Class 4, Distance Format, Credit 4**

4002-723 Interactive Courseware
Computer software that teaches is referred to as courseware. This course was designed to help you make the transition from "general" Instructional Design (4002-722/510) into the actual application of these principles in a computer-based environment. Although the basic principles of instructional design hold true in all media environment, using these teaching and learning principles is somewhat different when developing instruction that will be delivered by computer. This course teaches procedures that have already been successful in the design and development of courseware. (4002-722) **Class 4, Distance Format, Credit 4**

4002-724 Performance Support Systems Design
An electronic performance support system (EPSS) is a software technology, designed to give each user what he or she needs when he or she needs it. It is designed to enable skilled performance without training. An EPSS can be defined functionally, by what it does. The job of an EPSS is to help a worker perform his or her job better. Typical components of an EPSS encompass tutorials, drills, simulations, and hypertexts, but often include expert systems, help systems, and intelligent job aids. This course examines some of the relevant literature supporting EPSS and provides students with the opportunity to design and develop several different components of a performance support system. (4002-722 and a two course programming sequence) **Class 4, Distance Format, Credit 4**

4002-725 Component Development
A programming course focused on the use, design and implementation of reusable software components. Students create and test components based on current technology. Issues of reusable design, quality, component libraries, and interoperability are included. Design and programming project is required. (4002-710) **Class 4, Distance Format, Credit 4**

4002-726 Research Methods
This course will prepare students to conduct research and to design experiments and analyze data for empirical studies in Information Technology. Students will explore qualitative and quantitative research methods, experimental and non-experimental design, theoretical framework development, statistical data analysis, sampling and data collection methods within the context of information technology research. Case studies, mini-research projects and scholarly writing assignments will be required. (0307-712 or equivalent) **Class 4, Distance Format, Credit 4**

4002-740 Geographic Information Science and Tech
This course provides a survey of the theory, concepts, and technologies related to representation and understanding of the earth—a scientific domain known as Geographic Information Science and Technology (GIS and T). Students will gain hands-on experience with technologies such as Global Positioning Systems (GPSs), Geographic Information Systems (GISs), remote sensing, Virtual Globes (Google Earth), and web mapping mashups. Furthermore, students will learn relevant GIS and T theory, concepts, and research trends such as spatial reasoning, spatiotemporal data representation, and spatial analysis. **Class 4, Credit 4 (F)**

4002-748 Spatial Model and Visual
This geographic analysis course explores the spatial and temporal modeling and visualization of natural and engineered systems and their interactions in the context of disaster management. Course topics include characterization of spatial and networked data from remote sensing platforms and sensor networks, three- and four-dimensional spatial analysis, network analysis, and approaches to predictive modeling and uncertainty analysis. Students will examine use of models and spatial data for decision support as they apply within a GIS. Students will collaborate on an in-depth, interdisciplinary, group project that will explore use of geographic analysis in a real environment or man-made disasters. Projects will be developed in a collaboration with a government planning agency and/or geospatial industry partner. (4002-740, or permission of instructor) **Class 4, Credit 4**

4002-752 Themes in Software Development and Mange
This course will present prominent and emerging views of technologies, approaches, and issues in application development to entering graduate students in the Software Development and Management Program. The range of topics will encompass a broad spectrum of the software development life cycle using readings from a variety of books and periodicals, independent research, and presentations by leading experts on application development. **Class 4, Distance Format, Credit 4**

4002-763 Advanced Bioinformatics Computing
This course will provide an in-depth exposure to advanced techniques in computational genomics. Topics may include: gene finding, genetic algorithms, hidden Markov models, neural networks, gene expression analysis, clustering algorithms, probabilistic models of evolution, phylogenetic trees, simple and complex diseases: gene mapping, SNP analysis, machine learning, molecular network analysis, probabilistic framework for modeling and interference, systems biology. (One year object oriented programming sequence, Discrete Math I (1016-265), Data Analysis I (1016-319) **Class 2, Lab 3, Credit 4**

4002-765 User Centered Design Methods
This course will focus on the major user centered design methodologies used in the development of applications and environments. Topics include: evolution of software design methods, emergence of user centered design, and key concepts and attributes of contextual, scenario-based, and performance-centered design. Case studies will be used to illustrate the different design methods. Software design projects will be required. (4004-745 or by instructor approval) **Class 4, Distance Format, Credit 4**

4002-770 Introduction to XML
This course will focus on the development and use of the extensible markup language (XML) to create structured data. Emphasis will be placed on the conceptual framework of XML, key components and practices of XML design, XML standards and methods of creating structured data and metadata, research issues in XML development and use. (4004-737 and 4004-739) **Class 4, Credit 4**

4002-771 XML Programming
Exchange of information between disparate programs is a significant problem in industry. Students will learn how to leverage XML to achieve interoperability between programs. Topics covered in this hands-on course include parsing and generating XML, and web services. (4002-770 and 4002-714) **Class 4, Credit 4**

4002-772 XML Transformation and Presentation
This course will explore techniques and technologies for transforming XML documents using XSLT and XSL-FO. The emphasis will be on transformation of XML data into human-readable documents, such as HTML pages and PDF files. Topics covered will include XSLT syntax and processing, XPath and XPointer. Students will implement projects to present XML data using a variety of transformation tools and technologies. (4002-770) **Class 4, Credit 4**

4002-774 Information Assurance Fundamentals
This course provides an introduction to the topic of information assurance as it pertains to an awareness of the risks inherent in protecting digital content in today's networked computing environments. Topics in secure data and information access will be explored from the perspectives of software development, software implementation, data storage, and system administration and network communications. Current software exploitation issues and techniques for information assurance will be investigated. (Graduate standing in GCCIS) **Class 4, Credit 4**

4002-784 Fundamentals of Database Client/Server Computing
Students will investigate strategies for client-server and server communication against single or multiple database servers. Specifically, students will configure, test, and demonstrate successful communication between multiple database servers and multiple clients. Similarities and differences between commercially available connectivity packages, and issues impacting performance will be explored. Programming exercises are required. (4002-360 or 4002-720 and 4002-219 or 4002-414 or 4002-714) **Class 4, Credit 4**

4002-785 Fundamentals of DBMS Architecture and Implementation
Students will be introduced to issues in client/server database implementation and administration. Topics such as schema implementation, storage allocation and management, user creation and access security, transaction management, data backup and recovery, and performance measurement and enhancement will be presented in lecture and investigated laboratory environment. Students will configure and demonstrate successful management of a database server for client access. (4002-360 or 4002-720 and 4055-744) **Class 5, Credit 4**

4002-787 Database Performance and Tuning
Students will explore database theory as it applies to the performance and tuning of database systems. Topics in database performance will be explored including: physical and logical design issues, the hardware and software environment, SQL statement execution and front end application issues. Techniques in performance monitoring and tuning will be investigated. (4055-744 and 4002-785) **Class 5, Credit 4**

4002-789 Data Warehousing
This course covers the purpose, scope, capabilities, and processes used in data warehousing technologies for the management and analysis of data. Students will be introduced to the theory of data warehousing, dimensional data modeling, the extract/transform/load process, warehouse implementation, dimensional-data modeling, and summary-data management. The basics of data mining and importance of data security will also be discussed. Hands-on exercises include implementing a data warehouse. (4002-785) **Class 4, Credit 4**

4002-810 Simulations and Learning Environments
A learning environment is an electronic environment in which students are provided resources from which to learn. These resources may include tutorials, but are generally far more experimental in nature. A valuable component within a learning environment is an instructional simulation, which provides an opportunity for learners to interact with a safe, virtual world. Kolb's experiential learning theory is a theoretical framework that can be used for designing learning environments. This course provides theoretical background along with hands-on development. (4002-722 and 4002-218 or equivalent programming experience) **Class 4, Credit 4**

4002-819 Integration Technologies
This course is an in-depth study of the major interoperability technologies. Exercises are used to illustrate how modern integration technologies address the economic and technical issues related to the development of integrated systems. Programming projects are required. (4002-710, 4002-725) **Class 4, Distance Format, Credit 4**

4002-820 Economics of Software Development
This course is an analysis of the factors that determine software cost, quality, and time to delivery. Topics include fundamentals of software development, identification of cost drivers, and analysis of productivity and quality data. Students use models to estimate software cost, delivery time, and operational reliability. (2+ years of software development experience and SD&M Bridge) **Class 4, Distance Format, Credit 4**

4002-821 Data Architecture and Management
This course will focus on data architectures, issues, and strategies for managing enterprise data as an organizational information asset. The fundamental meaning and management of data is emphasized as an enabler to enterprise data integrity, enterprise data architecture, and satisfaction of enterprise business requirements. Topics include metadata management, business process integration, data and process governance, repository management, data quality, data architectures, and current technologies in information exchange. Data integration and programming projects are required. (4002-710, 4002-720) **Class 4, Distance Format, Credit 4**

4002-823 Agent-based Modeling
This course is intended as an introduction to the emerging area of Agent-Based Modeling, a subset of the study of complex adaptive systems. Agent-based modeling is at the intersection of research (theory development and confirmation) and computational simulation. This course will be an introduction to these topics, focusing on the research aspects of agent-based modeling: the use of computation as a test bed for developing and testing social science theories. The role of visualization in agent-based modeling development and analysis is presented. Students will analyze the social science literature for current models and theories and will develop computational models incorporating these theories. (4004-730; 0514-784)

4002-825 Systems Architectures
A programming course focused on the application of interoperability technologies. Students develop integrated systems based on software components, applications, databases, web sites, heterogeneous operating systems and networks. (4002-819) **Class 4, Distance Format, Credit 4**

4002-830 Project Management
This is a course in the methods and techniques of managing a software development project. Topics include defining project goals, work breakdown structure, defining tasks, project plans, estimation and scheduling techniques, work monitoring and measurements. (2+ years of software development experience and SD&M Bridge) **Class 4, Distance Format, Credit 4**

4002-831 Process Management
This is a course in the methods and techniques of managing a software development environment. Topics include development organization structure, team management, staff development, project selection and prioritization, cost/benefit analysis, role of standards, and organization communication. (2+ years of software development experience and SD&M Bridge) **Class 4, Distance Format, Credit 4**

4002-865 Program Evaluation
This course provides the structure for a graduate capstone experience. Students learn fundamental evaluation terminology and frameworks for program evaluation, such as the CIPP model. Designs for evaluating projects are discussed. Students will design and conduct a full scale evaluation of an online learning or knowledge management system, and will produce a formal, written document that functions as the capstone experience for the degree. (4002-810 and 4002-845) **Distance Format, Credit 4**

4002-876 Secure E-commerce
This course covers the concepts required to implement a secure e commerce site. Topics include the assessment of security in a proposed or an existing site, the implications of decisions impacting security and the implementation considerations needed to establish a secure site. (4002-875) **Class 4, Distance Format, Credit 4**

4002-890 Graduate Seminar in IT
This is the IT seminar course to allow for special one-time offerings of graduate topics or to allow faculty to pilot new graduate offerings. Specific course details (such as the course topics, format, resource needs, and credit hours)will be determined by the faculty member(s) who propose a given special-topics offering. (As appropriate for topic proposed. Corequisites as appropriate for topic proposed.) **Credit 2–8**

4002-892 CSCW and Groupware
This course will examine the role of information technology in collaborative work settings. An overview of relevant theory, technologies, and standards will provide the context for examining the integration and strategic use of e-mail distributed networking, the World Wide Web, conferencing and enhanced messaging. (4004-745) **Class 4, Distance Format, Credit 4**

4002-893 Seminar in Thesis and Project Preparation
This course provides a structure, methodology and forum for the capstone experience proposal development and committee selection. (Two-thirds of graduate course work not including prerequisite courses) **Class 2, Distance Format, Credit 2**

4002-895 Software Development and Management Caps
A presentation demonstrating current awareness and understanding of trends impacting the software development and management field. Students prepare a portfolio summarizing their course work in the SD&M program and discuss the relationship of their course work to advances in software development technology and practice. (Enrollment in last quarter of study) **Distance Format, Credit 4**

4002-897 MS Thesis
Capstone experience for the Master of Science in Information Technology degree program. Students must submit an accepted thesis proposal in order to enroll. (Permission of graduate studies committee) **Credit 0–8**

4002-898 MS Project
Capstone experience for the Master of Science in Information Technology. Student must submit an accepted proposal in order to enroll. (Permission of the graduate studies committee) **Credit 0–8**

4002-899 Independent Study
The student will work independently under the supervision of a faculty advisor on a topic not covered in other courses. **Credit 0-**

4002-999 Graduate Co-op Education
An optional cooperative educational experience is available to graduate students to add practical employment experience to their studies to support their career objectives and personal goals. (Completion of program Bridge requirements and two-thirds of program of study with 3.0 GPA or better; or permission of graduate coordinator) **Credit 0**

4004-730 Interactive Media Development
Students will build on their understanding of basic media types to develop interactive user interfaces to rich-media content, such as video, audio, graphics, and text. They will learn to control and synchronize multiple media assets in a variety of environments utilizing authoring tools such as Macromedia Director. Students will design and implement applications that support a high level of interactivity and develop strategies for delivering these programs via CD-ROM and the World Wide Web. Programming will be required. (4004-741 or equivalent, and 4080-231 or 4002-218, or a two-course programming sequence) **Class 4, Credit 4**

4004-736 Web Client-side Programming
This course will explore the analysis, design, development, and implementation of client-side scripting in the context of internet technologies and Web-based client systems and applications. Students will learn to use native technologies for designing and building usable and effective interactive Web-based systems, clients, and interfaces. Key features addressed will include browser and platform compatibility, object reusability, bandwidth and communications issues, scripting environments, privacy and security, and related technologies and API's. Programming required. (4004-737) **Class 4, Credit 4**

4004-737 Website Design and Technologies
Assuming a basic knowledge of HTML coding and web page design, this class moves into large-scale site development, and an introduction to advanced web technologies. Building on the web page design concepts introduced in 4004-741, this course focuses on site design issues, including scalability, maintenance, and integration of web technologies into the business or organizational context. Technologies introduced include cascading style sheets, dynamic HTML, basic JavaScript, and streaming media. (4004-741) **Class 4, Credit 4**

4004-739 Programming for the World Wide Web
The World-wide Web is no longer just linked as static HTML documents. Web pages can be generated dynamically and can interact with a user to modify pages on-the-fly, validate user inputs and entertain. This course is an overview of several forms of programming that are used in the creation of interactive and dynamic web content. This course provides a practical overview of programming in the context of the World-wide Web. It will enable students to develop web pages and web sites that incorporate both client-side and server-side programming by installing and modifying existing scripts as well as writing new scripts. (4004-737 and a two-course programming sequence) **Class 4, Credit 4**

4004-741 Fundamentals of Web Based Multimedia
This class provides an introduction to web-based multimedia development and implementation. Topics covered include uses of web based multimedia in business and historical contexts, differences between web-based and stand-alone multimedia, basic HTML and web page design, digital image creation and manipulation, and the incorporation of audio, video, and animated components in web-based multimedia. Students will learn to use computer-mediated communication and internet utilities in support of multimedia development. (Computer literacy) **Class 4, Credit 4**

4004-745 Foundations of Human-Computer Interaction
Human-computer interaction (HCI) is a field of study concerned with the design, evaluation and implementation of interactive computing systems for effective human use and with the study of major phenomena surrounding them. This course surveys the foundation concepts and major issues of the HCI field including: cognitive psychology, human factors, interaction styles, user analysis, task analysis, interaction design methods and techniques, and evaluation. The primary focus of this course will be on the users and their tasks. **Class 4, Distance Format, Credit 4**

4004-748 Usability Engineering
This team project oriented course stresses the importance of good software interfaces and the relationship of user interface design to human computer interaction. Topics include: the usability engineering life cycle, effective system design and development, usability heuristics, testing, assessment methods, and international user interfaces. This course focuses on the design, testing, and development of effective user interfaces. (4004-745 and 4004-730) **Class 4, Distance Format, Credit 4**

4004-749 Usability Testing
This project-based course will focus on the formal evaluation of user interfaces. Topics include: usability test goal setting, recruitment of appropriate users, design of test tasks, design of the test environment, test plan development and implementation, analysis and interpretation of the results, and documentation and presentation of results and recommendations. (4004-748 and a statistics course) **Class 4, Distance with a visit, Credit 4**

4004-751 Web Database Integration
An introduction to technologies, techniques, and contexts for developing dynamic web sites that are driven by back-end databases. Builds on the concepts of web programming and multi-user relational databases introduced in prerequisite classes. (4004-737, 4004-739 and 4002-360 or 4002-720) **Class 4, Credit 4**

4004-755 Advanced Topics in HCI
Human-computer interface (HCI) is an evolving field. This course is designed to study the current themes and advanced issues of HCI. Topics will vary depending upon current research and developments in the field. (4004-745) **Class 4, Distance Format, Credit 4**

4004-774 Eye Tracking: Theory, Method. and Applications
This course will provide a theoretical and practical study of eye movements and eye tracking, and will focus on the application of eye tracking to usability testing. Course topics include: eye movements and visual perception; types of eye trackers and theory of operations; data analysis; and the application of eye tracking to various domains. Laboratory projects will be required. (4004-745 and Statistics) **Class 2, Lab 2, Credit 4**

4004-775 Remote Usability Development and Testing
This course will discuss the tools and procedures of remote usability testing and apply them to the development of an effective user interface. Topics include: the software development life cycle, design and development of effective interfaces, heuristic evaluations, assessment methods, usability testing procedures and protocols, remote testing tools and procedures, and analyze testing results and propose recommendations. (4004-745, 4004-730 and Statistics, not intended for students taking 4004-748 and 4004-749) **Distance Format, Credit 4**

4004-780 Application Domain in HCI
This course will provide a theoretical and case-based study of several areas of HCI, all considered within an application domain of information technology. Application domains may include medical informatics, bioinformatics, game design, and entertainment. Course topics include: a scientific approach to UI design (usability engineering), domain-specific user analysis and user profiles, social and cultural influences, general and domain-specific design issues, information visualization, data integration, mobile devices, security, privacy and ethics. (4004-745) **Class 4, Credit 4**

4004-781 **Usability Economics**
User-centered design methodologies are proven enablers for developing successful systems and are important to realizing enterprise benefits. An understanding of usability economics is needed to effectively integrate usability engineering into the systems development process. This course provides students with the necessary background and methods to prepare cost-benefit analysis of applying usability engineering in a variety of system development domains. Other topics include: strategies for introducing usability engineering life cycle into an organization; developing a usability culture; and developing enterprise usability standards. (4004-745, and 4004-748 or 4004-775) **Distance Format, Class 4, Credit 4**

4004-897 **MS HCI Thesis**
Capstone experience for the Master of Science in Human-Computer Interaction. Student must submit an accepted proposal in order to enroll. (Permission of the HCI graduate program coordinator) **Credit 0–8**

4004-898 **MS HCI Project**
Capstone experience for the Master of Science in Human-Computer Interaction. Student must submit an accepted proposal in order to enroll.(Permission of the HCI program coordinator) **Credit 0–8**

Computer Science

4003-700 **Computer Programming and Problem Solving**
Introduction to the classical and contemporary theory of computation covering regular, contxt-free, and computable (recursive) languages with finite state machines, pushdown automata, and Turing machines. Basic concepts of computability theory. (1016-265, 4003-232) **Class 4, Credit 4**

4003-703 **Advanced C++ and Program Design**
The course covers design techniques and advanced programming. Topics include the software development life cycle; analysis and design using the Unified Modeling Language (UML); advanced programming in the C++ programming language will be used; and implementation strategies for external data structures. Individual and group programming projects will be required. Homework assignments are an integral part of the course. (Programming Skills, 4003-561) **Class 4, Credit 4**

4003-707 **Advanced Programming**
The goal of this course is to introduce the language Java. Topics include class design and implementation, inheritance, exceptions, files, threads, swing, network programming, and remote method invocation. We will use object-oriented technology as a means to an end to design and implement software solutions. Programming assignments are an integral part of the course. (Object-oriented Programming + C) **Credit 4**

4003-709 **Programming Language Concepts**
A study of the syntax and semantics of a diverse set of high-level programming languages. The languages chosen are compared and contrasted in order to demonstrate general principles of programming language design. This course emphasizes the concepts underpinning modern languages rather than the mastery of particular language details. Programming projects will be required. Alternative RIT offering: 4003-450 (4003-704, Algorithms and Data Structures, 4003-705 or 1016-265) **Class 4, Credit 4**

4003-710 **Computer Organization**
An introduction to computer architecture and assembly language programming concepts and techniques. Topics include Boolean algebra, combinational and sequential circuit design, storage mechanisms and their organization, the instruction cycle in a simple CPU, assembly language programming, programming at the device level, and the role of assembly language in understanding the hardware/software interface. Digital logic and software projects will be required. (4003-334, 1016-265) **Class 4, Credit 4**

4003-713 **Operating Systems**
A general survey of operating system concepts. Topics include process synchronization, interprocess communication, deadlock, multiprogramming and multiprocessing, processor scheduling and resource management, memory management, overlays, static and dynamic relocation, virtual memory file systems, logical and physical I/O, device allocation, I/O processor scheduling, process and resource protection. Programming projects will be required. Alternative RIT offering: 4003-440. (4003-704 or 4003-707) **Class 4, Credit 4**

4005-701 **Computability**
Computability is the heart of theoretical computer science for it is the theory which attempts to formalize the notion of computation. Topics include computation by while-programs, Turing machines, recursive function theory, symbol manipulation systems, program methodology, the limitation of the concept of effective computability. (4003-700) **Credit 4**

4005-702 **Computational Complexity**
This course is concerned with the mathematical analysis of computer algorithms. Topics include matrix operations, combinatorial algorithms, integer and polynomial arithmetic, NP-completeness, and lower bounds on algorithms involving arithmetic operations. (4003-700) **Credit 4**

4005-704 **Complexity and Computability**
This course provides an introduction to complexity theory and computability theory. It starts with an overview of basic complexity classes, with special focus on NP-theory. This is followed by a study of problems complete for NP and PSPACE, the Church-Turing thesis, and undecidability of a selection of classical problems. Some advanced topics in computability, like degrees of unsolvability, the recursion theorem, or Gödel's incompleteness theorem will be discussed. (4003-700) **Class 4, Credit 4**

4005-705 **Cryptography**
The course is devoted to the review of basic cryptographic algorithms, their implementation and usage. Classical encryption techniques and those of Rivest-Shamir-Adleman and EL Gamal will be seen in depth, and an overview of several others will be presented. This course also presents authentication schemes and interactive proof protocols. Students will write a term paper, either theoretical based on literature or reporting a student's own implementation or experiments with a chosen cryptographic scheme. Depending on the size of the group, some or all students will give a presentation to the class. (4003-334; 1016-265; set by instructor) **Class 4, Credit 4**

4005-706 **Cryptography II**
This course investigates advanced topics in cryptography. Topics include an overview of necessary background in algebra and number theory, private and public key cryptosystems, and basic signature schemes. Additional topics include number theory and basic theory ofGalois fields used in cryptography; history of primality algorithms and the polynomial time test of primality; discrete logarithm based cryptosystems including those based on elliptic curves; interactive protocols including the role of zero-knowledge proofs in authentication; construction of untraceable electronic cash on the net; and quantum cryptography. Other topics may include digital watermarking, fingerprinting, and steganography. Programming will be required. (4005-705 Cryptography I or 4003-482 and permission of instructor) **Class 4, Credit 4**

4005-709 **Topics in Computer Science Theory**
Current topics in the field. The format of this course is a combination lecture and seminar. Students may register for this course more than once. Topics covered in the past include: arithmetic algorithms, data encryption, the Fast Frontier Transform, combinatorial optimization, logic. Programming projects may be required. (Set by instructor) **Credit 1–4**

4005-710 **Programming Language Theory**
An introduction to the basic concepts of programming language design. It begins with a survey of the issues that are involved in the design and implementation of languages. Specific tools for the description of syntactic and semantic structure are introduced. The balance of the course is an analysis of programming language structure, using these descriptive tools to give precise form to the discussion. Programming assignments will be required. (1016-265, 4003-709) **Class 4, Credit 4**

4005-711 **Compiler Construction**
This course discusses design and implementation of language processors and translators. Topics include lexical, syntactic, and sematic descriptions, algorithms for analysis tools, and programming techniques, as well as environment-, stack-, and heap-based interpreters and code generation for typical computer architectures. Teams of students will be required to design and implement a programming language with nested block structure and data aggregates. (4003-700, 4003-707, and 4003-709, or permission of instructor) **Class 4, Credit 4**

4005-713 **XML-Architectures, Tools and Techniques**
This course is a critical review of the XML standard and its major applications for data description, transformation, storage, and transport, and in its role as a meta language for little languages used within software development and network communication. XML as a tool for language design is compared to a parser-generator based approach. The implementation of XML parsing is compared to other forms of language recognition. Students are expected to complete programming assignments, some involving Java, and give a team presentation (which includes a demonstration and online presence) about an XML-based technology available from the internet. (4003-707 or permission of instructor) **Class 4, Credit 4**

4005-714 **Programming Skills**
The goal of this course is to introduce the student to a programming paradigm and an appropriate programming language chosen from those that are currently important in industry or that show high promise of becoming important. A significant portion of the learning curve occurs through programming assignments with exemplary solutions discussed later in class. Students must complete a separate term project which will require some

skills not discussed in class. The instructor will post specifics prior to registration. With the approval of the program coordinator, this course can be taken for credit more than once, provided each instance deals with a different paradigm and language. (4003-707 or permission of instructor) **Class 4, Credit 4**

4005-715 Language Based Security
This course explores the two major roles played by programming language-based mechanisms in developing secure systems that share mobile data or code. First, the course covers principles and practice of secure coding including topics such as good versus bad code, design, and implementation; security principles and architectures; and automation and testing. Second, the course examines techniques based on language design and implementation including topics such as secure operating system structures; software based fault isolation; reference monitors; type-safe languages; certifying compilers; proof-carrying code; automated program analysis and program rewriting. Computing projects are required. (4003-440/713 and 4003-450/709 or permission of instructor) **Class 4, Credit 4**

4005-716 Software Development Tools
This course investigates and evaluates various software tools used in the development of software. Topics include simple dependency-based tools such as make and ant, as well as full-featured integrated development environments. Working with and proposing modeling languages for such tools is and important part of the course. Programming projects will be required. (Completion of CS Bridge courses or permission of instructor)

4005-719 Topics in Programming Languages
Current topics in the field. The format of this course is a combination lecture and seminar. Students may register for this course more than once. Topics covered in the past include: logic programming, data flow, functional or applicative, and object oriented languages, programming language semantics, formal verification. Programming projects will be required. (Permission of the instructor, completion of the Bridge program) **Class 1–4, Credit 1–4**

4005-720 Computer Architecture
Review of commercially available computer systems, including classical CPU and control unit design, register organization, primary memory organization and access, internal and external bus structures, and virtual memory schemes. Alternatives to classical machine architecture such as the stack machine and the associative processor are defined and compared. Parallel processors and distributed systems are also presented, along with an analysis of their performance relative to nonparallel machines. Programming projects are required. (4003-710, 4003-707, 4003-713) **Class 4, Credit 4**

4005-729 Topics in Computer Architecture
Current topics in the field. The format of this course is a combination lecture and seminar. Students may register for this course more than once. Programming projects will be required. (Permission of the instructor, completion of the Bridge program) **Class 1–4, Credit 1–4**

4005-730 Distributed Systems
An introduction to the study of distributed systems. The course covers distributed system architectures such as client-server and peer-to-peer, distributed system design issues such as communication, fault tolerance, coordination, and deadlock, distributed system middleware such as Remote Method Invocation (RMI) and Tuple space, and the theory of distributed algorithms such as logical clocks and leader election. Programming projects are required. (4003-713 or equivalent, 4003-707 or equivalent) **Credit 4**

4005-731 Distributed Operating Systems II
This course addresses the practical issues involved in the design of a distributed operating system. The following topics are discussed: implementations of the process environment, processor scheduling, file systems, and the management of distributed memory. Examples of specific implementations will be discussed. Other topics (e.g., security) may be covered, at the discretion of the instructor. A group or individual project, involving the design and implementation of one or more components of a distributed operating system, will be a major component of this course. (4005-730, 4003-707 or equivalent) **Class 4, Credit 4**

4005-735 Parallel Computing I
A study of the hardware and software issues in parallel computing. Topics include an introduction to the basic concepts, parallel architectures and network topologies, parallel algorithms, parallel metrics, parallel languages, network topology, granularity, applications, parallel programming design and debugging. Programming projects will be required. (4003-713) **Class 4, Credit 4**

4005-736 Parallel Computing II
A study of selected topics in parallel algorithm design through the analysis of algorithms used in various areas of application. This course will investigate the interplay between architecture and algorithmic structure and will discuss the effect that these issues have on the complexity and efficiency of parallel algorithms. Programming projects are required. (4005-735) **Class 4, Credit 4**

4005-739 Topics in Operating Systems
Current topics in the field. The format of this course is a combination lecture and seminar. Students may register for this course more than once. Topics covered in the past include: Unix internals, concurrency methods, Petri Nets, parallel programming and algorithms, security, operating systems performance, software environments, communicating sequential processes ("CSP"). Programming projects will be required. (Permission of the instructor, completion of the Bridge program) **Credit 1–4**

4005-740 Data Communication and Networks I
This course is an introduction to the concepts and principles of computer networks. Students will design and implement projects using application protocols, and will study transport, network, and data link protocols and algorithms. This course also includes an introduction to local area networks, data transmission fundamentals, and network security. Programming projects will be required. (Probability, 4003-707) **Class 4, Credit 4**

4005-741 Advanced Computer Networking
This course explores state-of-the-art techniques and open research problems in computer and wireless networks. Topics include internet architecture design, peer-to-peer overlay networks, network security, routing protocols for wireless ad hoc networks, energy efficient issues in mobile networks, wireless sensor networks, routing protocols, and congestion control mechanisms. Reading research papers, presenting recent research results, conducting a team project, and writing term papers are required. (4005-740 Data Communications and Networks I or equivalent; 4003-703 Advanced C++ and Program Design or equivalent; 4003-707 Advanced Java Programming or equivalent; or permission of the instructor) **Credit 4**

4005-742 Ad-hoc Networks
This course explores serverless ad-hoc networks. Topics include authentication, confidentiality, routing, service discovery, middleware and key generation and key distribution. Programming projects are required. (CSI-CS3 or 4003-707, 4003-420 Data Communications and Networking) **Class 4, Credit 4**

4005-743 Secure Operating Systems Network
This course provides students with an introduction to the issues surrounding security aspects in operating systems and networks. Case studies will be used to illustrate security issues in operating systems and networks. Topics include but are not limited to the orange book, access control, firewalls, and an evaluation of the security aspects in a distributed system. Where appropriate, programming exercises will be used to improve understanding of security issues. Exercises may involve group as well as individual projects. It is expected that student presentations will be given during the quarter. (4005-740 and 4003-440 or permission of the instructor) **Class 4, Credit 4**

4005-746 Security Measurement and Testing
Regulatory, financial, and organization reasons drive the requirement to measure computer systems' security performance. The course will introduce students to the algorithmic foundations and modern methods used for security evaluation and tool design. It will combine a theoretical review of the methods and models currently applied for computer security evaluation and an investigation of computer security through the study of user practice. Students will be required to complete homework, deliver a class presentation, implement a team project and lead the team's work, and undertake research on the topic assigned. (4005-730 Distributed Systems, 4005-740 Data Communication and Networks I) **Credit 4**

4005-747 Intelligent Security Systems
The course will introduce students into the current state of artificial intelligence applications in computer security systems design. It will review different application areas such as intrusion detection and monitoring systems, access control and biological authentication, firewalls structure and design. The students will be required to conduct research and analysis of existing intelligent security applications and tools, as well as, to implement a course programming project on design of a specified security tool based on neural networks and/or fuzzy rules systems. (4005-750, Introduction to Artificial Intelligence, or by the permission of instructor) **Credit 4 (S)**

4005-749 Topics in Data Communication
Current topics in the field. The format of this course is a combination lecture and seminar. Students may register for this course more than once. Topics covered in the past include: network reliability, special-purpose protocols, error-correcting codes. Programming projects will be required. (Permission of the instructor, completion of the Bridge program) **Class 1–4, Credit 1–4**

4005-750 Introduction to Artificial Intelligence
An introduction to the field of artificial intelligence, including both theory and applications. A programming language that allows effective symbolic manipulation (PROLOG) is used to demonstrate the capabilities and limitations of the material presented in class. Topics include search strategies and their implementation, logic, networks, frames and scripts, production, symbolic manipulation and list processing, problem-solving methods, expert systems, natural language understanding, and selections from vision, robotics, planning and learning. Programming assignments are an integral part of the course. (4003-709) **Class 4, Credit 4**

4005-751 Knowledge Based Systems
An introduction to the issues and techniques of building knowledge based systems. Topics will include a survey of existing expert system architectures and implementations, knowledge representation techniques, expert system building tools, and knowledge acquisition. In addition to examining existing expert systems, students will implement expert systems. Programming projects will be required. (4005-750) **Class 4, Credit 4**

4005-753 Biologically Inspired Intelligent System
This course examines contemporary topics in artificial intelligence in neuroscience, cognitive science and physiology. Students will focus on developing computer models that are biologically inspired and leverage current knowledge in these areas with the goal to develop systems that understand their environment. An in-depth research paper on a relevant topic, a programming project, and a presentation will be required. A background in biology is not required. (Permission of instructor) **Credit 4**

4005-754 Image Understanding
This course explores the theory and methodologies used to interpret images in terms of semantic content. Techniques from image processing and pattern recognition are extended for the purpose of scene understanding using both a bottom-up and top-down approach. Topics include human visual perception, knowledge representation, object recognition, contextual classification, scene labeling, constraint propagation, interpretation trees, semantic image segmentation, 3D models and matching, active vision, and reasoning about images. Programming projects are required. (4005-757 or 4003-457 or permission of instructor)

4005-755 Neural Networks and Machine Learning
Neural networks, systems with massively connected parallel primitive computing elements, are, metaphorically, computers structured after natural brains. Such systems promise much better performance than classical computers at pattern recognition and related areas. In this seminar, we will present several neural network models, introduce the current research activity, and develop some underlying mathematics. Students will have the opportunity to develop and present models, both paper and software simulated, and to utilize canned simulators. Students will be exposed to the current research literature. Programming projects will be required. (4003-700 and completion of Bridge) **Class 4, Credit 4**

4005-756 Genetic Algorithms
Genetic algorithms provide a powerful approach for searching large, ill-behaved problem spaces. In this course, we will study the theoretical foundations of genetic algorithms as well as their application to a variety of search and optimization problems. This course will cover topics from the current research literature, and students will be expected to do a library research review and perform an experimental project. Programming projects will be required. (4003-700, 4005-710) **Class 4, Credit 4**

4005-757 Introduction to Computer Vision
An introduction to the underlying concepts of computer vision and image understanding. The course will consider fundamental topics, including image formation, edge detection, texture analysis, color, segmentation, shape analysis, detection of objects in images and high level image representation. Depending on the interest of the class, more advanced topics will be covered, such as image database retrieval or robotic vision. Programming assignments are an integral part of the course. (Completion of Bridge) **Class 4, Credit 4**

4005-758 Advanced Computer Vision
This course examines advanced topics of current research interest in computer vision including motion analysis, video processing and model based object recognition. The topics will be studied with reference to specific applications, for example video interpretation, robot control, road traffic monitoring, and industrial inspection. A research paper, an advanced programming project, and a presentation will be required. (4005-757 or permission of instructor) **Credit 4**

4005-759 Topics in Artificial Intelligence
Current topics in the field. The format of this course is a combination lecture and seminar. Students may register for this course more than once. Topics covered in the past include: logic programming, natural language processing, pattern recognition, specialized AI languages and programming paradigms, robotics. Programming projects will be required. (Permission of the instructor, completion of the Bridge program) **Class 1–4, Credit 1–4**

4005-761 Computer Graphics I
Computer Graphics I is a study of the hardware and software principles of interactive raster graphics. Topics include an introduction to the basic concepts, 2-D and 3-D modeling and transformations, viewing transformations, projections, rendering techniques, graphical software packages and graphic systems. Students will use a standard computer graphics API to reinforce concepts and study fundamental computer graphics algorithms. (4003-707 or 4003-243**) Class 4, Credit 4**

4005-762 Computer Graphics II
This course will investigate the theory of computer image synthesis. Seminal computer graphics papers will be used to describe the various components of the image synthesis pipeline and explain, just as in photography, how the path of lights in a virtual scene can be simulated and used to create photorealistic imagery. The course will emphasize the theory behind rendering tools and libraries available for image synthesis. The student will put theory into practice via programming assignments and a capstone project. Topics will include light and color, three-dimensional scene specification, camera models, surface materials and textures, rendering (local, ray tracing, radiosity), procedural shading and modeling, tone reproduction, and advanced rendering techniques. (4005-761 or 4002-735) **Class 4, Credit 4**

4005-763 Computer Animation Algorithms and Techniques
This course takes a look at Computer Animation from a programmer's perspective. It will investigate the theory, algorithms and techniques for describing and programming motion for virtual 3D worlds. Approaches that will be explored include keyframing systems; kinematics, motion of articulated figures, procedural and behavioral systems, and the use of motion capture data. This course is a programming-oriented course with major deliverables including the implementation of techniques presented in lecture as well as a final project concentrating on an area of a student's choice. Students enrolling in this course are expected to have proficiency in the use of a 3D API (e.g. OpenGL, DirectX, Java3D). The course will additionally prepare graduate students to do research in this area through reading, summary, and survey of papers from the animation literature. (4005-761 or 4002-735 or permission of instructor)

4005-764 Procedural Shading
This course will present the theory and algorithms behind procedural shading in computer graphics, as well as techniques for using shaders effectively in creating stunning visual effects. The course will compare and contrast real-time shader architectures and students will gain expertise in both environments. The format of the course delivery will be part lecture, part studio style, with weekly lab assignments based upon the techniques presented in the class. During the latter half of the course, students will be assembled into teams to implement, describe, and document a programming solution for a particular special effect based on a written specification. This final, team-based project will serve as the final exam for the course. Students enrolling in this course are expected to have proficiency in either OpenGL or DirectX. (4005-762: Computer Graphics II or 4002-735 3D Graphics Programming)

4005-765 Applications in Virtual Reality
This course will explore the application of virtual reality software and technologies within a given problem domain via team based collaboration on a large scale VR project. Focus of individual student teams may include: technical framework, viewing paradigms, VR devices, and use of audio. Reading and summarizing of articles from VR literature will be required in making design decisions. Students should have a strong programming background and a proficiency in a 3D API (OpenGL, DirectX, or Java3D). Students with expertise in distributed systems and an interest in graphics or virtual reality are also encouraged to register. **Class 4, Credit 4**

4005-769 Topics in Computer Graphics
This project-oriented course builds on topics developed in 4005-761, Computer Graphics I. Expanded topics include styandard graphics software, anomation techniques, 3D modeling methods, hidden surace and line algorithms, shading, antialiasing color modesla nd design of the user interface. Student will be required to design and implement an interactive system for an application that incorporates several of the above areas. Programming projects will be required. (4005-761 or permission of instructor) **Class 4, Credit 4**

4005-771 Database Systems
Broad introduction to database management systems (DBMS) and the design, implementation, and applications of databases. Topics include an overview of DBMS architectures, concepts and implementations of the relational model, SQL, database design and modeling techniques, and issues such as recovery, concurrency, physical implementation concerns and performance and management aspects. Optional topics include: alternative approaches to designing database systems (for example, object-oriented or extended relational systems), distributed databases, database machines, and database interfaces and languages. A programming project is required. (4003-334) **Class 4, Credit 4**

4005-772 Database Systems Implementation
This course covers data structures and algorithms used to implement database management systems. Topics include physical data organizations, indexing and hashing, query processing and optimization, database recovery techniques, transaction management, concurrency control, and database performance evaluation. Current research topics in database system implementation are explored. Programming projects will be required. (4005-771) **Class 4, Credit 4**

4005-773 Data Cleaning and Preparation
This course provides an introduction to the concepts and techniques used in preparing data for subsequent data mining. Topics include the knowledge discovery process; data exploration and its role; data extraction, cleaning, integration and transformation; handling numeric, unstructured, text, web, and other forms of data; and ethical issues underlying data preparation and mining. Computing projects, a term paper and presentations are required. (4005-771 Database Systems and 1016-351 Probability, or permission of the instructor). **Credit 4**

4005-774 Secure Database Systems
This course explores policies, methods and mechanisms for protecting enterprise data. Topics include data reliability, integrity, and confidentiality; discretionary and mandatory access controls; secure database architectures; secure transaction processing; information flow, aggregations, and inference controls, and auditing; security models for relational, object-oriented, statistical, XML, and real time database systems. Programming projects are required. (4002-484, or 4003-485, or 4010-443 or equivalent) **Class 4, Credit 4**

4005-775 Data Mining
This course provides an introduction to the concepts and techniques used in the field of data mining. The course covers the knowledge discovery process that included data selection, cleaning, coding: different statistical, pattern recognition, and machine learning techniques: and reporting and visualization of general structures. Computing projects, a term paper, and presentations are required. (4005-771, and permission of instructor) **Credit 4**

4005-779 Topics in Data Management
Current topics in the field. The format of this course is a combination lecture and seminar. Students may register for this course more than once. Topics covered each quarter will focus on current developments in database and transaction systems; covered areas could include, for instance, data mining, or secure database systems, or temporal database systems, or secure transaction processing. Programming projects are required. (4005-771, or permission of instructor)

4005-784 Privacy and Security
This course provides students with an introduction to the issues surrounding security of computer systems and privacy concerns in an increasingly information-based society. This class will consider numerous social issues in computing, including risks and liability involved in using information as well as ethical concerns. Case studies will be used to illustrate both common and historic problems in computer security. Group and individual programming projects will be used to improve understanding of security issues. Students will research specific areas of interest and report their results to the class. (4003-420 and 4003-713) **Class 4, Credit 4**

4005-785 Secure Coding
This course provides an introduction to principles and practice of secure coding including topics such as principles of secure coding, security architectures and design, operational practices and testing, and defenses against software exploitation. Basic cryptography including private and public key systems, encryption standards, crytosystems, and digital signatures is covered from a secure coding perspective. Other topics include software based fault isolation, type safe languages, certifying compilers; proof-carrying code, and automated program analysis and program rewriting. Presentations and computing projects will be required. (Completion of bridge courses in the MS Computer Science or permission of instructor) **Class 4, Credit, 4**

4005-800 Theory of Computer Algorithms
A study of techniques to design and analyze the complexity of algorithms. This course will make students aware of a large number of classical algorithms and their complexity and will introduce the area of NP-completeness. Programming projects will be required. (Algorithms and Data Structures and 4003-705 or 1016-265) **Class 4, Credit 4**

4005-801 Topics in Advanced Algorithms
This course focuses on advanced algorithms and data structures in a specialized area of computer science or in a specific scientific domain. Both practical and theoretical aspects of algorithms will be explored to provide coverage of the state of the art and shortcomings of computing in the specialized areas. This includes proofs of correctness and complexity analysis of the algorithms. Students will write a term paper that explores the current state of research in the area or reports on the student's implementation and experiments with algorithms for a chosen problem. Students will also be required to make presentations. The instructor will post the specifics of each course offering before the registration. With the approval of the program coordinator, this course can be taken for credit more than once, provided each instance concerns a different specialized area or domain. **Credit 4**

4005-810 E-science
An introduction to concepts, methods, and techniques for conducting scientific investigations with the aid of a computer. Topics include the e-Science method: discrete modeling and simulation; continuous modeling and simulation; data analysis; data storage and querying; data visualization; and high performance computing. Programming projects will be required. (1016-282, Calculus II or equivalent; or permission of instructor) **Credit 4**

4005-890 MS Thesis
Capstone of the Master's Degree Program. Students must submit an acceptable thesis proposal in order to enroll. (Permission of the graduate studies committee; 4005-893) **Credit 0–9**

4005-891 MS Project
Alternative capstone of the Master's Degree Program. Student must submit an acceptable project proposal in order to enroll. (Permission of the graduate studies committee. (4005-893) **Credit variable 2–5**

4005-893 MS Project/thesis Seminar
In this course the student will develop a Master's Project or Thesis topic. It will be necessary for the student to make presentations in the class, form a committee and write a Master's Proposal. This course must be completed prior to registering for 4005-891.(Complete 16 graduate hours with a minimum 3.0 GPA) **Class 2, Credit 2**

4005-898 Independent Study
A supervised investigation of selected topics within computer science. Consent of the sponsor and department approval are required.

4005-899 Seminar
Current advances in computer science(set by instructor). **Credit 4**

4005-999 Graduate Co-op Education
One block of full-time, paid employment in the computing field. See the CS graduate program coordinator or RIT's Office of Cooperative Education for further details. (Good standing, completion of Bridge and 16 graduate credits) 2

Medical Informatics

4006-766 **Build Elec Health Record**
This course explores the acquisition, storage, and use of information in the electronic health record (EHR) through hands-on development and programming. Students will learn about the types of information used in clinical care: text, structured data, images, and sounds. Other topics covered include: clinical vocabularies (existing schemes and their limitations); how clinical information is generated and utilized; methods of information storage and retrieval; departmental systems (laboratory, radiology, and hospital information systems); organizational systems (including scheduling, registration and financial systems); and the legal, social and regulatory problems of EHRs including security and confidentiality. (4004-745, MIF 410) **Class 4, Credit 4**

4006-887 **Med Info Capstone I Des**
This team-based course is the first course in a two-course Medical Informatics Capstone sequence. The course provides students with the opportunity to apply the knowledge and skills learned in course work to designing a solution to a real problem in the medical informatics domain. Project work initiated in this course will be completed in the Medical Informatics Capstone II (Development). (Completion of all year 1 program requirements) **Class 2, Credit 2**

4006-888 **Med Info Capstone II Dev**
This team-based course is the second in a two-course Medical Informatics Capstone sequence. The course provides students with the opportunity to apply the knowledge and skills learned in course work to implement a solution to a real problem in the medical informatics domain. Project work initiated in the Medical Informatics Capstone I (Design) course will be carried forward and completed in this Medical Informatics Capstone II (Development) course. (4006-887) **Class 2, Credit 2**

Software Engineering

4010-710 **Research Methods**
Overview of the academic research methodologies used in graduate level work. Topics include: writing style, audience analysis, research planning, experimental design, document structure, research validation, and the process for submission and review to conferences and journals. **Credit 2–4**

4010-748 **Secure Software Engineering: Requirement**
Overview of the secure software issues and principles that should be addressed during requirements of engineering and design. Topics include: risk management and software requirement specification. Designing for security and security in implementation. (4010-361)

4010-758 **Secure Software Engineering: Verification**
Overview of the secure software issues and principles that should be addressed during testing. Topics include: test planning, security goal test planning, testing tools, testing security requirements, testing the security of a design, grey box testing techniques, acceptance testing techniques, and contemporary issues regarding testing for security.

4011-700 **Software Engineering Practicum I**
A project course where students practice what they have learned or are learning in class, through directed study. During the first week of class teams of students are assembled. The practicum is an ongoing project, in which students register to participate as "engineers" in a specific role in accordance to individual levels of expertise and profile. (Enrollment in the Software Engineering Master's Program) **Credit 4, Class 0, Lab 4**

4011-701 **Software Engineering Practicum II**
A project course where students practice what they have learned or are learning in class through directed study. During the first week of class teams of students are assembled. The practicum is an ongoing project, in which students register to participate as "engineers" in a specific role, in accordance to individual levels of expertise and profile. (4011-700) (Enrollment in the Software Engineering Master's Program) **Credit 4, Class 0, Lab 4**

4011-702 **Software Engineering Practicum III**
A project course where students practice what they have learned or are learning in class through directed study. During the first week of class, teams of students are assembled. The practicum is an ongoing project in which students register to participate as "Master Engineers" in a specific role in accordance to individual levels of expertise and profile. For this practicum students register as Master Engineers. (4011-701) **Credit 4, Class 0, Lab 4**

4011-710 **Research Methods**
Overview of the academic research methodologies used in graduate level work. Topics include; writing style, audience analysis, research planning, experimental design, document structure, research validation, and the process for submission and review to conferences and journals. (Admission to the MSSWE program. Students from graduate programs other than Software Engineering require departmental approval). **Credit 4, Class 4, Lab 0**

4011-720 **Software Evolution and Re-engineering**
This course explores the concepts of software evolution and re engineering and introduces approaches and support tools used to extract the information needed to assess existing software systems. Major maintenance activities are presented including estimating maintenance costs, managing change and predicting maintainability with software quality metrics. Organizational issues relative to product maintenance are discussed. Principles of software reuse and reverse engineering techniques are demonstrated through the use of class activities, team projects and case studies. (4011-710 Research Methods and 4011-750 Software Modeling). **Credit 4, Class 0, Lab 4**

4011-730 **Process Engineering and Environments**
In this course, students will study the Software Process Engineering Metamodel (SPEM) standard as a tool for modeling and analyzing engineering processes. Students will use SPEM to characterize various process and organization models and patterns, and they will align these process characteristics to categories of needs for various organizations and projects. The students will study process engineering frameworks and the configuration and assembly of reusable process components into processes. Students will also study how tools and methods support the process and will identify issues in tool/artifact integration across the software development life cycle. They will apply their learning to engineer software engineering processes, tools, and methods appropriate for their graduate projects and course projects. (Admission to MSSWE program) **Credit 4, Class 0, Lab 4**

4011-740 **Empirical Software Engineering**
This course focuses on the application and analysis of Software Engineering (SE) experimentation as a means of improving both the technical and process-oriented aspects of SE; includes software quality and testing, software design, maintenance, and software development techniques. Topics of interest include, but are not limited analysis of empirical studies of software processes and products, evaluation and comparison of techniques and models (e.g. cost estimation, analysis and design methods, testing), analysis of reports on benefits derived from using studied technologies, examination of predictive models, and the characterization of research methods (measurement theory, experimental design, qualitative modeling, analysis approaches, grounded theory, protocol studies, families of experiments). (4011-710 Students from graduate programs other than SE require departmental approval) **Credit 4, Class 0, Lab 4**

4011-749 **Graduate Seminar**

4011-750 **Software Modeling**
Modeling plays a pivotal role during the pre-construction and post construction activities of the software lifecycle. During the preconstruction, models help software engineers understand, specify, and analyze software requirements and design. During the post construction, models can be used to analyze software systems while in operation. This kind of analysis includes reliability and safety issues as well as timing constraint analysis. (Admission to the MSSE program) **Credit 4, Class 0, Lab 4**

4011-760 **Software Quality Engineering**
This course begins with an exploration of the concepts underlying quality systems and the use of metrics. Students are encouraged to discuss the advantages as well as the limitations of systems and quantitative approaches, with a view to understanding the importance of interpretation in metrics usage and of matching quality systems choices to organizational objectives and culture. They learn the use of modern metrics such as DRE, PCE, COQ/COPQ, reliability objectives and SUMI scores through exercises in analyzing and interpreting charts. This is complemented with a project where they work in teams to design an appropriate quality system for a specific project/organizational situation. (4011-701, 4011-730. Students from graduate programs other than Software Engineering require departmental approval). **Credit 4, Class 0, Lab 4**

4011-770 **Software Architecture and Product Lines**
A system's software architecture is the first technical artifact that illustrates a proposed solution to a stated problem. For all but the simplest system, the achievement of qualities such as flexibility, modifiability, security and reliability is critically dependent on the components and interactions defined by the architecture. The course focuses on the definition of architectural structures, the analysis of architectures in terms of tradeoffs among conflicting restraints, the documentation of architecture for use over a product's life cycle, and the

role of architecture in defining product lines based on reusable components. (4011-701, 4011-750. Students from graduate programs other than Software Engineering require departmental approval.) **Credit 4, Class 0, Lab 4**

4011-780 Software Engineering Experience Research
This course provides the student with an opportunity to reflect on his/her experience throughout this program and to relate that experience to his/her professional goals. The student builds a professional document during the last academic quarter of study. The report must include an in-depth research report on a topic selected by the student and in agreement with the student's experience report advisor. The report must be structured as a conference paper, and must be submitted to a conference selected by the student and his/her advisor. (Department authorization) **Credit 4, Class 0, Lab 4**

Computing and Information Sciences

4040-807 Teaching Skills Workshop I
Teaching is a valuable and desirable skill for PhD students. This first of a series of workshops provides an introduction to the concepts and skills needed for quality teaching in higher education. Students will be provided with lecture, reading, and class activities centered on building skills in educational analysis, design, and assessment. **Credit 2**

4040-809 Teaching Skills Apprenticeship
This course provides students with an opportunity to work with an experienced faculty member as an assistant. Students will be provided with an opportunity to observe and discuss teaching techniques with an experienced faculty "mentor." Students will be provided with opportunities to contribute to the teaching of a course, and will receive feedback on their teaching techniques and materials. (4040-807) **Credit 1**

4040-810 Research Methods
This course provides the theoretical background and practical application of various research methods that can be used in computing and information sciences. The students will learn general approaches to scholarship in the computing and information sciences field, and will explore research methods and associated data analysis techniques; including correlational and experimental design research techniques. Additionally, students will gain an overview of a variety of research methods and terminology, and will conduct literature reviews. Students will analyze several existing research studies, and design and conduct studies. (0307-711 or permission of instructor) **Credit 4**

4040-811 Introduction to Research
The course will concentrate on best practices in research in the areas of computer and information sciences. It will advance the student s generic research skills necessary for achieving research results, their presentation and publication. It will train students in refereeing and interacting with reviewers and choosing the media and means for publication. Writing styles specific to area publications will be discussed. The students will have to prepare a paper, submit it to their peers' review and discussions, and deliver a presentation based on the paper. The students must actively participate in the reviews and in class and on-line discussions. **Credit 4**

4040-820 Discovery
This course provides the necessary foundation in the theory and practice of discovering information from large data sets. Managing and interpreting the increasing quantities of scientific and business data to generate useful knowledge is a major challenge. Computing and information sciences professionals need to be able to combine data from multiple data sources, extract relevant information, and present it so that domain experts can develop knowledge and understanding. Topics include informatics, knowledge discovery, data visualization, information sharing and presentation, and, ethical issues underlying access and interpretation of large data sets. Computing projects are required. (4002-784 or permission of instructor) **Credit 4**

4040-830 Connectivity
This course draws attention to commonalities underlying social networks, biological networks, and communications networks. This will give the students a deeper understanding of the issues, a broader set of models and metaphors for designing new communication systems, and will better prepare them for development of connectivity solutions that meet the needs of users and communities they serve. Topics include fundamental and emerging concepts in networking, and the analytical and heuristic tools that people use to develop and analyze networks. Computing exercises will be required to provide hands-on experience with selected tools and technologies. (4005-740 or permission of the instructor) **Credit 4**

4040-840 Security and Trust
This course studies general security issues in a computing environment. This includes theoretical, practical, social, policy and procedural, human factors, and technological aspects. Students will learn to evaluate the security attributes in a computing-based environment. Topics are: cryptography, network security, policies and procedures, access control, secure software engineering, and human factors of security. Computing exercises will be required. (4040-820 or permission of the instructor) **Credit 4**

4040-849 Ph.D. Seminar
Current advances in computing and information sciences. (Prerequisite courses set by instructor) **Credit 1–4**

4040-850 Design
This course focuses on problem-solving and design approaches integrating the areas of interaction, informatics, and infrastructure into application domains. A primary goal is to give students a project-oriented experience in system-level design for creating and building multidisciplinary systems too complex to be treated by engineering analysis alone, and in the context of use inspired basic research. A second goal is to introduce students to existing design representations and methodologies, and to the concepts and terminology of domain-specific product line engineering. Topics include various types of systems and their lifecycles and process frameworks; effective system design representations and development methods; usability heuristics testing and assessment methods, product line domain engineering concepts; project planning and oversight tools. (4002-725, 4010-0361, 0306-661, or permission of instructor) **Credit 4**

4040-890 Dissertation and Research
Students will perform use-inspired original research in the interaction, informatics, and infrastructure areas of computing and information sciences applied to specific domain(s). Students will receive guidance from their adviser(s) in choosing an appropriate topic. (Permission of the Ph.D. program director) **Credit 0–32**

4040-896 Cyberinfrastructure Colloquium
Best practices in collaborative cross-disciplinary research and in communication will be developed and exemplified in a cyberinfrastructure colloquium which will be open to all students and faculty. **Credit 0**

4040-899 Independent Study
Ph.D. students will work with supervising faculty on a project or research study of mutual interest. The design and evaluation will be determined through discussion with the supervising faculty and documented through completion of an independent study form. The independent study must be approved by the Ph.D. program director. **Credit 1–6**

Networking, Security and System Administration

4055-721 Perl for System Administration
This course will provide students with an introduction to the Perl programming language, with examples and problems drawn from the system administration arena. In addition to the essentials of the language, students will be taught how to locate and install Perl Modules for use on a computing system. Toward the end of the course, OOPerl (Object Oriented Perl) will be introduced, as an extension to Modules. Application areas discussed will include programs for walking the files system, user account creation and manipulation, and the processing of log files. (Completion of a two course object oriented programming sequence) **Class 4, Credit 4**

4055-726 Research Methods in NSSA
This seminar introduces students to the MS in Networking, and System Administration, or the MS in Computer Security and Information Assurance, by providing an opportunity to meet the faculty involved in the program and their fellow students. Students will learn about current areas of research in networking, security, and system administration and the areas of research interest of the faculty. To encourage students to begin thinking about their final project or thesis, students will develop a research proposal that may serve as the basis for their later project/thesis proposal. In addition, this course provides an overview of the academic research methodologies used in graduate level work. Topics include: experimental research, correlation, experiment observation, surveys, and case studies. Also included will be document structure, validation, and the process for submission and review to conferences and journals. **Class 4, Credit 4**

4055-744 *Nix Fundamentals for Application Domains
Students will use a Unix-like operating system as it pertains to the support of web, application and database systems. This course allows students to explore design requirements for production servers as applied to domain areas such as web servers, web services, database applications and multimedia content distribution. Topics will include: file system organization and permissions, user interfaces, package management, and services. **Class 4, Credit 4**

4055-746 Telecommunications Network Protocols
Network topologies are discussed, with coverage of layers, 1, 2, 3, and 4. Access control, framing, network protocols, (IP) transport protocols (TCP and UDP), session initiation protocols (SIP), subnetting, port numbers, hubs, switches, routers, and other topics are covered. (No prerequisites) **Class 4, Credit 4**

4055-755 Secure Wireless Networks
Providing security in today's complex networks is a complicated subject and requires network managers to be well versed in the many aspects comprising network security. In order to accommodate the rapid expansion of networks and the alarming rate in which network security is breached, there is a need for more and better educated people who understand the basics of security in a networked world. This course is designed to provide students with the foundation needed to understand the problems of network security, perform a risk analysis to ascertain the threats and cost of an attack, and design and implement security strategies to effectively build a defense to minimize the effects of these attacks. (4055-746 or equivalent knowledge) **Class 4, Credit 4**

4055-760 Computer Viruses and Malicious Software
This course involves the study of malicious software (malware) including computer viruses, worms, and Trojan horses. Topics include the various mechanisms used in the construction of malicious software; existing commercial anti-virus software; preventative and reactive means for dealing with malicious software on workstations, servers and in networks; training and education of users; and reliable sources to monitor for alerts as well as the prevention of hoaxes. (4002-716, C++ for Programmers or equivalent) **Class 3, Lab 2, Credit 4**

4055-761 Principles of System Administration
Students are introduced to fundamental system administration topics and technologies that serve as the basis for later course work in system administration. Topics covered include; ethics and system administration, the law and system administration, and the role of the system administrator in organizations. Technologies covered include: computing resource management, the TCP/IP protocol suite, the Domain name Service (DNS), the Dynamic Host Configuration Protocol (DHCP), and the Lightweight Directory Access Protocol (LDAP). Students will use the Remote Laboratory Emulation System (RLES) to complete laboratory exercises. (4050-350 and 4050-351) **Class 4, Credit 4**,

4055-780 Computer System Security
This course provides an introduction to computer network security. The areas covered will include the liability, exposure, opportunity, and ability to exploit various weaknesses in a networked computer environment. The forms of the attacks and the detection and defense of the attacks will be discussed. The issues and facilities available to both the intruder and administrator will be examined and evaluated with illustrative laboratory exercises. (4055-761 or equivalent, corequisite: 4055-780 lab) **Class 3, Lab 2, Credit 4**

4055-782 Wireless Adhoc/sensor Networks
This course will introduce students to the diverse literature on ad hoc/sensor networks, and expose them to the fundamental issues in designing and analyzing ad-hoc/sensor network systems. Students will study related technologies and standards ranging from networking, OS support and algorithms, to security. Of primary concern will be protocol design, communication and computational challenges posed by these systems. Activities will include constructing ad-hoc/sensor networks, programming on the sensor hardware, and studying the performance of various protocols. (Prerequisites: 4055-746 and a two course sequence in object-oriented programming) **Class 3, Lab 2, Credit 4**

4055-815 Introduction to Routing and Switching
This course is a laboratory-based course that focuses on the standard used to establish internetwork structures that will support a TCP/IP data stream for higher level services to operate over. It is primarily concerned with the network layer and below. Although the course focuses on the TCP/IP protocol suite and the Ethernet LAN protocol, other protocols may be studied. Students will use their knowledge of how to connect computers (PC) in a LAN and learn how to connect separate networks together to form an internetwork. Bridging and switching concepts are investigated (such as the resolution of bridging loops through the appropriate algorithms). Routed and routing protocols and algorithms are studied and implemented. (4050-342) **Class 3, Lab 2, Credit 4**

4055-817 Emerging Network Technologies
The Internet has experienced profound growing pains in the last several years that have called into question the adequacy of some of the underlying technologies upon which it has been based. In response to this there are a substantial number of emerging network technologies that if widely adopted may allow the Internet to continue to grow and develop. This course is designed to provide students with an overview of several of these emerging network technologies. The course will consist of a combination of lectures, independent labs and simulation and modeling exercises. **Class 4, Credit 4**

4055-818 Network Management
This course will introduce students to the advanced concepts related to the development and implementation of network management tools utilizing a scripting language and the simple network management protocol (SNMP). Theoretical concepts related to network management and tool development will be discussed as well as the requirements of tool use in an enterprise scale network environment. Scripting/programming projects required. (4055-817) **Class 3, Lab 2, Credit 4**

4055-841 Advanced Computer Forensics
This course provides students with knowledge and understanding of computer forensics. It will also provide a theoretical foundation for the techniques and methods needed for the extraction of information from digital devices. Students will gain exposure to the spectrum of available computer forensics tools along with developing their own tools for "special needs" situations. The core forensics procedures necessary for ensuring the admissibility of evidence in court, as well as the legal and ethical implications of the process, will be covered on both Unix and Windows under multiple file systems. (4055-716 or equivalent and 4055-761 or equivalent) **Class 4, Credit 4**

4055-850 Network Design and Performance
This course will examine the design and performance of networks. Students will learn to design networks based on identified needs, analyze the performance of that network. The designs include site, campus, and enterprise. WAN technologies will be combined with LAN technologies in the design of enterprise networks. Students will learn to assess the business goals and their application to the network goals. Students will learn to evaluate the security goals of the network and to integrate these goals in the design. (4002-455, 4055-746, 4055-761) **Class 4, Credit 4**

4055-862 Advanced Routing Protocols
Managing complex network environments requires an understanding of the sophisticated routing protocols necessary for controlling information flow. This course will examine the routing protocols in standard use and their application in typical enterprise and large internet service provider (ISP) environments. The advantages and disadvantages of each protocol will be investigated. In addition, emerging networking technologies and the protocols needed to facilitate their implementation will also be discussed. (4055-746 or equivalent) **Class 4, Credit 4**

4055-863 Protocol Design and Implementation
Students will use a package that provides them access to the lowest layers of the OSI model available to software. Employing this package, students will write programs to interact with established protocols, and to implement their own protocols. What a protocol is will be discussed and what makes a protocol good or bad will also be explored. (4055-746 and 4002-716) **Class 5, Credit 4**

4055-882 Enterprise Security
This course is designed to provide students with the advanced concepts needed to establish network security strategies to ensure adequate protection for the corporate environment and yet provide accessibility for the corporate community. (4055-761 or 4055-746) **Class 4, Credit 4**

4055-883 Enterprise Networking
This course will provide students with the knowledge and understanding to apply modeling and simulation techniques to predict throughput in large-scale enterprise networks. Theoretical concepts of large-scale networks will be discussed and students will create software models based on this theory. This course will provide students with the knowledge needed to apply available tools for modeling network functionality to determine the impact of network infrastructure modification, device reconfiguration, and the impact of new application rollout. Modeling/simulation projects required. (4055-850, Network Design and Performance) **Class 4, Credit 4**

4055-884 **Enterprise Service Provisioning**
Advances in server software and hardware have made it possible for large organizations to consolidate software services onto fewer, higher powered servers while at the same time enhancing reliability and availability. This course will explore available technologies such as cluster computing and server virtualization as they can be used to deploy software services in enterprise environments. (4055-761 or equivalent, 4055-817. **Class 4, Credit 4**

4055-886 **Security Audits of Web Servers and Appli**
This course will provide students with an introduction to processes and procedures for performing a technical security auditing of web servers and web based applications. Students will not only explore the existing XML/WebServices threats, but also learn to apply appropriate auditing tools to identify new vulnerabilities existing in or stemming from web servers and applications. Students will write and present their audit reports on web servers and applications' vulnerabilities. (4055-780 or equivalent) **Class 4, Credit 4**

4055-890 **Graduate Seminar in NSSA**
This is the NSSA seminar course to allow for special one-time offerings of graduate topics or to allow faculty to pilot new graduate offerings. Specific course details (such as the course topics, format, resource needs, and credit hours) will be determined by the faculty member(s) who propose a given special-topics offering. (As appropriate for topic proposed) **Credit 2–8**

4055-896 **Proposal Development**
Capstone experience for the Master of Science in Applied Networking and Systems Administration. Students will submit an accepted proposal as a prerequisite for the formal thesis. (Permission of the NSSA graduate studies committee) **Class 2, Credit 1**

4055-897 **MS NSSA Thesis**
This is a capstone experience for graduate students in the Master of Science in Networking and System Administration and the Master of Science in Computing Security and Information Assurance. This course will provide an opportunity for students to carry out an individual piece of research on a specified topic area in the NSSA domain. This research should make an original contribution to the body of knowledge in the area of study. Students must submit an accepted thesis proposal in order to enroll. (4055-896 or permission of instructor) **Credit 8**

4055-899 **Graduate Independent Study in NSSA**
Graduate students will work with a supervising faculty member on a project of mutual interest. Project design and evaluation will be determined through discussion with the supervising faculty member and documented through completion of an independent study form to be filed with the Department of NSSA. **Credit 1–6**

4055-999 **Grad Coop in NSSA**
Students will gain experience and a better understanding of the application of technologies discussed in classes by working in the field of networking, security, or system administration. Students will be evaluated by their employer. (Good standing; completion of Bridge and 16 graduate credits)

Interactive Games and Media

4085-715 **Programming for Designers**
This course is an introduction to programming for students with a background in design. Students will write programs to construct and control interactive, media-rich experiences. Students will employ fundamental concepts of object-oriented computer programming such as classes, variables, control structures, functions, and parameters in their code. Students will develop their problem solving skills and begin building a "logical toolkit" of algorithms and program design strategies. Students will extend existing software objects provided by the instructor, as well as create new objects of their own design. Programming projects will be required. (2014-786) **Credit 4 (W)**

4085-727 **Introduction to Digital Audio Production**
Technologies and techniques for producing and manipulating digital audio are explored. Topics include digital representations of sound, digital audio recording and production, MIDI, effects, synthesis techniques, real-time performance issues, and the application of digital audio to multimedia and Web production. (Permission of the instructor) **Credit 4 (W)**

4085-728 **Interactive Narrative**
This course will examine elements of narrative and storytelling within computer games. Students will learn how narrative works within these environments and how it differs from standard narrative, whether the digital creation is original or derived from a traditional narrative source. Students will learn to apply different theories of Ludology (theory and critical analysis of computer games) to analysis and critique of computer games. Students will write treatments, flowcharts, storyboards and scripts for their own games and then implement prototypes based on those documents. Students will complete written assignments. (Permission of the instructor) **Credit 4 (F)**

4085-732 **Game Design**
In this course, students will examine technical requirements for the creation of computer games based on previously developed design artifacts. They will create a design document consistent with current industry practices, building upon a written script, related materials and prototype and will present the draft design documents for critique. (4085-728) **Credit 4 (W)**

4085-735 **Interactive Game and Audio**
This course provides the students with exposure to the design, creation and production of audio in interactive applications and computer games. Students will become familiar with the use of sound libraries, recording sounds in the studio and in the field, generating sound with synthesizers, and effects processing. Students will create sound designs for interactive media, integrating music, dialog, ambient sound, sound effects and interface sounds within interactive programs. (Third-year standing. In addition, must have successfully completed 4085-727 or permission of instructor) **Credit 4 (S)**

4085-738 **Multi-user Media Spaces**
This course will focus on the development of interactive applications that use network connectivity to allow multiple users to interact with each other in real time and in a persistent virtual community. The course will integrate multiple technologies dealing with connectivity, database access, server-side logic and object-oriented programming environments. Important human-computer interaction issues will be raised around the design and processing of messages and the traffic patterns generated by multi-user messaging. (4085-746) **Class 4, Credit 4**

4085-742 **Interactive Media Development**
The development of interactive media requires principles garnered from a variety of disciplines. Through readings, critiques, exercises and discussions, students will explore what makes an interactive media application (or component of an application) successful and what types of applications are best suited to interactive media. This course provides an introduction to the design and development of interactive media for student with technical skills developed for making other types of interactive software. (Permission of instructor) **Credit 4 (W)**

4085-743 **Interactive Media Project**
This advanced graduate course will allow students to work as domain specialists on teams competing one or more large projects over the course of the quarter. The projects will have a Game Design and Development and/or New Media core, but will require expertise in a variety of sub-domains; including web design and development, social computing, computer game development, multi-user media, human computer interaction and streaming media. Students will learn to apply concepts of project management and scheduling, production roles and responsibilities, and their domain skill sets to multidisciplinary projects. Students will complete design documents, progress reports and final assessments of themselves and their teammates in addition to completing their assigned responsibilities on the main projects. (Permission of instructor) **Class 4, Credit 4 (S)**

4085-744 **Building Online Communities**
In this graduate seminar students design and then work in teams to implement fully-functional on-line communities and/or social software tools to support on-line communities. They are also responsible for attracting members, and promoting their communities. Students will also evaluate the performance of their designs, interaction of their online communities, and their own management skills. (4085-794 or 4004-737) **Class 4, Credit 4 (S)**

4085-746 **Programming Interact Multimedia**
In this course, students will create object-oriented interactive applications in domains such as simulation, games, education and artificial life. They will build data structures and classes to create virtual worlds in 2 and 3 dimensions, populated by autonomous agents. Programs will often extend modules created by previous classes or the instructors. Some projects may require working in groups. (4002-730) **Class 4, Credit 4 (F, W, S)**

4085-757 Graphical Elements of the User Experience
This course provides a theoretical framework covering principles of GUI and its effect upon the user experience. Emphasis will be upon principles that guide the user toward certain behaviors and elicit a sense of identity. This course is designed to articulate methods used to manipulate visual perceptions of space and surface. Students will apply these methods to create user interfaces that reflect the utility and character appropriate for specific projects. (4085-742 or equivalent) **Credit 4 Class 4, Credit 4 (S)**

4085-790 Emerging Themes in Entertainment Technology
This course examines current technologies as well as future trends that will impact the direction of technology development within the video games industry. Topics of study may include, but are not limited to: graphics hardware, graphics algorithms, content creation tools, content organization tools, artificial intelligence techniques, machine learning techniques, game play networking, audio and video hardware and algorithms, user interface development, control and feedback systems, simulation systems, console game systems, experimental gameplay, as well as game engine technology and corresponding development APIs. (Graduate standing in Game Design and Development) **Class 4, Credit 4 (S)**

4085-791 History and Critical Analysis of Computer Games and Interactive Entertainment
This course provides a historical perspective on the evolution of computer and video game design, development and production. Related interactive digital entertainment will also be investigated to provide an understanding of historical issues related to games, computer games, and interactive media. Topics include analysis and critique of analog and interactive television technology, the application of computing and technology to the arts and literature, the business of computer games and cultural responses to computer games. Students will critique computer games and other interactive entertainment products in the context of these topics, the trade press, and personal experience. (Graduate standing in Game Design and Development) **Class 4, Credit 4 (F)**

4085-792 Development Process in the Game Industry
This course examines the individual and group roles of the development process model within the game design and development industry. Students will transform design document specifications into software and hardware needs for developers, testers, and end users. Students will examine team dynamics and processes for programming, content development, testing, deployment, and maintenance. Students will explore design process through the deconstruction of the game industry's software lifecycle model. (Graduate standing in Game Design and Development, or permission of the instructor) **Class 4, Credit 4 (F)**

4085-793 Business and Legal Aspects of Game Development
This course will provide students with a practical background in business and legal practices specific to the video games industry. Students will be introduced to entrepreneurship in the video games industry, confidentiality rules, game developer rights and responsibilities, the developer/publisher/retailer relationship, contract development, intellectual property rules and regulations, royalties, licensing, and legal responsibilities for content and consumer impact. Projects may include individual and group research, examination of case studies, and written and oral reports on current industry practice. (Graduate standing in Game Design and Development, or permission of instructor) **Class 4, Credit 4 (W)**

4085-794 Online Identity, Social, and Community Behavior
This course introduces students to the expanding body of research and popular writing on online identity, social and community behavior and its application to the development of new on-line communities and social software tools. Students will create their own prototypes for on-line communities and/or software tools and will participate in and evaluate existing online environments. (Graduate standing in Game Design and Development) **Class 4, Credit 4 (W)**

4085-802 Perspectives on Computer Mediation
This course examines the design and implementation of software for computer mediation from several perspectives: the computer support for cooperative work (CSCW) perspective addresses activity and organization management, the computer-mediated collaboration (CMC) perspective addresses social systems for computing, and the computer supported collaborative learning (CSCL) perspective addresses collaborative and constructivist learning systems. Students will investigate the design and implementation of computer mediated experiences across several domains, including, but not limited to: social computing, pervasive and ubiquitous computing, computer-based learning environments, entertainment and game systems, as well as visualization and simulation systems. Students will be required to work in teams to design a large-scale computer mediated project. (4085-757 or 4004-745) **Class 4, Credit 4 (S)**

4085-804 Building Tools for Creative Practice
Students will be introduced to many of the patterns defining modern computer interfaces and will use them to implement a novel interface of their own design. Students will develop implementation skills for prototyping traditional and experimental interfaces for computing devices. Design patterns and classes will be used to implement components of a typical graphical user interface. Students will then apply these programming strategies to build a toolkit for a new, less conventional interaction style of their own design. Programming projects will be required. (4004-730 and 4004-745) **Class 4, Credit 4 (W)**

4085-834 2D Graphics Programming
Students explore the use of an advanced graphics API to access hardware accelerated graphics. Course discussion will include the use of scene graphs, optimizations, and integration with the API object structure. Students will explore advanced use of the API calls in production code, to construct environments capable of real-time performance. (Graduate standing in Game Design and Development or permission of instructor) **Class 4, Credit 4 (S)**

4085-835 3D Graphics Programming
Students will explore the use of an advanced graphics API to access hardware accelerated graphics. This course will include discussion of scene graphs, optimizations, and integration with the API object structure. Students will explore advanced use of the API calls in production code, to construct environments capable of real-time performance. (4085-834) **Class 4, Credit 4 (F)**

4085-836 Game Engine Design and Development
This course will provide students with theory and practical skills in game engine design topic areas such as understanding the graphics pipeline as it influences engine design, hardware principles and the relationship to game engine construction, mathematical principles, scene graph construction and maintenance, advanced scene graph manipulation, textures, materials, and lighting, collision systems, physics, particle systems, and control systems. Furthermore, this course will examine software and toolsets that assist game engine designers in their tasks. Students will be expected to design and implement a game engine in teams as well as properly document their design and development strategy. (4085-835) **Class 4, Credit 4 (W)**

4085-887 Capstone Design in MS GD&D
This course allows students within the game design and development program to develop a capstone proposal and design document. The capstone design document specifies the scope and depth of the capstone project. In addition to the group and individual responsibilities for the cohort capstone project experience. (Permission of MS Game Design and Development faculty) **Class variable, Credit 0–4 (W)**

4085-888 Capstone Development in MS GD&D
This course provides Master of Science in Game Design and Development students with capstone project experiences. Students are expected to work in cohorts towards the implementation of a game system that properly illustrates proficiency in the application of theory and practice towards a large-scale project. For each student, individual responsibilities for the group project will be defined in consultation with both the group and the faculty. Students must successfully complete the Capstone Design course and present a satisfactory capstone project proposal to the faculty before enrolling in this course. (4085-887 and permission of MS Game design and Development faculty advisor) **Class variable, Credit 0–4 (S)**

4085-890 Graduate Seminar in Interactive Games and Media
This is intended to allow for special one-time offerings of graduate topics or to allow faculty to pilot new graduate offerings. Specific course details (such as the course topics, format, resource needs, and credit hours) will be determined by the faculty member(s) who propose a given special-topics offering. (as appropriate for topic proposed) **Class 4, Credit 2–8 (F, W, S)**

4085-891 Advanced AI: Evolutionary Computing
This course will provide students with theory and practical skills in Evolutionary Computing. Topic areas include the history and evolution of artificial life, evolutionary computing, and biologically inspired AI applied to the domain of video game AI. Students will be expected to design and implement a game in teams as well as properly document their design and development strategy. (4005-750) **Class 4, Credit 4 (W)**

4085-899 Independent Study
The student will work independently under the supervision of a faculty advisor on a topic not covered in other courses. (Proposal signed by a faculty member) **Class 4, Credit 1–8 (F, W, S)**

4085-999 Graduate Co-op Education
An optional cooperative educational experience is available to graduate students to add practical employment experience to their studies to support their career objectives and personal goals. (Permission of graduate coordinator) **Class 0 Credit 0 (F, W, S)**

Kate Gleason College of Engineering

Harvey J. Palmer, Dean
www.rit.edu/kgcoe

Programs of study

Doctor of Philosophy degree in:	Page
Microsystems Engineering	92

Master of Science degrees in:	
Applied Statistics	80
Computer Engineering	81
Electrical Engineering	82
Industrial Engineering	85
Manufacturing Leadership	86
Materials Science and Engineering (offered jointly with the College of Science)	188
Mechanical Engineering	87
Microelectronic Engineering	89
Product Development	95
Sustainable Engineering	96

Master of Engineering degrees in:	
Engineering Management	84
Industrial Engineering	86
Mechanical Engineering	89
Microelectronics Manufacturing Engineering	91
Sustainable Engineering	97
Systems Engineering	98

Advanced Certificates in:	
Statistical Methods for Product and Process Improvement	99
Statistical Quality	99
Vibrations Engineering	100

Online learning option available

The Kate Gleason College of Engineering offers comprehensive, innovative graduate programs in a broad range of engineering disciplines. Programs include traditional master of science degrees, master of engineering degrees, and a broad-based, cross-disciplinary doctoral program in microsystems engineering. In conjunction with the College of Science, the Kate Gleason College offers an interdisciplinary MS degree in materials science and engineering. Additionally, the college partners with a number of other RIT colleges to offer integrated dual degrees in which students earn a BS and an MS in a five-year timeframe.

The master of science degree is research based and leads to either employment in industry or graduate study at the doctoral level. The master of engineering degree is a terminal master's program focused on career development for industry. A capstone experience combined with additional course work replaces the traditional thesis requirement.

Details on specific programs, including courses, research activities, thesis requirements, and assistantships, are outlined in this *Graduate Bulletin* as well as on the college and program websites.

Admission requirements

The college offering the program makes all decisions on graduate admission. Please refer to each individual program for information regarding specific admission criteria. For general graduate admission information, please refer to the Admission section of this bulletin.

Financial aid and scholarships

Please refer to the Financial Aid and Scholarship section of this bulletin for information regarding financial aid, scholarships, grants, loans, and graduate assistantships.

Faculty

The college's faculty is committed to continuous learning and professional growth. They work closely with graduate students on research, thesis, and graduate project work.

Advisers: A member of the faculty is appointed as a faculty adviser for each graduate student and supervises the student's progress toward the degree completion. For master of engineering programs that include an internship, a second adviser (for the internship) is assigned once an internship proposal is submitted. This adviser, in cooperation with the student's industrial adviser, will monitor and evaluate the student's internship experience and recommend to the department head the number of academic credits to be awarded for the experience.

Facilities

The college provides students with state-of-the-art laboratories, including machine tools and manufacturing, ergonomics, advanced systems integration, production systems, materials processing, biofluids, fuel cells, thermal analysis, robotics, electronics, microchip fabrication (clean room), VSLI, embedded systems, hardware design, analog devices, lasers and optics, electromagnetics, computer architecture, and digital design, to name a few. Close corporate partnerships provide the college with access to current software and equipment used in industry.

Study options

Full-time study: Students may matriculate on either a full- or part-time basis. A full-time student will generally take between 12 and 18 credits per quarter, depending upon their research or graduate project activity and can complete the degree requirements in one calendar year. A full-time student in a master of engineering degree program may choose to alternate academic quarters with an internship.

Part-time study: The college encourages practicing engineers in the greater Rochester industrial community to pursue a program of study leading to the master of science or master of engineering degree without interrupting their employment. To facilitate this, many of the courses are scheduled in the late afternoon or early evening. Students employed full-time are limited to a maximum of two courses or 8 credits each quarter. A student who wishes to register for more than 8 credits must obtain the approval of his or her adviser and the department head.

Nonmatriculated status: An individual may take graduate courses as a nonmatriculated student if they have a bachelor's degree from an approved undergraduate school and the necessary background for the specific courses in which they wish to enroll. The courses taken for credit usually can be applied toward the master's degree when the student is formally admitted to the graduate program at a later date. However, the number of credits that will be transferred to the degree program from courses taken at RIT as a nonmatriculated student is normally limited to a maximum of 12 credits.

Applied Statistics, MS

http://www.rit.edu/cqas/academics/msappliedstatistics

Steven M. LaLonde, Graduate Program Director
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Program overview

The MS program in applied statistics is available to both full- and part-time students. Those working toward their baccalaureate degree in certain RIT departments are eligible to apply for a joint BS/MS program. Cooperative education options also are available. The MS degree is also available in an online learning format, which is especially appealing to students who are unable to attend classes on campus.

The program is primarily intended for students who do not wish to pursue a degree beyond the MS. However, a number of our students are either working on, or have attained, a doctoral degree at other universities.

Curriculum

The program requires 45 credit hours and includes seven core courses plus four courses from a career option.

Core courses

0307-742	Statistical Computing
0307-801	Design of Experiments I
0307-802	Design of Experiments II
0307-821	Theory of Statistics I
0307-822	Theory of Statistics II
0307-841	Regression Analysis I
0307-842	Regression Analysis II

Students, in conjunction with their advisers' recommendations, should take the core courses early in the program. In any event, they must be taken within the first 30 credit hours of the degree.

Career options

There are three standard career options, each of which is designed to allow students to specialize within their career endeavors. A specialized career option is also available. The three standard career options and their respective required courses are as follows:

Quality engineering

0307-721	Statistical Process Control
0307-731	Statistical Acceptance Control
0307-781	Quality Management
0307-782	Quality Engineering

Industrial statistics

0307-803	Design of Experiments III
0307-846	Statistical Data Mining
0307-862	Reliability Statistics I
0307-883	Quality Engineering by Design

Statistical theory and methods

0307-824	Probability Models
0307-830	Multivariate-Analysis Theory
0307-831	Multivariate-Analysis Applications
0307-862	Reliability Statistics I

Advisers can help identify an appropriate career option and develop a program structured to meet individual professional objectives.

Three additional courses and a capstone course

Three additional courses are chosen by students with the help of their advisers. These courses are usually department courses but may include (along with transfer credits) up to 9 credits from other courses related to the program that are consistent with students' professional objectives.

Students, with adviser approval, may choose to write a research thesis or conduct a research project instead of taking the full three electives. Theses are usually for 6 credits, and projects are usually for 3 credits.

A required capstone course is designed to ensure that students can integrate the knowledge from their courses to solve more complex problems. This course is taken near the end of a student's course of study.

Full-time students on scholarship must register for and attend the Statistics Seminar (0307-895) in the fall, winter, and spring quarters. This is a non-credit bearing course that is graded on a pass-fail basis.

Other requirements

Candidates must attain an overall program grade point average of 3.0 (B), with no more than two grades of C, for graduation. A minimum of 24 credits in 800-level courses is required in the degree program. Course work must be completed within seven years. Contact the department for more details on these requirements.

Students are strongly encouraged to further develop their writing, speaking, presentation, and computer skills as they progress through the program.

Admission requirements

To be considered for admission to the MS program in applied statistics, candidates must fulfill the following requirements:

- Hold a baccalaureate degree from an accredited institution,
- Submit official transcripts (in English) of all previously completed undergraduate and graduate course work,
- Submit a current resume,
- Submit two letters of recommendation, and
- Complete a graduate application.

Additional information

Six Sigma Black Belt

Students may earn a Six-Sigma black belt after obtaining either the advanced certificate in statistical quality or the MS in applied statistics. Students should ensure an appropriate course selection by reviewing the Black Belt requirements on the center's website. In addition, students will need to complete an additional qualifying project.

Advanced certificate programs

Two advanced certificate programs, in statistical quality and in statistical methods for product and process improvement, also are available. Each requires 18 quarter-credit hours (equivalent to six courses) and both are available to part-time students. In both programs, the courses are a subset of the MS program courses and are offered on campus and in the online learning format. The advanced certificate in statistical quality is aimed primarily at quality managers, quality engineers, or those who aspire to such positions. The advanced certificate in statistical methods for product and process improvement is designed for engineers, scientists, and other professionals who want a solid education in the statistical methods that are most closely related to their work, but who wish to finish a program in a shorter time period than the MS program.

Computer Engineering, MS

http://www.ce.rit.edu/academics/msce.htm

Program overview

The master of science degree in computer engineering builds upon a bachelor of science degree in computer engineering (or a related discipline) and provides students with a higher level of specialized knowledge in computer engineering, strengthening their ability to successfully formulate solutions to current technical problems in computer engineering, and offering a significant independent learning experience in preparation for further graduate study or for continuing professional development at the leading edge of the computer engineering discipline. The MS program is expected to accommodate recipients of BS degrees in other majors, such as electrical engineering or computer science, after some additional bridge courses.

Curriculum

The degree requires 45 credits and includes a core curriculum of four courses, three courses within an area of concentration, two graduate electives (subject to a faculty adviser's approval), and 9 credits of thesis research. Core courses and graduate electives are meant to provide breadth of knowledge. The concentration allows students to pursue an area of specialization in the field of computer engineering by completing a cohesive set of three courses beyond the core degree requirements. This provides students with enough depth to conduct meaningful thesis research. The graduate committee must approve a student's chosen thesis research topic. The committee consists of at least three faculty members, the majority of whom are computer engineering faculty. The committee chairperson normally serves as the student's faculty adviser.

All computer engineering students with graduate standing are expected to attend the Computer Engineering Graduate Seminar. These courses build on the knowledge a student has previously gained through a BS degree in computer engineering or a related discipline.

Core courses

COURSE		QTR. CR. HRS.
0306-720	Electronic Design Automation	4
0306-730	VLSI Design	4
0306-740	Analytical Topics for Computer Engineers	4
0306-756	Multiple Processor Systems	4

Thesis research

One critically important aspect of graduate study is the student's preparation to lead challenging, state-of-the-art technical projects. To do this effectively, it is essential that the student obtain experience in reviewing related work of others in the field, as well as to conduct meaningful independent research under faculty mentorship.

Thesis work begins by selecting a faculty adviser, identifying a topic, forming a committee, and submitting a proposal. The thesis topic, formulated by working closely with a faculty adviser, is related to recent technical developments in the field of computer engineering. Upon completion of the research outlined in the thesis proposal, the work is reported in a document submitted to the faculty committee and a thesis defense presentation. A technical paper resulting from the thesis research is submitted to a refereed conference or journal for publication.

Areas of concentration

The following areas of concentration are available. Students are allowed to take relevant courses from other academic programs, such as electrical engineering and computer science.

VLSI and digital systems design

0306-720	Electronic Design Automation (core)
0306-730	VLSI Design (core)
0306-731	VLSI Design Projects
0306-732	Low Power Design
0306-758	Fault Tolerant Digital Systems
0306-759	Principles of Digital Interfacing

Computer architecture

0306-722	Advanced Computer Architecture
0306-724	High Performance Architectures
0306-756	Multiple Processor Systems (core)
0306-772	Special Topics: Computer Architecture

Digital image processing and computer vision

0306-784	Digital Image Processing Algorithms
0306-785	Computer Vision
0306-772	Special Topics: Computational Intelligence

Computer networking

0306-710	Network Modeling, Design and Simulation
0306-715	Wireless Networks
0306-795	Network Security
0306-722	Special Topics: Wireless Communications

Embedded systems and control

0306-763	Embedded and Real-time Systems
0306-775	Robotics
0306-764	Modeling of Real-Time Systems
0306-776	Robust Control

Admission requirements

To be considered for admission to the MS program in computer engineering, candidates must fulfill the following requirements:

- Hold a baccalaureate degree from an accredited university in computer engineering or a related field,
- Submit official transcripts (in English) from all previously completed undergraduate and graduate course work,
- Have an GPA of 3.0 or higher,
- Submit scores from the Graduate Record Exam (GRE),
- Submit two letters of reference from individuals well qualified to judge the candidate's ability for graduate study, and
- Complete a graduate application.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language (TOEFL).

Electrical Engineering, MS

http://www.rit.edu/kgcoe/eme/

Program overview

The master of science degree in electrical engineering allows students to customize their course work while working closely with electrical engineering faculty in a contemporary, applied research area. Upon matriculation into the program, students formulate a plan of study in consultation with an adviser. All students with graduate standing are expected to attend the Electrical Engineering Graduate Seminar for every quarter they are on campus. The MS degree is awarded upon the successful completion of a minimum of 4 credit hours, including either a 9-credit-hour thesis or a 5-credit hour graduate paper.

Curriculum

Graduation requirements

The MS degree is awarded upon the successful completion of an approved graduate program consisting of a minimum of 45 quarter credit hours with a grade point average of 3.0 or higher. Under certain circumstances, a student chooses or is required to complete more than the minimum number of credits.

Summer quarter

A select number of 600- and 700-level courses are available during the summer quarter. Consult the department for details.

600-level courses

These courses are senior-level undergraduate professional electives. A maximum of two courses from the following list may be taken by a graduate student and counted toward the MS degree.

0301-601	/805 Modern Optics for Engineers
0301-610	Analog Electronic Design
0301-612	Semiconductor Devices III
0301-615	State Space Control
0301-630	Biomedical Instrumentation
0301-631	Biomedical Sensors and Transducers I
0301-632	Fundamentals of Electrophysiology
0301-633	Biomedical Signal Processing
0301-636	Biorobotics/Cybernetics
0301-646	Power Electronics
0301-647	Artificial Intelligence Systems
0301-650	Design of Digital Systems
0301-651	Physical Implementation
0301-655	Microcomputer Software I
0301-662	Neural Networks
0301-664	Embedded Microcontroller Systems
0301-677	Digital Filters and Signal Processing
0301-679	Analog Filter Design
0301-685	Principle of Robotics
0301-686	Microelectromechanical Devices
0301-688	MEMS System Evaluation
0301-692	Communication Networks
0301-693	Digital Data Communications

Courses other than those listed in this bulletin are developed and offered periodically by the department of electrical engineering. Information is available from the department office the month before the beginning of each academic quarter. Course offerings are subject to minimum enrollment requirements.

Schedule of all electrical engineering graduate courses, 700 and 800-level

Core Courses

COURSE		QTR. CR. HRS.
Fall		
0301-702	Random Signals and Noise	
0301-703	Matrix Methods in Electrical Engineering	
Winter		
0301-702	Random Signals and Noise	
0301-703	Matrix Methods in Electrical Engineering	

Communication

COURSE		QTR. CR. HRS.
Fall		
0301-693	Digital Data Communication	
0301-729	Antenna Theory and Design	
Winter		
0301-692	Communications Networks	
0301-717	Microwave Circuit Design	
0301-794	Information Theory	
Spring		
0301-710	Advanced Electromagnetic Theory	
0301-802	Wireless Communication	
0301-816	Design and Characterization of Microsystems	

Control systems

COURSE		QTR. CR. HRS.
Fall		
0301-615	State Space Control	
0301-769	Fuzzy Logic and Applications	
Winter		
0301-761	Modern Control Theory	
0301-815	Multivariable Modeling	
Spring		
0301-733	Robust Control	
0301-765	Optimal Control	

Robotics

COURSE		QTR. CR. HRS.
Fall		
0301-688	/885 Principles of Robotics	
0301-647	/847 Artificial Intelligence	
Winter		
0301-761	Modern Control Theory	
0301-836	Biorobotics/Cybernetics	
Spring		
0301-895	Advanced Robotics	

Signal and image processing

COURSE		QTR. CR. HRS.
Fall		
0301-677	/887 Digital Signal Processing	
Winter		
0301-768	Adaptive Signal Processing	
0301-779	Digital Image Processing	
Spring		
0301-749	Speech and Image Compression	
0301-770	Pattern Recognition	
0301-803	Digital Video Processing	

Integrated electronics

COURSE		QTR. CR. HRS.
Fall		
0301-610	Analog Electronic Design	
0301-713	Solid State Physics	
Winter		
0301-712	Advanced Field Effect Devices	
0301-726	Mixed Signal IC Design	
Spring		
0301-711	Advanced Carrier Injector Transistors	
0301-730	Advanced Analog IC Design	

Digital systems

COURSE		QTR. CR. HRS.
Fall		
0301-650	Design of Digital Systems	
Winter		
0301-650	Design of Digital Systems	
0301-651	Physical Implementation	
0301-732	Advanced Topics in Digital System Design	
Spring		
0301 -741	Design for Testability	
0301-810	Advanced Computer Architecture	

MEMS

COURSE		QTR. CR. HRS.
Fall		
0301-789	Fundamentals of MEMS	
0301-799	Nano and Microengineering	
Winter		
0301-760	Modern Control Theory	
Spring		
0301-798	Microfluidic MEMS	
0301-804	MEMS Evaluation	

Admission requirements

To be considered for admission to the MS program in electrical engineering, candidates must fulfill the following requirements:

- Hold a baccalaureate degree from an accredited university in an engineering or a related field,
- Submit official transcripts (in English) from all previously completed undergraduate and graduate course work,
- Have an GPA of 3.0 or higher,
- Submit scores from the Graduate Record Exam (GRE),
- Submit two letters of reference from individuals well qualified to judge the candidate's ability for graduate study, and
- Complete a graduate application.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language (TOEFL).

Candidates with a bachelor of science degree in non-electrical engineering fields may be considered for admission, however, they may be required to undertake bridge courses to ensure they are adequately prepared for graduate studies in electrical engineering.

Additional information

Policies

The following general rules apply:

- All students seeking the master of science degree in electrical engineering must satisfactorily complete the core course Matrix Methods in Electrical Engineering (0301-703). Students are expected to take the course immediately after entering the program, since it is a prerequisite for many of the other graduate courses.
- Those students who have selected focus areas in control systems, communications, signal and image processing, or robotics must also take Random Signals and Noise (0301-702).
- Each student must take at least four courses from the electrical engineering department in the chosen focus area.
- All course selections must be approved by one of the graduate advisers. All courses must be at 700-level or above with one exception: a student is allowed to take a maximum of two 600-level courses for full credit in the graduate program.
- All students must satisfy a research component through one of the following activities:
  1. Graduate thesis (9 credit hours): The inclusion of a thesis (0301-890) as a formal part of the degree program is optional but strongly encouraged. Thesis work is done under the supervision of a faculty adviser and defended before a committee when complete.
  2. Graduate research paper (5 credit hours): A student may choose to write a graduate paper in lieu of a thesis. The graduate paper is an extensive term paper on a topic of professional interest. The objective is to enable the student to undertake an independent and in-depth literature search and write a report summarizing the findings. A faculty member interested in the paper's topic will serve as the student's supervisor and direct the scope and depth of the paper, as well as the format of the final written version. The student must consult with and obtain approval from a faculty member about a suitable topic for the paper. The course Graduate Paper (0301-800), is used to register for the paper. The student should plan to take at least 5 credit hours in 0301-800. The student choosing this option is required to take a minimum of 10 courses for 40 credits.
- All graduate work must be completed within a seven-year period starting from the first course applied toward the MS degree. Also, a student who is pursuing thesis/project options may be required to register for continuation of thesis/project credits if he or she is not enrolled for any credits in a given quarter. For complete details, please consult the continuation of thesis/project/dissertation policies.

Engineering Management, ME

http://www.rit.edu/kgcoe/ise/grad/me_em.html

Michael E. Kuhl, Graduate Program Director
(585) 475-2134, mekeie@rit.edu

Program overview

The engineering management curriculum is a combination of engineering courses from the industrial and systems engineering program and management courses from the E. Philip Saunders College of Business. The program combines technical expertise with managerial skills to focus on the management of engineering and technological enterprises. Students in the engineering management program will understand the technology involved in engineering projects and the management process through which

the technology is applied. The objective of this degree program is to provide a solid foundation in the areas commonly needed by managers who oversee engineers and engineering projects. In addition to industrial engineering expertise, students will gain valuable knowledge in areas such as organizational behavior, finance, and accounting.

Curriculum

Typical scheduled ISE course offerings

Fall

0303-620	Engineering Economy
0303-701	Linear Programming
0303-703	Supply Chain Management
0303-626	Contemporary Production Systems I
0303-727	Advanced Manufacturing Engineering
0303-760	Product/Process Development and Design
0303-766	Manufacturing Systems
0303-790	Fundamentals of Sustainable Design

Winter

0303-702	Integer and Nonlinear Programming
0303-710	Systems Simulation
0303-729	Advanced Systems Integration
0303-731	Advanced Topics in Ergonomics and Human Factors
0303-734	System Safety Engineering
0303-758	Design of Experiments
0303-761	Rapid Prototyping
0303-765	Databases for IS
0303-784	Project Management
0303-791	Lifecycle Assessment and Costing

Spring

0303-620	Engineering Economy
0303-704	Logistics Management
0303-711	Advanced Simulation Techniques
0303-720	Production Control
0303-732	Biomechanics
0303-792	Design for the Environment
0303-801	Design for Manufacture

Admission requirements

To be considered for admission to the ME in engineering management, candidates must fulfill the following requirements:

- Hold a baccalaureate degree in engineering, mathematics, or science,
- Have a minimum cumulative undergraduate GPA of 3.00,
- Submit official transcripts (in English) of all previously completed undergraduate and graduate course work,
- Submit scores from the Graduate Record Exam (GRE) (optional),
- Submit letters of recommendation,
- Submit a statement of purpose, and
- Complete a graduate application.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language. Minimum scores of 550 (paper-based) or 213 (computer-based) are required.

Industrial Engineering, MS

http://www.rit.edu/kgcoe/ise/grad/ms_ie.html

Michael E. Kuhl, Graduate Program Director
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Program overview

The master of science degree in industrial engineering allows students to customize their course work while working closely with industrial engineering faculty in a contemporary, applied research area. Faculty members are currently conducting applied project and research work in the areas of contemporary manufacturing processes/systems, ergonomic/biomedical analysis, logistics and supply chain management, sustainable design and development, systems engineering/product development, and systems simulation.

Curriculum

The MS degree in industrial engneering is awarded upon successful completion of a minimum of 45 credit hours of study. This includes 9 courses and a 9 credit hour thesis. All students are required to complete at least three quarters of Graduate Seminar (0303-800), Graduate Thesis Seminar I (0303-888), and Graduate Thesis Research Seminar II (0303-889).

Typical scheduled ISE course offerings

Fall

0303-620	Engineering Economy
0303-701	Linear Programming
0303-703	Supply Chain Management
0303-626	Contemporary Production Systems I
0303-727	Advanced Manufacturing Engineering
0303-760	Product/Process Development and Design
0303-766	Manufacturing Systems
0303-790	Fundamentals of Sustainable Design

Winter

0303-702	Integer and Nonlinear Programming
0303-710	Systems Simulation
0303-729	Advanced Systems Integration
0303-731	Advanced Topics in Ergonomics and Human Factors
0303-734	System Safety Engineering
0303-758	Design of Experiments
0303-761	Rapid Prototyping
0303-765	Databases for IS
0303-784	Project Management
0303-791	Lifecycle Assessment and Costing

Spring

0303-620	Engineering Economy
0303-704	Logistics Management
0303-711	Advanced Simulation Techniques

0303-720	Production Control
0303-732	Biomechanics
0303-792	Design for the Environment
0303-801	Design for Manufacture

Admission requirements

To be considered for admission to the MS in industrial engineering, candidates must fulfill the following requirements:

- Hold a baccalaureate degree in engineering, mathematics, or science,
- Have a minimum cumulative undergraduate GPA of 3.00,
- Submit official transcripts (in English) of all previously completed undergraduate and graduate course work,
- Submit scores from the Graduate Record Exam (GRE),
- Submit letters of recommendation,
- Submit a statement of purpose, and
- Complete a graduate application.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Langage. Minimum scores of 550 (paper-based) or 213 (computer-based) are required.

Industrial Engineering, ME

http://www.rit.edu/kgcoe/ise/grad/me_ie.html

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Program overview

The master of engineering in industrial engineering focuses on the design, improvement, and installation of integrated systems of people, material, information, equipment, and energy. The program emphasizes specialized knowledge and skills in the mathematical, physical, computer, and social sciences together with the principles and methods of engineering analysis and design. The overarching goal of industrial engineering is the optimization of the system, regardless of whether the activity engaged in is a manufacturing, distribution, or a service-related capacity. The student graduates with a variety of skills in the areas of applied statistics/quality, ergonomics/human factors, operations research/simulation, manufacturing, and systems engineering.

Curriculum

Typical scheduled ISE course offerings

Fall

0303-620	Engineering Economy
0303-701	Linear Programming
0303-703	Supply Chain Management
0303-626	Contemporary Production Systems I
0303-727	Advanced Manufacturing Engineering
0303-760	Product/Process Development and Design
0303-766	Manufacturing Systems
0303-790	Fundamentals of Sustainable Design

Winter

0303-702	Integer and Nonlinear Programming
0303-710	Systems Simulation
0303-729	Advanced Systems Integration
0303-731	Advanced Topics in Ergonomics and Human Factors
0303-734	System Safety Engineering
0303-758	Design of Experiments
0303-761	Rapid Prototyping
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0303-784	Project Management
0303-791	Lifecycle Assessment and Costing

Spring

0303-620	Engineering Economy
0303-704	Logistics Management
0303-711	Advanced Simulation Techniques
0303-720	Production Control
0303-732	Biomechanics
0303-792	Design for the Environment
0303-801	Design for Manufacture

Admission requirements

To be considered for admission to the ME in industrial engineering, candidates must fulfill the following requirements:

- Hold a baccalaureate degree in engineering, mathematics, or science,
- Have a minimum cumulative undergraduate GPA of 3.00,
- Submit official transcripts (in English) of all previously completed undergraduate and graduate course work,
- Submit scores from the Graduate Record Exam (GRE) (optional),
- Submit letters of recommendation,
- Submit a statement of purpose, and
- Complete a graduate application.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Langage. Minimum scores of 550 (paper-based) or 213 (computer-based) are required.

Manufacturing Leadership, MS

http://www.mml.rit.edu/

Mark W. Smith, Director
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Christine Fisher, Coordinator
(585) 475-7971, mml@rit.edu

Program overview

The master of science degree in manufacturing leadership is designed for experienced professionals moving to mid- and senior-level positions in manufacturing and service organizations. The program integrates business and engineering courses, delivering them in a part-time format where students continue to work while taking classes in the evenings or online.

Manufacturing leadership is a highly focused program developed jointly by the E. Philip Saunders College of Business and the Kate Gleason College of Engineering. Particular emphasis is placed on supply chain management, global manufacturing and operations, lean thinking, leadership, and decision making. A capstone project, oriented to the solution of a manufacturing or services management problem or process improvement initiative, enables students to apply new skills and capabilities to the solution of a pressing real-world problem, with significant financial benefit to sponsors. Two electives allow for additional depth or breadth in subjects of relevance to students and their sponsoring organizations.

Curriculum

The program consists of 48 credits of engineering and business courses and an integrative capstone project. The courses are as follows:

Choose one of the following courses:

0101-703	Accounting for Decision Makers
0101-794	Cost Accounting in Technical Organizations

Plus:

0102-740	Organizational Behavior and Leadership
0303-703	Supply Chain Management
0303-723	Global Facilities Planning
0303-760	Product/Process Design and Development
0303-762	Systems Modeling and Decision Making
0303-766	Manufacturing Systems
0307-781	Quality Management
0303-784	Systems and Project Management
	Two elective courses*
0303-891	Capstone Integrative Project

*Contact the program office for elective options.

Admission requirements

To be considered for admission to the MS program in manufacturing leadership, candidates must fulfill the following requirements:

- Hold a baccalaureate (or equivalent) degree from an accredited institution,
- Submit official transcripts (in English) of all previously completed undergraduate and graduate course work,
- Have a minimum cumulative grade point average of 2.8.
- Have at least two years of experience in a manufacturing-related organization or business environment,
- Submit two professional recommendations,
- Submit a current resume,
- Participate in a personal interview with the admissions team (after other application materials are received), and
- Complete a graduate application.

Exceptions may be considered on a case-by-case basis. No graduate entrance exam is required, although candidates are welcome to support their application with results from the Graduate Management Admission Test (GMAT) or Graduate Record Exam (GRE).

Additional information

Prerequisite knowledge

Admitted students must possess knowledge and skills at the introductory course level in probability and statistics, engineering economy or basic accounting, and manufacturing processes.

Format

Students may start the program during any quarter and complete the course work at their own pace. Classes are available on campus (evenings) or online (video conference and asynchronous format) to accommodate the needs of local students as well as those who travel or live outside the Rochester area.

Students may take up to three courses on a nonmatriculated basis. Credits earned while enrolled as a non-matriculated student may be applied to the degree program following formal admission.

Areas that need strengthening may be addressed by guided reading, formal course work, independent study, seminars, or other suitable means. For further information about the manufacturing leadership program, please contact the program director or the Office of Graduate Enrollment Services.

Mechanical Engineering, MS

http://www.rit.edu/kgcoe/mechanical/grad/msme

Program overview

The master of science degree in mechanical engineering is awarded upon successful completion of an approved graduate program consisting of a minimum of 45 quarter credit hours. A minimum of 36 credits are to be earned in course work and 9 credits of thesis. A maximum of 9 quarter credits may be transferred from graduate courses taken outside the university, provided such courses complement a student's proposed graduate program in the mechanical engineering department. Upon matriculation into the MS program, the student should formulate a plan of study in consultation with his or her adviser.

Curriculum

The program includes core courses (8 credit hours), focus area courses (12 credit hours), elective courses (16 credit hours), and a thesis (9 credit hours). All full-time MS students are required to attend the weekly graduate seminar each quarter they are on campus. At least 28 credit hours of graduate-level course work, including the core and focus area courses, must be taken in the mechanical engineering department. Eight credits may be taken as upper-level undergraduate electives (a course number beginning with 0304-6xx) or as technical courses outside of the department, with prior approval. Typical out-of-department courses include advanced engineering, mathematics, and science courses.

Core courses

All students are required to complete the following core courses:

COURSE		QTR. CR. HRS.
0304-870	Mathematics for Engineers I	4
0304-871	Mathematics for Engineers II*	4

* An alternative course may be approved by an adviser and/or department head.

Focus area courses

Al students must develop a graduate focus area of study, with prior approval from their adviser and the department head. The focus area should consist of at least 12 credits of graduate study in mechanical engineering (0304-7xx or higher) and be related to the student's technical and professional development interests. Examples of focus areas include controls, materials science, thermo/fluids, and mechanics/design.

Elective courses

All students must complete a minimum of 16 credits of elective courses.

Graduate mechanical engineering focus area and elective courses

0304-701	Research Methods
0304-710	Fuel Cell Technology
0304-729	Renewable Energy Systems
0304-730	Design Project Management
0304-743	Intermediate Control Systems
0304-745	Micro and Nano Characterization of Materials
0304-746	Engineering Properties of Materials
0304-752	Fundamentals of Tribology
0304-754	Fundamentals of Fatigue and Fracture Mechanics
0304-756	Aerosols in the Respiratory Tract
0304-758	Intermediate Engineering Vibrations
0304-810	Introduction to Continuum Mechanics
0304-816	Finite Elements
0304-820	Advanced Optimal Design
0304-821	Advanced Vibrations
0304-823	Systems Modeling
0304-828	Special Topics in Applied Mechanics
0304-830	Introduction to Computational Fluid Dynamics Analysis
0304-831	Computational Fluid Dynamics Applications
0304-833	Heat Exchanger Design
0304-834	Boiling and Condensation
0304-838	Ideal Flows
0304-840	Signal Processing
0304-843	Advanced Control Systems
0304-847	Microscale Transport Phenomena
0304-848	Special Topics in Thermo Fluid Systems
0304-851	Convective Phenomena
0304-852	Advanced Turbomachinery
0304-865	Computer Implementation of Finite Elements
0304-872	Analytical Mechanics
0304-885	Advanced Mechanics of Solids
0307-712	Fundamentals of Statistics II
0307-770	Design of Experiments for Engineers
1028-705	Experimental Techniques
1028-710	Materials Properties and Selection

Students are allowed to take a maximum of two upper-level undergraduate electives (course numbers beginning with 0304-6xx) in mechanical engineering. However, if students choose to take upper-level undergraduate electives in mechanical engineering, they may be limited regarding the number of out-of-department electives. Some examples are as follows:

0304-610	Topics in Mechanical Engineering Design
0304-615	Robotics
0304-618	Computer-Aided Design
0304-620	Introduction to Optimal Design
0304-622	High Performance Vehicle Engineering
0304-623	Powertrain Systems and Design
0304-624	Vehicle Dynamics
0304-635	Heat Transfer II
0304-638	Design of Machine Systems
0304-640	Internal Combustion Engines
0304-642	Air Pollution Dispersion Modeling
0304-643	Control Systems
0304-644	Introduction to Composite Materials
0304-652	Fluid Mechanics of Turbomachinery
0304-658	Engineering Vibrations
0304-660	Refrigeration and Air Conditioning
0304-671	Aerostructures
0304-672	Dynamics of Machinery
0304-678	Propulsion
0304-680	Advanced Thermodynamics
0304-682	Flight Dynamics
0304-683	Orbital Mechanics

A student also may earn a limited number of credits by doing an independent study with guidance from a member of the graduate faculty. Areas for independent study include selected topics in applied mathematics, analytical mechanics, nonlinear mechanics, fracture mechanics, heat transfer, fluid mechanics, thermodynamics, control systems, optimal control, thermal stresses, composite materials, and biomechanics.

Thesis

Prior to completing 20 quarter credit hours of graduate work, students should prepare a formal thesis proposal and discuss it with the faculty adviser. An acceptable proposal (including a statement of work, extensive literature search, and proposed timeline), signed by the student and approved by the student's faculty adviser and department head, is required prior to registering for thesis credits. Students must form a graduate thesis committee in coordination with their adviser and present their proposal to their committee for review and approval during the first quarter in which they have registered for thesis credit. Students are required to deliver a successful written and oral presentation of their thesis.

Admission requirements

To be considered for admission to the MS program in mechanical engineering, candidates must fulfill the following requirements:

- Hold a baccalaureate degree from an accredited university in mechanical engineering or a related field,

- Submit official transcripts (in English) from all previously completed undergraduate and graduate course work,
- Have an GPA of 3.0 or higher,
- Submit scores from the Graduate Record Exam (GRE). Minimum scores of 1200 (V&Q) and 3.0 (writing) are required,
- Submit three letters of reference from individuals well qualified to judge the candidate's ability for graduate study, and
- Complete a graduate application.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language (TOEFL) or the International English Language Testing System (IELTS).

Additional information

Course calendar

Graduate courses are generally offered every other year, with the most common graduate courses offered every year. For further information on current-quarter course offerings, students should review the open and closed courses at http://infocenter.rit.edu. For information on long-term course planning and proposed course offerings, students should discuss their plans with their adviser.

Mechanical Engineering, ME

http://www.rit.edu/kgcoe/mechanical/grad/mengme

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Program overview

The ME in mechanical engineering is an internship program leading to the professional terminal degree of master of engineering. The capstone experience may be a course design project, a well-organized and carefully chosen industrial internship, or an independent study project in place of a conventional master's thesis requirement. This master's degree is particularly well-suited for students who wish to study part time, those interested in updating their technical skills, and those not focused on a research-oriented master of science thesis.

Curriculum

The program consists of core courses (12 credit hours), concentration courses (16 credit hours), and elective courses (20 credit hours).

Core courses (12 credits)

All graduate students in the mechanical engineering program are required to complete the following core courses.

COURSE		QTR. CR. HRS.
0304-823	Systems Modeling	4
0304-865	Computer Implementation of FEM	4
0304-870	Mathematics for Engineers I	4

The program, although rooted in engineering, is significantly interdisciplinary by design. The program may range over several colleges in the university, assembling courses that will best help students meet their professional objectives.

At least 32 credit hours of graduate-level course work, including core courses, must be taken in the mechanical engineering department. Some possible concentration areas are business, print media, controls, manufacturing, materials science, thermo/fluids, and design engineering. A minimum of 48 credits are required for the degree. Students may complete the program as a course-only program of study, with a capstone design project in a graduate elective course. Students may choose to complete a three-month industrial internship or a project that includes a paper (both worth 4 elective credits) as one of their elective courses.

Admission requirements

To be considered for admission to the ME program in mechanical engineering, candidates must fulfill the following requirements:

- Hold a baccalaureate degree from an accredited university in mechanical engineering, physics, or a related field,
- Submit official transcripts (in English) from all previously completed undergraduate and graduate course work,
- Have an GPA of 3.0 or higher,
- Submit three letters of reference from individuals well qualified to judge the candidate's ability for graduate study, and
- Complete a graduate application.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language (TOEFL) or the International English Language Testing System (IELTS).

Microelectronic Engineering, MS

http://www.rit.edu/kgcoe/eme/mems

Program overview

The objective of the master of science program in microelectronic engineering is to provide an opportunity for students to perform graduate-level research as they prepare for entry into the semiconductor industry or a doctoral program. The program requires strong preparation in the area of microelectronics and requires a thesis.

Program outcomes

The program has a number of outcomes for its students:

- Understand the fundamental scientific principles governing solid-state devices and their incorporation into modern integrated circuits.
- Understand the relevance of a process or device, either proposed or existing, to current manufacturing practices.
- Develop in-depth knowledge in existing or emerging areas of the field of microelectronics, such as device engineering, circuit design, lithography, materials and processes, and yield and manufacturing.

- Apply microelectronic processing techniques to the creation/investigation of new process/device structures.
- Communicate technical material effectively through oral presentations, written reports, and publications.

The prerequisites include a bachelor of science degree in engineering (such as electrical or microelectronic engineering), including an introductory course in device physics and an introductory course in fabrication technology. Students from RIT's BS program in microelectronic engineering will meet these prerequisites. Students who do not have these prerequisites can take these courses during their first quarter of study and still complete the MS program in two years. The prerequisite courses will not count toward the 36 credits of graduate courses required for the MS degree.

Curriculum

The program consists of eight graduate courses (700-level or higher), including seven core courses and one elective course for students with a BS degree in a discipline other than microelectronic engineering. Five core courses and three elective courses are required for students with a BS in microelectronic engineering. In addition, all students are required to take a variable-credit (1 or 0 credit) seminar/research course each quarter they are enrolled in the program. Up to 4 credits will be allowed toward the required 36 credit hours. A 9-credit thesis, which includes an oral defense, is required of all students. The total number of credits needed for the MS in microelectronic engineering is 45.

Core courses

0301-712	Physics and Scaling of CMOS
0305-702	Microelectronics II, Lab
0305-703	Microelectronics III, Lab
0305-704	Semiconductor Process and Device Modeling
0305-705	Quantum and Solid State Physics for Nanostructures
0305-721	Microlithography Materials, Lab
0305-731	Microelectronics Manufacturing I, Lab
0305-732	Microelectronics Manufacturing II, Lab

**Microelectronics Manufacturing I and Lab (0305-731) cannot be taken for graduate degree credit by students with a BS in microelectronic engineering.*

Elective courses

The following elective courses are offered:

0305-706	SiGe and SOI Devices and Technology
0305-707	Nanoscale CMOS and Beyond
0305-714	Micro- and Nano-Characterization
0305-722	Microlithography Systems, Lab
0305-732	Microelectronics Manufacturing II, Lab
0305-830	Metrology for Yield and Failure Analysis
0305-870	Microelectromechanical Systems
0305-890	Special Topics

Based on particular needs, with departmental approval, students may choose electives from other programs at the university.

Sample of a typical course schedule

COURSE		QTR. CR. HRS.
Fall		
0305-560	Transition Semiconductor Devices II	4
0305-701	Transition Microelectronics I, Lab	4
0305-721	Microlithography Materials and Processes, Lab	4
0305-801	Seminar/Research	1
Winter		
0305-702	Microelectronics II, Lab	4
0305-731	Microelectronics Manufacturing I, Lab	4
0305-801	Seminar/Research	1
	Full Time Equivalency*	3
Spring		
0305-703	Microelectronics III, Lab	4
0305-xxx	Elective	4
0305-801	Seminar/Research	1
	Full Time Equivalency*	3
Summer		
	Research	
Fall		
0305-705	Quantum and Solid State Physics for Nanostructures	4
0305-801	Seminar/Research	1
0305-889	Thesis	3
	Full-time Equivalency*	
Winter		
0301-712	Physics and Scaling of CMOS	4
0305-704	Semiconductor Process and Device Modeling	4
0305-801	Seminar/Research	1
0305-899	Thesis	3
Spring		
0305-801	Seminar/Research	1
0305-899	Thesis	3
	Full-time Equivalency*	8

Sample schedule for students with a BS in microelectronic engineering

COURSE		QTR. CR. HRS.
Fall		
0301-705	Quantum and Solid State Physics for Nanostructures	4
0305-801	Seminar/Research	1
0305-xxx	Elective 1	4
	Full-time Equivalency*	3
Winter		
0301-712	Physics and Scaling of CMOS	4
0305-704	Semiconductor Process and Device Modeling	4
0305-801	Seminar/Research	1
	Full-time Equivalency*	3
Spring		
0305-732	Microelectronic Manufacturing II	4
0305-801	Seminar/Research	1
0305-xxx	Elective 1	4
	Full-time Equivalency*	3
Summer		
	Research	

COURSE		QTR. CR. HRS.
Fall		
0305-xxx	Elective 2	4
0305-801	Seminar/Research	1
0305-899	Thesis	3
	Full-time Equivalency*	4
Winter		
0305-xxx	Elective 3	4
0305-801	Seminar/Research	1
0305-899	Thesis	3
	Full-time Equivalency	4
Spring		
0305-xxx	Elective 4	4
0305-801	Seminar/Research	1
0305-899	Thesis	3
	Full-time Equivalency*	4

*A full-time equivalency form must be completed for each quarter of the academic year for which the form is requested.

Thesis

A thesis is required for degree completion. Normally, the thesis is undertaken once the student has completed all course requirements. Planning for the thesis, however, should begin as early as possible. Generally, full-time students should complete their degree requirements, including thesis defense, within two years (six academic quarters and one summer quarter) from the date of entry.

Admission requirements

To be considered for admission to the MS program in microelectronic engineering, candidates must fulfill the following requirements:

- Hold a baccalaureate degree from an accredited university in engineering or a related field,
- Submit official transcripts (in English) from all previously completed undergraduate and graduate course work,
- Have an GPA of 3.0 or higher,
- Submit scores from the Graduate Record Exam (GRE),
- Submit two letters of reference from individuals well qualified to judge the candidate's ability for graduate study, and
- Complete a graduate application.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language (TOEFL).

Candidates applying with a bachelor's degree in non-electrical or non-microelectronic engineering fields may be considered for admission, however, they may be required to take additional bridge courses to ensure they are adequately prepared for graduate study.

Microelectronics Manufacturing Engineering, ME

http://www.rit.edu/kgcoe/eme/meme

Program overview

The master of engineering degree in microelectronics manufacturing engineering provides a broad-based education to students with a bachelor's degree in traditional engineering or science disciplines who are interested in a career in the semiconductor industry.

The ME degree is awarded upon successful completion of an approved graduate program consisting of a minimum of 45 credit hours. The program consists of one transition course, seven core courses, two elective courses, and a minimum of 5 credits of internship. Under certain circumstances, a student may be required to complete more than the minimum number of credits. The transition course is in an area other than that in which the BS degree was earned. For example, chemistry majors may be required to take a two-course sequence in circuits and electronics.

Program outcomes

The program has a number of outcomes for its students:

- Design and understand a sequence of processing steps to fabricate a solid state device to meet a set of geometric, electrical and/or processing parameters.
- Analyze experimental electrical data from a solid state device to extract performance parameters for comparison to modeling parameters used in the device design .
- Understand current lithographic materials, processes, and systems to meet imaging and/or device patterning requirements.
- Understand the relevance of a process or device, either proposed or existing, to current manufacturing practices .
- Perform in a microelectronic engineering environment, as evidenced by a three-month internship.
- Appreciate the areas of specialty in the field of microelectronics, such as device engineering, circuit design, lithography, materials and processes, and yield and manufacturing.

Curriculum

Core courses

0305-701, 702, 703	Microelectronics Processing I, II, III
0305-731, 732	Microelectronics Manufacturing I, II
0305-721	Microlithography Materials and Processes
0305-722	Microlithography Systems

COURSE		QTR. CR. HRS.
Fall		
0305-701	Microelectronics I, Lab	4
0305-721	Microlithography Materials and Processes, Lab	4
	Transition	4

COURSE		QTR. CR. HRS.
Winter		
0305-702	Microelectronics II, Lab	4
0305-731	Microelectronics Manufacturing I, Lab	4
	Transition	4
0305-xxx	Elective 1	4
Spring		
0305-703	Microelectronics III, Lab	4
0305-722	Microlithography Systems, Lab	4
0305-732	Microelectronics Manufacturing II, Lab	4
0305-xxx	Elective 2	4
Summer		
	Internship	5

Microelectronics

The Microelectronics I, II, and III course sequence covers major aspects of integrated circuit manufacturing technology, such as oxidation, diffusion, ion implantation, chemical vapor deposition, metalization, plasma etching, etc. These courses emphasize modeling and simulation techniques as well as hands-on laboratory verification of these processes. Students use special software tools for these processes. In the laboratory, students design and fabricate silicon MOS and bipolar integrated circuits, learn how to utilize most of the semiconductor processing equipment, develop and create a process, and manufacture and test their own integrated circuits.

Microlithography

The microlithography courses are advanced courses in the chemistry, physics, and processing involved in microlithography. Optical lithography will be studied through diffraction, Fourier, and image-assessment techniques. Scalar diffraction models will be utilized to simulate aerial image formation and influences of imaging parameters. Positive and negative resist systems as well as processes for IC application will be studied. Advanced topics will include chemically amplified resists; multiple-layer resist systems; phase-shift masks; and electron beam, X-ray, and deep UV lithography.

Laboratory exercises include projection-system design, resist-materials characterization, process optimization, electron-beam lithography, and excimer laser lithography.

Manufacturing

The manufacturing courses include topics such as scheduling, work-in-progress tracking, costing, inventory control, capital budgeting, productivity measures, and personnel management. Concepts of quality and statistical process control are introduced. The laboratory for this course is the student-run factory functioning within the department. Important issues such as measurement of yield, defect density, wafer mapping, control charts, and other manufacturing measurement tools are examined in lectures and through laboratory work. Computer-integrated manufacturing also is studied in detail. Process modeling, simulation, direct control, computer networking, database systems, linking application programs, facility monitoring, expert systems applications for diagnosis and training, and robotics are supported by laboratory experiences in the integrated circuit factory. An online (distance delivery) version of this program exists for engineers employed in the semiconductor industry. Please refer to RIT's Online Guide for details.

Internship

The program requires a 5 credit internship, which is equivalent to at least three months of full-time, successful employment in the semiconductor industry. The purpose of the internship is to provide a structured and supervised work experience that enables students to gain job-related skills that will assist them in achieving their desired career goals.

Students with prior engineering-related job experience may request "credit by experience." This request must be made with the department head and supported by a letter from the appropriate authority substantiating the student's job responsibility, duration, and performance quality. Upon approval, the student is advised to deposit the incurred fee to the bursar after the transfer of credit is granted.

For students who are not working in the semiconductor industry while enrolled in this program, the internship can be completed at RIT. It will involve an investigation or study of a subject or process directly related to microelectronic engineering under the supervision of a faculty adviser. An internship may be taken any time after the completion of the first quarter, must total at least 5 credits, and may be designed in a number of ways. For example, one 5-credit internship (typically a three-month, full-time work experience), five 1-credit experiences, or any combination of separate credits interspersed throughout the graduate program may be used, as long as the total is the equivalent of three months of work. In these cases, full graduate tuition is charged. At the conclusion of the internship, submission of a final internship report to the faculty adviser is required.

Microsystems Engineering, Ph.D.

http://www.rit.edu/kgcoe/grad/phd

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Program Overview

The multidisciplinary doctorate degree in microsystems engineering builds on the fundamentals of traditional engineering and science combined with curriculum and research activities addressing the numerous technical challenges of micro- and nanosystems. These include the manipulation of electrical, photonic, optical, mechanical, chemical, and biological functionality to process, sense, and interface with the world at a nanometer scale. The goal of the program is to provide a foundation to explore future technology through research in nano-engineering, design methods, and technologies and their integration into micro- and nano-scaled systems. Some of the program's areas of exploration include the following:

- Scaling-driven nanoelectronics including:
  - new materials, techniques, and architectures for next generation semiconductor devices
  - innovations in device patterning and nanolithography
  - new materials research including germanium, III-V materials, carbon nanotubes, and spintronics
- MEMS (micro-electro-mechanical systems), MEOMS (micro-electro-optical-mechanical systems) and NEMS (nano-electro-mechanical systems) device, processing and materials research for smart sensors, actuators, biochips, and micro-implantable appliances
- Photonics and nanophotonics imaging, communications, and sensing research including couplers, micro-lasers, microdetectors, integrated silicon waveguides, silicon spectrometers, and biosensors
- Photovoltaic research in silicon, organic, and stacked solar cells and thermophotovoltaics
- Scaled micro- and nano- electronics for integration into biomedical systems
- New and improved technologies in organic electronic components and devices
- Microfluidics research on the behavior, control, and manipulation of fluids at the micro-scale

Mission

The program fulfills a critical need for an expanded knowledge base and expertise in the innovation, design, fabrication, and application of micro- and nano-scale devices, components, and systems. RIT is becoming an internationally recognized leader in education, research, and economic development in the fields of microsystems and nanoscale engineering.

The curriculum of this multidisciplinary program is structured to provide each student with a sound background and a thorough foundation in engineering and science. The curriculum provides world-class education through the innovative application of educational technologies and partnerships.

Program highlights

The program is designed for students with a strong background in engineering and the physical sciences, and with an interest in hands on exploration into new fields of micro- and nano-systems.

- The program has a world-renowned, multidisciplinary faculty that shares resources and expertise ranging from nanoelectronics to nanopower research to MEMS and NEMS. The program is administered by core faculty from RIT's colleges of engineering and science.
- Unique state-of-the art research laboratories have been designed to provide a focus for microsystems and nanoscale engineering research across traditional disciplinary boundaries. An industrial scale semiconductor and microsystems clean-room is at the heart of the research facilities, providing students access to the most advanced micro- and nano-electronic processing capabilities.
- Students explore applications of microsystems and nanotechnology through close collaboration with industry and government laboratories.
- Graduates from the program have discovered exciting opportunities in new technology frontiers.

Curriculum

A total of 99 quarter credit hours of combined graduate course work and research are required for completion of the program. This includes a minimum of 60 credit hours of course work and a minimum of 27 hours of research credit toward the dissertation. The course work requires a combination of 16 hours of foundation courses, 36 hours of major and minor technical area courses, and 8 hours of elective courses. The student must pass the Comprehensive Exam, the Qualifying Exam, the Candidacy Exam, and the Dissertation Defense Exam for completion of degree requirements.

Phase 1: The first phase prepares students with a foundation in science and engineering and determines the student's ability to conduct independent research. This includes foundation and specialization courses taken during the first year together with the successful completion of the Comprehensive Exam. The Comprehensive Exam tests the student's ability to think and learn independently, to critically evaluate current research work in a field of microsystems engineering, and to use good judgment and creativity to determine appropriate directions for future research work.

Phase 2: The second phase consists of course work in the program of study along with preliminary research. Much of this course work will support the dissertation research to be conducted in the third phase. This second phase is completed when the student has finished most of the formal course work as prescribed in the program of study, has prepared the Dissertation Proposal, and has passed the Qualifying Examination.

Phase 3: The third phase consists of the completion of the experimental and/or theoretical work needed to complete the student's dissertation along with the required publication of results. The Candidacy Exam is taken and a defense of the dissertation is completed. The defense consists of a public oral presentation and examination.

Course work

The course work requirements for the doctorate are divided into four parts to ensure that students complete a well-rounded program of study with the necessary concentration in their specialized field.

Foundation courses (16 credit hours)

0305-701	Microelectronics I
0308-702	Introduction to Nanotechnology and Microsystems
0308-703	Material Science for Microsystems Engineering
1028-704	Introduction to Theoretical Methods

Major technical interest area (20 credit hours)
Students will complete a sequence of three courses (12 credit hours) in the major technical research area and a sequence of two courses (8 credit hours) in a support area.

Two minor technical interest areas (16 credit hours)
Two course sequences in each minor technical area are completed. At least one sequence must be outside of the student's undergraduate degree major.

Electives (minimum of 8 credit hours)

General course requirements
The total number of credit hours taken toward the doctorate depends upon the highest degree completed by the student before entering the program. Students entering the program without prior graduate work must complete a minimum of 60 credit hours of course work as outlined above. The course work should consist primarily of graduate level (700 and 800) courses with no more than three (3) upper level undergraduate (600) courses.

Students entering the program with a master's degree may be permitted to use up to 32 credit hours toward the minimum 60 credit hours of course work required for the degree, based on the approval of the program director.

All students are required to maintain a cumulative grade point average of 3.0 (on a 4.0 scale) to remain in good standing in the program.

Examples of course sequences:

MEMS

0308-786	MEMS Design
0308-811	Microsystems Design and Packaging

Microelectronics

0305-702	Microelectronics II, Lab
0305-703	Microelectronics III, Lab
0305-707	Nanoscale CMOS and Beyond

Nanopatterning

0305-721	Microlithography Materials, Lab
0305-722	Microlithography Systems, Lab
1051-733	Optics

Electronics

0301-726	Mixed Signal IC Design
0301-730	Advanced Analog IC Design
0301-814	RF Integrated Circuit Design

Photonics

0308-721	Micro-optics
0308-831	Micro and Nano-Photonics
0308-841	Advanced Micro-Photonics

Microfluidics

0301-798	Microfluidic MEMS
0304-847	Microscale Heat and Mass Transfer

Advising
Doctoral students' work is overseen by an adviser, the advisory committee, and the program's director.

Program of study
Based on the requirements of the program, students should prepare a program of study after passing the Comprehensive Exam and no later than the winter quarter of the second year. The program of study should be reviewed periodically by the student and the adviser, and modifications should be made as necessary. Upon completion of the Qualifying and Candidacy exams, the student's adviser and advisory committee may add additional course work requirements so that the student is sufficiently prepared to carry out and complete their dissertation research.

Comprehensive examination
Every student enrolled in the program must take the Comprehensive Examination which tests student's ability to think and learn independently, to critically evaluate current research work in the field of microsystems engineering, and to use good judgment and creativity to determine appropriate directions for future research work. The exam must be completed successfully before a student can submit a thesis proposal and attempt the Qualifying Examination.

Research proposal
A research topic chosen by the student and their research adviser becomes the basis for the dissertation. The research proposal sets forth both the exact nature of the matter to be investigated and a detailed account of the methods to be employed. In addition, the proposal usually contains material supporting the importance of the topic selected and the appropriateness of the research methods to be employed.

Qualifying examination
The Qualifying Examination is an oral examination based on the dissertation research proposal and allows the advising committee to judge the student's ability to execute a research task and to communicate the results. The exam also serves to evaluate the proposed topic to ensure that if completed as posed it constitutes an original contribution to knowledge.

Candidacy exam
The Candidacy Exam is administered by the student's adviser and the advisory committee between the time the student passes the Qualifying Exam and registration for the Dissertation Defense. This normally occurs approximately six months prior to the dissertation defense.

Dissertation exam
The culmination of a student's work toward the doctorate degree is the publication of their research. In addition to developing experimental and technical skills during the creation of research, a student needs to acquire the necessary literary skills to communicate results to others. The preparation of the proposal and the dissertation manuscripts will demonstrate these skills. It is also expected that these skills are developed through the publication

of technical papers and communications. The dissertation defense and examination is scheduled after all course requirements for the degree have been successfully completed.

Admission requirements

To be considered for admission to the doctorate program in microsystems engineering, candidates must fulfill the following requirements:

- Hold a baccalaureate degree from an accredited university in the physical sciences or engineering,
- Submit official transcripts (in English) from all previously completed undergraduate and graduate course work,
- Have an undergraduate GPA of 3.0 or higher, or a graduate GPA of 3.5 or higher,
- Submit scores from the Graduate Record Exam (GRE). Minimum scores of 1200 (V&Q) and 3.0 (writing) are required.
- Submit three letters of reference from individuals well qualified to judge the candidate's ability for graduate study, and
- Complete a graduate application.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language (TOEFL).

Product Development, MS

http://www.mpd.rit.edu/

Mark W. Smith, Director
(585) 475-7102, mark.smith@rit.edu
Christine Fisher, Graduate Program Director
(585) 475-7971, mpdmail@rit.edu

Program overview

Product innovation is essential to business survival and growth. The creation and introduction of new products and services has reached an unprecedented level of complexity, requiring the coordination of diverse teams of professionals from research and development, marketing, finance, manufacturing, procurement, sales, and service. Companies, especially technology-based organizations, need leaders with an enterprise-wide perspective and knowledge base in both engineering and management. This includes individuals who possess a broad blend of technical and business skills, understand markets and the value-chain, and have the integrated systems perspective needed to commercialize increasingly complex products and systems. The master of science degree in product development provides the educational foundation that technical professionals need for high-impact roles in product and technology innovation.

The program is for engineers, scientists, and technical professionals who aspire to product development leadership positions throughout their organizations. Designed by academic and industry leaders, the curriculum integrates business and technical elements to develop leaders with the knowledge, skills, behaviors, and perspective to effectively deploy best-in-class product development methods, tools, and practices. The program integrates formal education, ongoing research, and industrial practice, and continuously refreshes the curriculum through active partnerships with other world-class universities, research centers, and companies.

Students acquire the foundation skills and strategic perspective necessary to become future leaders and senior managers responsible for driving business growth through product innovation. They develop receptiveness to change and continuous improvement, an understanding of the enablers to business success, and an enhanced ability to recognize barriers to success early in the commercialization cycle, when corrective actions are least costly.

Curriculum

The 60 quarter credit hour program consists of business and engineering courses (10 required courses and three electives) plus a capstone project (8 credits).

Core courses

0303-780	Excellence in Product Development
0303-784	Systems and Project Management
0303-786	Engineering of Systems I
0303-788	Engineering of Systems II

Foundation courses

0101-703	Accounting for Decision Makers
0102-740	Organizational Behavior and Leadership
0105-761	Marketing Concepts
0303-764	Operations and Manufacturing Systems
0303-785	Decision and Risk Benefit Analysis
0303-787	Systems Optimization

Elective courses

Elective courses afford the opportunity for students to tailor the program to better meet personal and organizational needs. Three elective courses (12 credits) are required. At least one elective must be from business and one from engineering. Recommended electives may include such courses as Managing Research and Innovation, Product Development in the Extended Enterprise, New Venture Creation, Supply Chain Management, Sustainable Design, and Advanced Topics in Product Development, among others.

Capstone project

Students must successfully complete a capstone project (8 credits) during the final nine months of the program, based on a real-world problem often identified in the companies where they work. The corporate-oriented capstone project encompasses the broad integrative aspects of new product development. It synthesizes, increases, and demonstrates the student's understanding and knowledge of previous program material and underscores the behaviors essential to product development leadership. The capstone project provides immediate benefits to sponsoring organizations and is an excellent opportunity for students to gain visibility and recognition. See the program website for descriptions of previous projects.

Admission requirements

To be considered for admission to the MS program in product development, candidates must fulfill the following requirements:

- Hold a baccalaureate degree in engineering, or a related scientific or technical field,
- Have a minimum GPA of 3.0,
- Have at least five years of experience related to product development (exceptions may be considered on a case-by-case basis),
- Submit official transcripts (in English) of all previously completed undergraduate and graduate course work,
- Submit at least one letter of recommendation from a current or recent supervisor,
- Submit a current resume,
- Participate in a personal interview with the admissions team (after other application materials are received), and
- Complete a graduate application.

No graduate entrance exam is required, although candidates are welcome to support their application with results from the Graduate Management Admission Test (GMAT) or the Graduate Record Exam (GRE).

All application materials are available from the Office of Graduate Enrollment Services or the program office.

Additional information

Sponsorship

Most students are sponsored by an employer who is committed to improving leadership capabilities in product development. Sponsorship includes permitting students to attend classes and also involves a commitment to work with the student to provide clear expectations and well-articulated career development plans that build upon the program. Candidates are welcome to sponsor themselves. Contact the Office of Financial Aid and Scholarship for information.

Format

Students may start the program during any quarter and complete the course work at their own pace. Classes are available on campus (evenings) and online (video conference and asynchronous format) to accommodate the needs of local students as well as those who travel or live outside the Rochester area.

Sustainable Engineering, MS

Brian Thorn, Graduate Program Director
(585) 475-6166, bkteie@rit.edu

Program overview

Sustainable engineering refers to the integration of social, environmental, and economic considerations into product, process, and energy system design methods. Additionally, sustainable engineering encourages the consideration of the complete product and process lifecycle during the design effort. The intent is to minimize environmental impacts across the entire lifecycle while simultaneously maximizing the benefits to social and economic stakeholders. The MS program in sustainable engineering is multidisciplinary and managed by the industrial and systems engineering department.

The program builds on RIT's work in sustainability research and education and offers students the flexibility to develop tracks in areas such as renewable energy systems, systems modeling and analysis, product design, and engineering policy and management. The program is offered on campus, and available on a full- or part-time basis.

Educational objectives

The program is designed to accomplish the following educational objectives:

- Heightened awareness of issues in areas of sustainability (e.g. global warming, ozone layer depletion, deforestation, pollution, ethical issues, fair trade, gender equity, etc.).
- Clear understanding of the role and impacts of various aspects of engineering (design, technology, etc.) and engineering decisions on environmental, societal, and economic problems. Particular emphasis is placed on the potential trade-offs between environmental, social, and economic objectives.
- Strong ability to apply engineering and decision-making tools and methodologies to sustainability-related problems.
- Demonstrated capacity to distinguish professional and ethical responsibilities associated with the practice of engineering.

Curriculum

Technical in nature, the program will equip engineers with the tools they need to meet the challenges associated with delivering goods, energy, and services through sustainable means. In addition to basic course work in engineering and classes in public policy and environmental management, students are required to complete a capstone project or thesis directly related to sustainable design challenges impacting society. Many of these projects can be incorporated into sustainable research by RIT faculty in the areas of fuel-cell development, life-cycle engineering, and sustainable process implementation.

Students must successfully complete a total of 45 credit hours of course work, participate in three quarters of the seminar series, and complete a thesis. This research-oriented program is designed to be completed in two years. Courses include the following:

Core (20 credit hours)

COURSE		QTR. CR. HRS.
0303-760	Product and Process Design and Development	4
0303-790	Fundamentals of Sustainable Engineering	4
0303-791	Life Cycle Assessment and Costing	4
0303-792	Design for the Environment	4
0304-729	Renewable Energy Systems	4

Engineering electives (8 credit hours)

Students select graduate courses in an area of interest such as energy, modeling, manufacturing and materials, transportation and logistics, and product design and development.

Contextual electives (8 credit hours)
Choose one from each group:
Social context group
- Energy Policy
- Technical Innovation and Public Policy
- Managing for Environmental Sustainability

Environmental technology group
- Resource Reduction
- Product Stewardship
- Industrial Waste Water Management
- Air Emissions
- Solid and Hazardous Waste Management

Sustainable engineering seminars
Three quarters of graduate seminars in sustainable engineering

Thesis (9 credit hours)

Admission requirements

To be considered for admission to the MS program in sustainable engineering, candidates must fulfill the following requirements:
- Hold a baccalaureate degree from an accredited university in engineering, mathematics, or science,
- Submit official transcripts (in English) from all previously completed undergraduate and graduate course work,
- Have an GPA of 3.0 or higher,
- Submit scores from the Graduate Record Exam (GRE),
- Submit a statement of purpose,
- Submit three letters of reference from individuals well qualified to judge the candidate's ability for graduate study, and
- Complete a graduate application.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language (TOEFL).

Applicants who have a bachelor's degree in a field outside of engineering may be considered for admission, however, additional bridge course work may be required before full admission into the program.

Sustainable Engineering, ME

Brian Thorn, Graduate Program Director
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Program overview

Sustainable engineering refers to the integration of social, environmental, and economic considerations into product, process, and energy system design methods. Additionally, sustainable engineering encourages the consideration of the complete product and process lifecycle during the design effort. The intent is to minimize environmental impacts across the entire lifecycle while simultaneously maximizing the benefits to social and economic stakeholders. The master of engneering program in sustainable engineering is multidisciplinary and managed by the industrial and systems engineering department.

The program builds on RIT's work in sustainability research and education and offers students the flexibility to develop tracks in areas such as renewable energy systems, systems modeling and analysis, product design, and engineering policy and management. The program is offered on campus, and available on a full- or part-time basis.

Educational objectives
The program is designed to accomplish the following educational objectives:
- Heightened awareness of issues in areas of sustainability (e.g. global warming, ozone layer depletion, deforestation, pollution, ethical issues, fair trade, gender equity, etc.).
- Clear understanding of the role and impacts of various aspects of engineering (design, technology, etc.) and engineering decisions on environmental, societal, and economic problems. Particular emphasis is placed on the potential trade-offs between environmental, social, and economic objectives.
- Strong ability to apply engineering and decision-making tools and methodologies to sustainability-related problems.
- Demonstrated capacity to distinguish professional and ethical responsibilities associated with the practice of engineering.

Curriculum

Technical in nature, the program will equip engineers with the tools they need to meet the challenges associated with delivering goods, energy, and services through sustainable means. In addition to basic course work in engineering and classes in public policy and environmental management, students are required to complete a capstone project or thesis directly related to sustainable design challenges impacting society. Many of these projects can be incorporated into sustainable research by RIT faculty in the areas of fuel-cell development, life-cycle engineering, and sustainable process implementation.

Students must successfully complete a total of 48 credit hours through course work, participate in three quarters of the seminar series, and complete a capstone project. This program is designed to be completed in one year (three quarters). Courses include the following:

Core (20 credit hours)

COURSE		QTR. CR. HRS.
0303-760	Product and Process Design and Development	4
0303-790	Fundamentals of Sustainable Engineering	4
0303-791	Life Cycle Assessment and Costing	4
0303-792	Design for the Environment	4
0304-729	Renewable Energy Systems	4

Engineering electives (16 credit hours)
Students will select graduate courses in an area of interest such as energy, modeling, manufacturing and materials, transportation and logistics, and product design and development.

Contextual electives (8 credit hours)
Choose one from each group:
Social Context Group
- Energy Policy
- Technical Innovation and Public Policy
- Managing for Environmental Sustainability

Environmental Technology Group
- Resource Reduction
- Product Stewardship
- Industrial Waste Water Management
- Air Emissions
- Solid and Hazardous Waste Management

Sustainable engineering seminars
Three quarters of graduate seminars in sustainable engineering

Capstone project (4 credit hours)
Applications in Sustainable Engineering

Admission requirements

To be considered for admission to the ME program in sustainable engineering, candidates must fulfill the following requirements:
- Hold a baccalaureate degree from an accredited university in engineering, mathematics, or science,
- Submit official transcripts (in English) from all previously completed undergraduate and graduate course work,
- Have an GPA of 3.0 or higher,
- Submit scores from the Graduate Record Exam (GRE),
- Submit a statement of purpose,
- Submit three letters of reference from individuals well qualified to judge the candidate's ability for graduate study, and
- Complete a graduate application.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language (TOEFL).

Applicants who have a bachelor's degree in a field outside of engineering may be considered for admission, however, additional bridge course work may be required before full admission into the program.

Systems Engineering, ME

http://www.rit.edu/kgcoe/ise/grad/me_se.html

Michael E. Kuhl, Graduate Program Director
(585) 475-2134, mekeie@rit.edu

Program overview

This program concentrates on the industrial and systems engineering courses that cover the science and technologies of decision making in a complex world in order to optimize the overall system rather than any one subsystem. Systems engineering improves the decision-making process by utilizing statistics, simulation, optimization, and computer science skills to enhance the design, control, operation, and understanding of systems. This discipline has shown rapid growth in both its development and recognition as a distinct field of engineering.

Curriculum

Typical scheduled ISE course offerings

Fall

0303-620	Engineering Economy
0303-701	Linear Programming
0303-703	Supply Chain Management
0303-626	Contemporary Production Systems I
0303-727	Advanced Manufacturing Engineering
0303-760	Product/Process Development and Design
0303-766	Manufacturing Systems
0303-790	Fundamentals of Sustainable Design

Winter

0303-702	Integer and Nonlinear Programming
0303-710	Systems Simulation
0303-729	Advanced Systems Integration
0303-731	Advanced Topics in Ergonomics and Human Factors
0303-734	System Safety Engineering
0303-758	Design of Experiments
0303-761	Rapid Prototyping
0303-765	Databases for IS
0303-784	Project Management
0303-791	Lifecycle Assessment and Costing

Spring

0303-620	Engineering Economy
0303-704	Logistics Management
0303-711	Advanced Simulation Techniques
0303-720	Production Control
0303-732	Biomechanics
0303-792	Design for the Environment
0303-801	Design for Manufacture

Admission requirements

To be considered for admission to the ME in systems engineering, candidates must fulfill the following requirements:
- Hold a baccalaureate degree in engineering, mathematics, or science,
- Have a minimum cumulative undergraduate GPA of 3.00,
- Submit official transcripts (in English) of all previously completed undergraduate and graduate course work,
- Submit scores from the Graduate Record Exam (GRE) (optional),
- Submit letters of recommendation,
- Submit a statement of purpose, and
- Complete a graduate application.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Langage. Minimum scores of 550 (paper-based) or 213 (computer-based) are required.

Statistical Methods for Product and Process Improvement, Adv. Cert.

Steven M. LaLonde, Graduate Program Director
(585) 475-5854, smleqa@rit.edu

Program overview

The advanced certificate in statistical methods for product and process improvement is designed for engineers, scientists, and other professionals who want a solid education in the statistical methods that are most closely related to their work. The program is a subset of courses taken from the MS program in applied statistics.

Curriculum

The advanced certificate includes six courses: three required core courses plus three electives chosen by the student with the assistance of their adviser.

Core courses

The three core courses are:

0307-801	Design of Experiments I
0307-802	Design of Experiments II
0307-841	Regression Analysis I

Electives

Students may choose three elective courses from the following list. Courses should be approved by the student's adviser.

0307-803	Design and Analysis of Experiments III
0307-831	Multivariate Analysis Applications
0307-842	Regression Analysis II
0307-846	Statistical Data Mining
0307-862	Reliability Statistics I*
0307-873	Time Series Analysis
0307-883	Quality Engineering by Design

*The reliability course also requires calculus with integration as a prerequisite.

Admission requirements

To be considered for admission to the advanced certificate in statistical methods for product and process improvement, candidates must fulfill the following requirements:

- Submit official transcripts (in English) of all previously completed undergraduate and graduate course work,
- Submit two letters of recommendation,
- Submit a current resume, and
- Complete a graduate application.

Additional information

Prerequisites

Students should have basic familiarity with MINITAB statistical software. This may be obtained by self-study; by completion of Data Analysis Using MINITAB, a three-day, noncredit course in data analysis and statistical computing; through similar MINITAB short courses; or through Statistical Computing (0307-742), which covers both SAS and MINITAB software.

Statistical Quality, Adv. Cert.

Steven M. LaLonde, Graduate Program Director
(585) 475-5854, smleqa@rit.edu

Program overview

The advanced certificate in statistical quality is aimed primarily at quality managers, quality engineers, or those who aspire to such positions.

Curriculum

Students have two options in which they may complete the course work for the advanced certificate.

Option #1

Students may choose six courses from the following list:

0307-721	Statistical Process Control
0307-731	Statistical Acceptance Control
0307-772	Applied Survey Design and Analysis
0307-781	Quality Management
0307-782	Quality Engineering
0307-801	Design of Experiments I
0307-802	Design of Experiments II

Option #2

A student may elect to take Design of Experiments for Engineers and Scientists (0307-770), along with the five non-experimental-design courses listed above (0307-721, 731, 772, 781, and 782). The courses in this advanced certificate program may be applied to a graduate program at a later date. The Design of Experiments for Engineers and Scientists (0307-770) course is a 4 credit course. It is not offered online and may not be applied toward the MS degrees in applied statistics or the advanced certificate in statistical methods for product and process improvement.

Admission requirements

To be considered for admission to the advanced certificate in statistical quality, candidates must fulfill the following requirements:

- Submit official transcripts (in English) of all previously completed undergraduate and graduate course work,
- Submit two letters of recommendation,
- Submit a current resume, and
- Complete a graduate application.

Additional information

Six Sigma Black Belt

Students may earn a Six-Sigma black belt after obtaining either the advanced certificate in statistical quality or the MS in applied statistics. Students should ensure an appropriate course selection

by reviewing the Black Belt requirements on the center's website. In addition, students will complete an additional qualifying project.

Prerequisites
Students should have basic familiarity with MINITAB statistical software. This may be obtained by self-study; completion of Data Analysis Using MINITAB, a three-day, non-credit bearing course in data analysis and statistical computing; through similar MINITAB short courses; or through Statistical Computing (0307-742), which covers both SAS and MINITAB software.

Vibrations Engineering, Adv. Cert.

Program overview

The advanced certificate in vibrations engineering provides students with specialized skills that are sought after in a variety of industrial settings. Engineers with skills in vibration engineering contribute to manufacturing production systems, aerospace systems, automotive engineering, medical product development, building mechanical and plumbing systems, consumer product development, and a host of industrial equipment and process systems. This program takes students beyond the normal preparation in vibrations engineering that students typically complete during their undergraduate program of study. Students learn to use sophisticated software tools, analytical techniques and experimental methods to design, develops and implement solutions for problems of vibration control and minimization in engineering systems. Students are exposed to modern technologies used in industry to ensure that they are prepared for their specialized job market. The program answers a need for graduate level instruction for practicing engineers in the greater Rochester area, in a field of importance for the 21st century.

Curriculum

The advanced certificate requires students to successfully complete three required courses and one graduate elective. Students may apply the courses within this certificate program towards a master's degree.

COURSE		QTR. CR. HRS.
0304-658	Engineering Vibrations	4
0304-758	Intermediate Engineering Vibrations	4
*Choose at least two electives from the following list:**		
0304-840	Signal Processing	4
0304-870	Mathematics for Engineers I	4
0304-871	Mathematics for Engineers II	4
0304-643	Control Systems	4
0304-743	Intermediate Control Systems	4
0304-843	Advanced Control Systems	4

*An alternative elective may be approved by the student's adviser and department head.

Graduate Faculty

Harvey J. Palmer, BS, University of Rochester; Ph.D., University of Washington, PE—Dean; Professor

Computer Engineering

Andreas Savakis, BS, MS, Old Dominion University; Ph.D., North Carolina State University—Professor, Department Head; Digital Image Processing, Computer Vision

Juan C. Cockburn, BS, Universidad Nacional de Ingenieria; MS, Ph.D., University of Minnesota—Associate Professor, Robust Control Systems, Active Vision

Amalan Ganguly, B. Tech, Indian Institute of Technology; MS, Ph.D., Washington State University—Assistant Professor

Kenneth Hsu, BS, National Taiwan Normal University; MS, Ph.D., Marquette University; PE—Professor, VLSI Design, System-on-Chip Design, and Verification

Dhireesha Kudithipudi, BS, Nagarjuna University; MS, Wright State University; Ph.D., University of Texas at San Antonio—Assistant Professor, Low Power VLSI Design, Nontraditional CMOS Technologies

Andres Kwasinski, M.Sc., Ph.D., University of Maryland at College Park—Assistant Professor, Communications and Digital Signal Processing

Sonia Lopez Alarcon, BS, Ph.D., Complutense University of Madrid—Assistant Professor, Computer Architecture

Marcin Lukowiak, MS, Ph.D., Poznan University—Assistant Professor, Reconfigurable Digital Systems Design, Electronic Design Automation

Roy W. Melton, B.Sc., M.Sc, Ph.D., Georgia Institute of Technology—Senior Lecturer, Computer Architecture

Muhammed E. Shaaban, BS, MS, University of Petroleum and Minerals; Ph.D., University of Southern California—Associate Professor, Computer Architecture, High Performance Computing

Shanchieh J. Yang, BS, National Chio-Tung University; MS, Ph.D., University of Texas at Austin—Associate Professor, Robotic and Sensor-Networks, Information Fusion and Intelligence Analysis

Electrical and Microelectronic Engineering

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Robert J. Bowman, BS, Pennsylvania State University; MS, San Jose State University; Ph.D., University of Utah—Professor, Analog Integrated Circuit Design, Semiconductor Physics, Biomedical Instrumentation

Edward E. Brown, Jr., BS, University of Pennsylvania; MS, Ph.D., Vanderbilt University—Associate Professor, Rehabilitation, Robotics, Control Systems, Biomechatronics

William W. Destler, BS, Stevens Institute of Technology; Ph.D., Cornell University— President, RIT; Professor, high power microwave sources, advanced accelerator concepts

Dale E. Ewbank, BS, MS, Ph.D., Rochester Institute of Technology—Lecturer, Microlithography, Optics, Design of Experiments, Electro-optic Microsystems

Lynn F. Fuller, BS, MS, Rochester Institute of Technology; Ph.D., State University of New York at Buffalo—Professor, IC Design, Semiconductor Manufacturing, MEMS and Microsystems

Karl D. Hirschman, BS, MS, Rochester Institute of Technology; Ph.D., University of Rochester—Micron Technology Professor; Director, Semiconductor and Microsystems Fabrication Laboratory; Associate Professor, Semiconductor Process Integration, Photonic Devices

Christopher R. Hoople, BS, Union College; Ph.D., Cornell University—Lecturer, Power Electronics, Device Physics

Mark Hopkins, BS, Southern Illinois University; MS, Ph.D., Virginia Polytechnic Institute—Associate Professor, Control Systems, System Identification

Michael A. Jackson, BS, MS, Ph.D., State University of New York at Buffalo—Associate Professor, Solid State Devices, IC Metrology, Electronic Materials and Processing, Photovoltaics

Santosh Kurinec, BS, MS, Ph.D., University of Delhi—Professor, Electronic Materials and Devices, IC Processing, Quantum and Nanoscale Devices, Non Volatile Memory, Photovoltaics

Sergey Lyshevski, MS, Ph.D., Kiev Polytechnic Institute—Professor, Microsystems

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P. R. Mukund, BS, MS, Ph.D., University of Tennessee—Professor, VLSI Design, Electronic Devices and Circuit Design

Dorin Patru, BS, MS, Technical University of Cluj-Napoca; Ph.D., Washington State University—Assistant Professor, Mixed-Signal and Digital Integrated Circuits and Systems

Robert E. Pearson, BS, MS, Rochester Institute of Technology; Ph.D., State University of New York at Buffalo—Associate Professor, Advanced Device and Process Modeling, VLSI Design and Parameter Extraction

Daniel B. Phillips, BS, State University of New York at Buffalo; MS, Ph.D., University of Rochester—Associate Professor, Biomedical Instrumentation, Signal Processing and Visualization, and Embedded Systems

Sannasi Ramanan, BS, BE, M.Tech., Ph.D., Indian Institute of Technology—Associate Professor, Semiconductor Devices

Sean L. Rommel, BS, Ph.D., University of Delaware—Associate Professor, Emerging Semiconductor Devices, Photonic Devices, Integration

Eli Saber, BS, State University of New York at Buffalo; MS, Ph.D., University of Rochester—Professor, Signal Image and Video Processing, Communications, Biomedical Imaging, Computer Vision

Ferat E. Sahin, BS, Istanbul Technical University; MS, Ph.D., Virginia Polytechnic Institute—Associate Professor, Artificial Intelligence, Control Systems, Robotics

Gill R. Tsouri, B.Sc., M.Sc., Ph.D., Ben-Gurion University—Assistant Professor, MIMO, OFDM/OFDMA Systems, Wireless Sensor Networks, Diversity Methods

Jayanti Venkataraman, BS, MS, Bangalore University; Ph.D., Indian Institute of Science—Professor, Electromagnetics

Industrial and Systems Engineering

Michael E. Kuhl, BS, Bradley University; MS, Ph.D., North Carolina State University—Interim Department Head; Professor, Systems Simulation

Robin R. Borkholder, BS, MS, State University of New York at Buffalo—Lecturer, Project Management

Andres L. Carrano, BS, Universidad Catolica Andrés Bello; MS, Ph.D., North Carolina State University—Associate Professor, Manufacturing, Sustainable Design and Development

Denis R. Cormier, BS, University of Pennsylvania; MS, State University of New York at Buffalo; Ph.D., North Carolina State University—Earl W. Brinkman Professor of Screw Machine Technology; Professor, Manufacturing, Rapid Prototyping

Marcos Esterman, BS, MS, Massachusetts Institute of Technology; Ph.D., Stanford University—Associate Professor, Systems Engineering, Product Development

Mike Hewitt, BS, MS, University of Michigan; Ph.D., Georgia Institute of Technology—Assistant Professor

John T. Kaemmerlen, BS, MS, Rochester Institute of Technology—Lecturer, Lean Production/Logistics

Matthew M. Marshall, BS, Rochester Institute of Technology; Ph.D., University of Michigan—Associate Professor, Biomechanics, Ergonomics

Jacqueline Reynolds Mozrall, BS, Rochester Institute of Technology; MS, North Carolina State University; Ph.D., State University of New York at Buffalo—Associate Dean; Professor, Industrial Engineering, Human Factors, Ergonomics

Madhu R. Nair, BS, Rochester Institute of Technology; MS, Lehigh University—Lecturer, Information Systems

Nabil Z. Nasr, BS, Helwan University; MS, Rutgers University; M.Eng., Pennsylvania State University; Ph.D., Rutgers University—Professor; Robotics, NC Programming, Manufacturing, Remanufacturing

Ruben A. Proano, BS, Universidad San Francisco de Quito; MS, Ph.D., University of Illinois at Urbana-Champaign—Assistant Professor, Operations Research, Logistics/Supply Chain Management

Moises Sudit, BS, Georgia Institute of Technology; MS, Stanford University; Ph.D., Purdue University—Visiting Associate Professor, Operations Research

Brian K. Thorn, BS, Rochester Institute of Technology; MS, Ph.D., Georgia Institute of Technology—Associate Professor, Applied Statistics, Sustainable Design and Development, Life Cycle Assessment and Costing

Mechanical Engineering

Edward C. Hensel, BS, Clarkson University; Ph.D., P.E., New Mexico State University, PE—Department Head; Professor, Numerical Simulation of Diffusion-based Systems, Multidisciplinary Design

Margaret Bailey, BS, Pennsylvania State University; Ph.D., University of Colorado at Boulder, PE—Professor, Energy Systems, Thermodynamics, Building Systems

Stephen Boedo, BA, State University of New York at Buffalo; MS, Ph.D., Cornell University—Associate Professor, Tribology and Lubrication

Agamemnon L. Crassidis, BS, MS, Ph.D., State University of New York at Buffalo—Associate Professor, Aerospace Engineering, Nonlinear Dynamics and Controls

Tuhin Das, B.Tech, Indian Institute of Technology; MS, Ph.D., Michigan State University—Assistant Professor, Automatic Controls, Fuel Cell Technology, Energy Systems

Steven Day, BS, Ph.D., University of Virginia—Associate Professor, Bioengineering, Implantable Devices, Fluids in Biosystems

Elizabeth A. DeBartolo, BS, Duke University; MS, Ph.D., Purdue University—Associate Professor, Fatigue and Fracture Mechanics, Materials Performance

David J. Gee, BS, University of California at Davis; MS, Ph.D., Boston University—Assistant Professor, Bioengineering Systems, Aerospace Systems

Hany A. Ghoneim, BS, MS, Cairo University; Ph.D., Rutgers University—Professor, Finite Elements, Vibrations

Amitabha Ghosh, B.Tech., M.Tech., Indian Institute of Technology; Ph.D., Mississippi State University—Professor, Computational Fluid Dynamics, Aerodynamics, Aerospace Engineering

Mario W. Gomes, BsE, Cornell University; MS, Georgia Institute of Technology; Ph.D., Cornell University—Assistant Professor, Sustainable Energy Systems

Surendra K. Gupta, B.Tech., Indian Institute of Technology; MS, University of Notre Dame; Ph.D., University of Rochester—Professor, Materials Science, Computer Software, Image Processing

Satish G. Kandlikar, BE, Marathwada University; M.Tech., Ph.D., Indian Institute of Technology—James E. Gleason Professor; Professor, Thermal Systems and Energy

Mark Kempski, BS, Purdue University; MS, Ph.D., State University of New York at Buffalo—Professor, Biomechanics, Bioengineering, Systems and Controls

Jason R. Kolodziej, BS, MS, Ph.D., State University of New York at Buffalo—Assistant Professor, Hybrid Vehicle Technology and Renewable Energy

Karuna Koppula, B. Tech, Andhra University; MS, University of New Hampshire; Ph.D., Michigan State University—Visiting Assistant Professor, Fluid Dynamics, Turbulent Flows

Margaretha J. Lam, BS, MS, State University of New York at Buffalo; Ph.D., Virginia Polytechnic Institute and State University—Lecturer, Vibrations, Optimization

Kathleen Lamkin-Kennard, BS, Worcester Polytechnic Institute; MS, Ph.D., Drexel University—Assistant Professor, Biomedical Engineering, Multi-physics Systems Modeling

Alexander Liberson, BS, MS, Ph.D., State University of Aerospace Technology (Moscow)—Visiting Associate Professor, Multiphase flow, combustion

Alan H. Nye, BS, MS, Clarkson College; Ph.D., University of Rochester—Associate Department Head; Professor, Automotive Engineering, Design of Systems

Ali Ogut, B.Ch.E., Hacettepe University; MS, Ph.D., University of Maryland—Professor, Fluid Mixing, Thermal Fluid Sciences, Energy and Environment

Risa J. Robinson, BS, MS, Rochester Institute of Technology; Ph.D., State University of New York at Buffalo—Associate Professor, Bioengineering, Aerosol Transport in Biological Systems

Frank Sciremammano Jr., BS, MS, Ph.D., University of Rochester, PE—Professor, Geophysical Fluid Dynamics and Environmental Engineering

Robert Stevens, BS, Swarthmore College; MS, North Carolina State University; Ph.D., University of Virginia—Associate Professor, Energy and Environment, MEMS, Thermal Properties, Energy Conversion, Thermoelectrics

Benjamin Varela, BS, Institute of Technology of Juarez; MS, Ph.D., New Mexico State University—Associate Professor, Innovative Materials, Automation and Fluid Power, Dynamics

Panchapakesan Venkataraman, B.Tech., Indian Institute of Technology; MS, Ph.D., Rice University—Associate Professor, Optimal Control, Fluid Mechanics, Optimal Design, Aerospace Engineering

Wayne W. Walter, BS, State University of New York Maritime College; MS, Clarkson College; Ph.D., Rensselaer Polytechnic Institute, PE—Professor, Applied Mechanics, Robotics, Vibrations

The John D. Hromi Center for Quality and Applied Statistics

Donald D. Baker, BA, Trinity College; M.Ed., MBA, Ed.D., University of Rochester—Director; Professor; Quality Standards, Quality Management and Problem Solving, Lean Six Sigma

Peter Bajorski, MS, University of Wroclaw; Ph.D., Technical University of Wroclaw—Associate Professor, Regression Models, Multivariate Analysis, Nonparametrics, Imaging Science Applications

Ernest Foukoue, Maitrise B.Sc., University of Yaounde; M.Sc., Aston University; Ph.D., University of Glasgow—Assistant Professor, Statistical Machine Learning and Data Mining

Steven M. LaLonde, BA, State University College at Potsdam; MBA, University of Rochester; MA, Ph.D., Syracuse University—Chair, Associate Professor, Multivariate Analysis, Survey Design and Analysis, Statistical Computing, Educational and Psychological Measurement

Daniel R. Lawrence, BA, BS, University of Akron; MA, Ball State University; MS, Rochester Institute of Technology; Ph.D., University of Toronto—Professor, Multivariate Analysis (categorical data), Qualitative Measurement, Psychometrics, Survey Design and Analysis

Robert J. Parody, BS, Clarkson University; MS, Rochester Institute of Technology; Ph.D., University of South Carolina—Assistant Professor, Experimental Design, Response Surface Methods, Quality Control and Improvement

Joseph G. Voelkel, BS, Rensselaer Polytechnic Institute; MS, Northwestern University; Ph.D., University of Wisconsin-Madison—Professor; Experimental Design, Process Modeling and Improvement, Multivariate Analysis, Reliability, Nonparametrics

Microsystems Engineering

Bruce W. Smith, BS, MS, Ph.D., Rochester Institute of Technology—Director; Intel Professor of Research and Technology; Professor, Microlithography, Nanopatterning and Nanomaterials, Thin Films Materials and Processes

Mustafa A. G. Abushagur, BS, Tripoli University; MS, Ph.D., California Institute of Technology—President, RIT Dubai; Professor, Micro-optical Systems, Micro-and Nano-photonic Devices

Stephen Boedo, BA, State University of New York at Buffalo; MS, Ph.D., Cornell University—Associate Professor, Mechanical Engineering; Tribology and Lubrication

David Borkholder, BS, Rochester Institute of Technology; MS, Ph.D., Stanford University—Associate Professor, Electrical Engineering; Biosensors (electromagnetic and chemical), Biomedical Instrumentation MEMS Fabrication, Systems Engineering

Robert J. Bowman, BS, Pennsylvania State University; MS, San Jose State University; Ph.D., University of Utah—Professor, Electrical Engineering; Analog Integrated Circuit Design, Semiconductor Physics, Biomedical Instrumentation

Christopher Collison, BS, Ph.D., Imperial College of London—Assistant Professor, Chemistry; Physical Chemistry: polymer chemistry

Denis R. Cormier, BS, University of Pennsylvania; MS, State University of New York at Buffalo; Ph.D., North Carolina State University—Earl W. Brinkman Professor of Screw Machine Technology; Associate Professor, Industrial Engineering

Tuhin Das, B.Tech, Indian Institute of Technology; MS, Ph.D., Michigan State University—Assistant Professor, Mechanical Engineering; Automatic Controls, Fuel Cell Technology, Energy Systems

Lynn F. Fuller, BS, MS, Rochester Institute of Technology; Ph.D., State University of New York at Buffalo—Professor, Microelectronic Engineering; IC Design, Semiconductor Manufacturing, MEMS and Microsystems

Karl D. Hirschman, BS, MS, Rochester Institute of Technology; Ph.D., University of Rochester—Micron Technology Professor; Director, Semiconductor and Microsystems Fabrication Laboratory; Associate Professor, Microelectronic Engineering; Semiconductor Process Integration, Photonic Devices

Seth M. Hubbard, BS, Drexel University; MS, Case Western Reserve University; Ph.D., University of Michigan—Assistant Professor, Physics, epitaxial crystal growth, growth and characterization of nanomaterials, high-efficiency photovoltaic devices, semiconductor device design and fabrication, thin films

Satish G. Kandlikar, BE, Marathwada University; M.Tech., Ph.D., Indian Institute of Technology—James E. Gleason Professor; Professor, Mechanical Engineering; Thermal Systems and Energy

Santosh Kurinec, BS, MS, Ph.D., University of Delhi—Professor, Microelectronic Engineering; Electronic Materials and Devices, IC Processing, Quantum and Nanoscale Devices

Brian J. Landi, BS, MS, Ph.D., Rochester Institute of Technology—Assistant Professor, Chemical Engineering, Carbon Nanotubes, Batteries, Wires

Zhaolin Lu, BS, Changqing University; MS, Michigan Technological University; Ph.D., University of Delaware—Assistant Professor, Photonics, Electromagnetics, and Nanoelectronics

Sergey Lyshevski, MS, Ph.D., Kiev Polytechnic Institute—Professor, Electrical Engineering; Microsystems

P. R. Mukund, BS, MS, Ph.D., University of Tennessee—Professor, Electrical Engineering; VLSI Design, Electronic Devices, Circuit Design

Stefan Preble, BS, Rochester Institute of Technology; Ph.D., Cornell University—Assistant Professor, Nanophotonics, Silicon Photonics, and Optics

Sean L. Rommel, BS, Ph.D., University of Delaware—Associate Professor, Microelectronic Engineering; Emerging Semiconductor Devices, Photonic Devices, Integration

Ferat E. Sahin, BS, Istanbul Technical University; MS, Ph.D., Virginia Polytechnic Institute—Associate Professor, Electrical Engineering; Artificial Intelligence, Control Systems, Robotics

Thomas W. Smith, BS, John Carroll University; Ph.D., University of Michigan—Professor, Chemistry; Organic/Polymer Chemistry: synthesis and device applications of block copolymer systems and nano composites

Electrical Engineering

0301-702 Random Signals and Noise
In this course the student is introduced to random variables and stochastic processes. Topics covered are probability theory, conditional probability and Bayes theorem, discrete and continuous random variables, distribution and density functions, moments and characteristic functions, functions of one and several random variables, Gaussian random variables and the central limit theorem, estimation of a random variable, random processes, stationarity and ergodicity, auto correlation, cross-correlation and power spectrum density, response of linear prediction, Wiener filtering, elements of detection, matched filters. (Graduate standing) **Class 4, Credit 4**

0301-703 Matrix Methods in Electrical Engineering
This course deals with the elements of discrete transforms and linear algebra. Topics include: discrete-time signals and systems, the Z-transform and its application, solution of difference equations, concepts of stability, discrete Fourier analysis, DFT, FFT algorithms, topics in linear algebra and matrices, eigenvalues and eigenvectors, functions of matrices, matrix transformations and operations, matrix poly-nominals and the Cayley-Hamilton theorem, state variables, relation between transfer functions and state variable representation of LTI systems, state transition matrix, and solution of state equations. (Graduate standing) **Class 4, Credit 4**

0301-710 Advanced Electromagnetic Theory
The primary objective is to provide the mathematical and physical fundamentals necessary for a systematic analysis of electromagnetic field problems. Topics include potential representations, scalar and vector Green's functions, Green's theorem, reciprocity, duality, equivalence principle, image theorem, and radiation from apertures, scattering, integral equation solutions, perturbation and numerical methods. (Graduate standing) **Class 4, Credit 4**

0301-711 Advanced Carrier Injector Transistors
An advanced level course in electronic transport in semiconductors and the operation of bipolar devices (pn junction diodes, bipolar junction transistors and semiconductor-controlled rectifiers). Topics include electron drift, diffusion and carrier lattice interactions, energy band diagrams in non-uniformly doped semiconductors, continuity equations, impact ionization, tunneling, advanced static and dynamic analysis of diodes and bipolar transistors, design of bipolar devices. Topics also include Heterojunction physics and Heterojunction Bipolar Transistors (HBT), including SiGe HBT. **Class 4, Credit 4**

0301-712 Advanced Field Effect Devices
An advanced level course on MOSFETs and submicron MOS devices. Topics include MOS capacitors, gated diodes, long channel MOSFET, subthreshold conduction and offstate leakage, short channel effects, hot-carrier effects, ion-implanted channels, MOS scaling and advanced MOS technologies. **Class 4, Credit 4**

0301-713 Solid State Physics
An advanced level course on solid-state physics, with particular emphasis on semiconductor materials. Topics include: basic semiconductor properties, elements of quantum mechanics, general and time-independent formulation of wave mechanics, outcomes and predictions, energy band theory, statistical mechanics and equilibrium carrier statistics, excess carriers in semiconductors, carrier transport. **Class 4, Credit 4**

0301-717 Microwave Circuit Design
The primary objective is to study the fundamentals of microwave engineering with emphasis on microwave network analysis and circuit design. Topics include microwave transmission lines such as wave guides, coax, microstrip and stripline, microwave circuit theory such as S-matrix, ABCD matrices, and even odd mode analysis, analysis and design of passive circuits and components, matching networks, micro-wave resonators and filters. **Class 4, Credit 4**

0301-726 Mixed Signal IC Design
This course covers basic analog functional blocks and mixed signal blocks, in CMOS technology. Topics include: device models, current sources and active loads, precision reference, operational amplifiers, comparators, sample and hold circuits and data converters design. Course involves circuit design and layout projects. (Graduate standing). **Class 4, Credit 4**

0301-727 VLSI Design
A course in the design of very large scale integrated circuits at the level of Mead and Conway's VLSI Design. Topics include MOS devices and circuits, n-channel MOS process, data and control flow in systematic structures, implementing integrated system design, system timing and examples of LSI computer systems. **Class 4, Credit 4**

0301-729 Antenna Theory and Design
The primary objective is to study the fundamental principles of antenna theory applied to the analysis and design of antenna elements and arrays including synthesis techniques and matching techniques. Topics include antenna parameters, linear antennas, array theory, wire antennas, microstrip antennas, self and mutual impedances, equivalence principle, Huygen's principle, aperture antennas, traveling wave antennas, reflector antennas. **Class 4, Credit 4**

0301-730 Advanced Analog IC Design
An advanced course in analog integrated circuit design. Students will study bipolar and MOS realization of operational amplifiers, analog multipliers, A to D and D to A converters, switched capacitor filters and more. The students will participate in design projects including circuit design, layout and SPICE simulation. (0301-726) **Class 4, Credit 4**

0301-732 Advanced Topics in Digital System Design
The purpose of this course is to introduce students to advanced topics in digital systems design not covered in depth in undergraduate classes or topics that are new to the design community. Topics include: design of digital systems using Hardware Description Languages (VHDL/Verilog), design of digital systems using asynchronous circuits, design of digital systems using wave-pipelined circuits, clock distribution in large digital systems, design of digital systems with threshold gates, multi-valued logic and design of DSP specific blocks. For specific evaluation and grading policy, contact assigned instructor before registration. (0301-240, 347, 365, 545) **Class 4, Credit 4**

0301-733 Robust Control
One of the most useful qualities of a properly designed feedback control system is robustness, i.e., the ability of the closed-loop system to continue performing satisfactorily despite large variations in the open-loop plant dynamics. This course will provide an introduction to the analysis and design of robust feedback systems. Topics include overview of linear algebra and linear systems, H_2 and H_∞ control, spaces, modeling and paradigms for robust control; internal stability; nominal performance (asymptotic tracking); balanced model reduction; uncertainty and robustness; H_2 optimal control; H_2 control; H_2 loop shaping; controller reduction; and design for robust stability and performance. Software: MATLAB: Robust Control Toolbox, and mu-Toolbox. (0301-703) **Class 4, Credit 4**

0301-741 Design for Testability
This course deals with the design systems for testability and for maintainability. A survey of criteria for testability is given. A discussion of fault simulation and test pattern generation is included. Random test pattern generators and associated data compression schemes such as signature analysis are also described. Scanning techniques (both scan path and boundary scan) are discussed. The tradeoffs between built-in testing capacity and additional silicon structures are weighed. A small project, usually involving simulation, will be required. (0301-650) **Class 4, Credit 4**

0301-742 Advanced Topics in Embedded Systems
An introduction to the theory and application of top-down design, structure, abstraction, segmentation, high-level languages, and operating systems to real-time programs for microprocessors. Students will become proficient in a structured high-level language. Topics include structure diagrams, separate module compilation, data types, data structures, self-documenting code, procedures, meaningful variable names, linkage with other languages, object code libraries, operating system calls, multi-tasking concurrent and re-entrant programs, and symbolic debugging. **Class 4, Credit 4**

0301-749 Speech and Image Compression
Modern compression techniques used in efficient digital transmission and storage of speech and image waveforms are dealt with. Topics include digital communication channels, sampling and reconstruction of one-dimensional and two-dimensional signals, coding concepts, bit rate, coder complexity, rate distortion and information-theoretic bounds, characteristics of speech and image waveforms, quantization techniques, uniform nonuniform, logarithmic, optimum (Max), entropy coding, adaptive, pulse code modulation (PCM) of audio and video waveforms, DPCM, ADPCM, and delta modulation, linear prediction, transform coding, optimum (Karhunen-Loeve) transform and its gain, sub-optimum transforms, DFT, DCT, DST, DHT, and DWHT, special coding schemes, run-length coding, block truncation coding, sub-band coding, vector quantization, comparative performance of various schemes. Computer assignments and demonstrations. **Class 4, Credit 4**

0301-761 Modern Control Theory
An advanced course in control theory, topics covered include review of state-space formulation of SISO systems, solution of state equations, STM and its properties, application of state-space concepts, state variable design, multivariate systems, preliminaries, systems of lease order, stability and control. **Class 4, Credit 4**

0301-764 Digital Control Systems
An introduction to the analysis and design of control systems in which the microcontroller plays a principal role. Topics include sampled data systems, Z and W-place analysis and design, algorithm generation and the effect of computer word length on noise and stability. The student will be expected to make use of the digital computer in the implementation of design procedures. (0301-703) **Class 4, Credit 4**

0301-765 Optimal Control
The course covers different optimization techniques, as applied to feedback control systems. The main emphasis is on the design of optimal controllers for digital control systems. The major topics are: different performance indices, formulation of optimization problem with equality constraints, LaGrange multipliers, Hamiltonian and solution of discrete optimization problem. Discrete Linear Quadratic Regulators (LQR), optimal and suboptimal feedback gains, Riccati equation and its solution, linear quadratic tracking problem, Dynamic Programming, Bellman's principle of optimality, and optimal controllers for discrete and continuous systems. (0301-761 or equivalent) **Class 4, Credit 4**

0301-768 Adaptive Signal Processing
An introduction to the fundamental concepts of adaptive systems, open and closed loop adaptive systems, adaptive linear combiner, performance function and minimization, decorrelation of error and input signal. Adaptation algorithms such as steepest descent, LMS and LMS/Newton algorithm. Noise and maladjustments. Applications will include system identification, de-convolution and equalization, adaptive arrays and multipath communication channels. (0301-702 or permission of instructor) **Class 4, Credit 4**

0301-769 Fuzzy Logic and Applications
This course introduces fuzzy logic and its applications in areas like control systems, image processing, decision making, etc. Major topics: fuzzy sets, rule base, generation and combinations of rules, de-fuzzification—fuzzy systems, choice of fuzzy variables, their division into fuzzy sets, choice of membership functions, the effect of these on system performance. Applications: discussion of published works and student projects using fuzzy logic. Students are required to research the published literature and/or do projects and take an active part in these discussions. **Class 4, Credit 4**

0301-770 Pattern Recognition
This course provides a rigorous introduction to the principles and applications of statistical pattern recognition. The topics covered include Bayesian decision theory, nearest-neighbor techniques, linear discriminant functions, and clustering. Parameter estimation and the supervised learning as well as principles of feature selection are included. (0301-702) **Class 4, Credit 4**

0301-772 Special Topics
Topics and subject areas that are not among the courses listed are frequently offered under the title of Special Topics. Such courses are offered in a normal format; that is, regularly scheduled class sessions with an instructor. (No regular course schedule) **Class 4, Credit 4**

0301-779 Digital Image Processing
This introductory course in digital image processing that begins with a study of two-dimensional signal processing and transform methods with applications to images. Image sampling is discussed followed by gray level description of images and methods of contrast manipulation including linear/nonlinear transformation and histogram equalization and specification. Image smoothing methods are considered including spatial and frequency domain low pass filtering, ADHOC methods of noise removal and median filtering. Following this, methods of image sharpening are studied including derivative methods and high pass filtering. Edge and line detection methods are discussed using masks and Hough transforms, methods of image segmentation and degradation and image restoration, including deblurring. Several extensive computer and DSP lab assignments required. (0301-702, 703 or permission of instructor) **Class 4, Credit 4**

0301-780 Independent Study
This course number should be used by students who plan to study a topic on an independent study basis. The student must obtain the permission of the appropriate faculty member before registering for the course. **Credit 4**

0301-786 MEMS Devices
Microelectromechanical systems (MEMS) are widely used in aerospace, automotive, biotechnology, instrumentation, robotics, manufacturing, and other applications. There is a critical need to synthesize and design high performance MEMS that satisfy the requirements and specifications imposed. Integrated approaches must be applied to design and optimized MEMS, which integrate microelectromechanical motion devices, ICs, and microsensors. This course covers synthesis, design, modeling, simulation, analysis, control and fabrication of MEMS. Synthesis, design and analysis of MEMS will be covered including CAD. (Fourth or fifth year standing for undergraduates, or graduate standing) **Class 4, Credit 4**

0301-789 Fundamentals of MEMS
This course introduces the student to Microelectromechanical systems (microscale transducers, actuators and sensors with ICs). Synthesis, design, modeling, simulation, analysis, control and fabrication of MEMS will be covered. The primary emphasis of the course will be concentrated on development of basic theory to attain fundamental understanding of MEMS, the design, analysis, control, fabrication and application of MEMS in robotics, electronics, biotechnology, medicine, avionics, transportation, security, defense, etc. (Graduate standing for graduate students, 0301-531 for undergraduate students) **Class 4, Credit 4**

0301-794 Information Theory
This course introduces the student to the fundamental concepts and results of information theory. This is a very important course for students who want to specialize in signal processing, image processing, or digital communication. Topics include definition of information, mutual information, average information or entropy, entropy as a measure of average uncertainty, information sources and source coding, Huffman codes, run-length constraints, discrete memoryless channels, channel coding theorem, channel capacity and Shannon's theorem, noisy channels, continuous sources and channels, coding in the presence of noise, performance bounds for data transmission, rate distortion theory. (0301-702) **Class 4, Credit 4**

0301-798 Microfluidic MEMS
The course begins with an overview of microfluidic technology to provide a framework and to clarify the relationship of microfluidics to microelectromechanical systems (MEMS) and microsystems in general. Three major topics comprise the course: 1) selected elements of fluidic dynamics theory, and the scaling and application of that theory to microscale dimensions; 2) design, fabrication, and characterization of microfluidic devices and microsystems including exploration of major alternative fabrication technologies, process integration and materials issues, and device- and system-level packaging/encapsulation challenges; 3) applications, including microvalves, micropumps, microflow control sensor, and devices for chemical and biochemical analysis. **Class 4, Credit 4**

0301-799 Nano and Microengineering
This course focuses on analysis and synthesis of nano- and micro electromechanical systems and devices. Synthesis, design, optimization, analysis, control and fabrication of nano and microsystems will be covered. Utilizing basic physical laws of nano and micro-engineering, distinct systems and devices will be examined. The application of nano and microengineering in nanocomputers avionics, security and transportation will be emphasized. Specific applications included are: super-fast data processing and computing, data storage, imaging, molecular intelligent automata, etc. (Graduate standing for graduate students; permission of instructor for undergraduate students) **Class 4, Credit 4**

0301-800 Graduate Paper
This course number is used to fulfill the graduate paper requirement under the non-thesis option for the MS degree in electrical engineering. The student must obtain the approval of an appropriate faculty member to supervise the paper before registering for this course. **Credit variable 0–5**

0301-802 Wireless Communications
The course will cover advanced topics in wireless communications for voice, data and multimedia. Topics covered are: 1) Channel modeling: Overview of current wireless systems, modeling wireless channels, path loss for different environments, log-normal shadowing, flat and frequency-selective multipath fading, LS estimation of channel parameters, and capacity limits of wireless communication channels. 2) Transmission over fading channels, 3) Techniques to improve the speed and performance of wireless links (adaptive modulation and diversity techniques such as maximum gain combining to compensate for flat-fading). 4) Techniques to combat frequency-selective fading (adaptive equalization, space time coding, multicarrier modulation (OFDM), and spread spectrum). 4) Applications for these systems, including the evolution of cell phones and PDAs, sensor networks will be discussed. (0301-693, 702) **Class 4, Credit 4**

0301-803 Digital Video Processing
In this graduate level course the following topics will be covered: Representation of digital video—introduction and fundamentals. Time varying image formation models including motion models and geometric image formation. Spatio-temporal sampling including sampling of analog and digital video, two-dimensional rectangular and periodic sampling, sampling of 3-D structures, and reconstruction from samples. Sampling structure conversion including sampling rate change and sampling lattice conversion. Two-dimensional motion estimation including optical flow based methods, block-based methods. Pel-cursive methods, Bayesian methods based on Gibbs Randon Fields. Three-dimensional motion estimation and segmentation including methods, point correspondences, optical flow and direct methods, motion segmentation, and stereo and motion tracking. (0301-779 or permission of instructor) **Class 4, Credit 4**

0301-804 MEMS Evaluation
This course focuses on evaluation of MEMS, microsystems and microelectromechanical motion devices utilizing MEMS testing and characterization. Evaluations are performed using performance evaluation matrices, comprehensive performance analysis and functionality. Applications of advanced software and hardware in MEMS evaluation will be covered. (0301-786, senior standing) **Class 4, Credit 4**

0301-805 Modern Optics for Engineers
This course provides a broad overview of modern optics in preparation for more advanced courses in the rapidly developing fields of lasers, fiber optics and non-linear optics. Topics covered: propagation of light, geometrical optics, polarization, interferometry, diffraction, and laser resonators. Introduction to non-linear optics: harmonic generation, optical parametric oscillators and amplifiers. At the end of the quarter, the students should have a firm foundation in classical optics. Lasers and non-linear optics will be introduced from a semi-classical perspective and will not require a quantum mechanical background. Students will write a paper on a topic of current research interest in the field. (0301-474) **Class 4, Credit 4**

0301-810 Advanced Computer Architecture
This course covers advanced topics in computer and processor architecture. Topics include: pipeline and parallel processor design, branch tables and prediction algorithms, single issue versus multiple issue processor architectures (VLIW, SIMD, superscalar), cache architectures, quantitative and qualitative evaluation of instruction set architectures. For specific evaluation and grading contact the assigned instructor before registration. (0301-240, 347, 365, 545) **Class 4, Credit 4**

0301-812 Advanced Topics-Physical Implementation
This course covers the analysis and physical design of very large scale integrated circuits. Topics covered include synthesis, cell layout, cell placement and system routing, extraction, layout versus schematic check, signal integrity, timing and noise immune design techniques. The course will address issues in current state-of-the art submicron and deep submicron CMOS technologies, with an emphasis on digital circuits and systems. For specific evaluation and grading policy contact the assigned instructor before registration. (0301 240, 347, 365, and 545) **Class 4, Credit 4**

0301-815 Multivariable Modeling
This course introduces students to the major topics, methods, and issues in modeling multiple-input multiple-output (MIMO) linear systems. The course covers methods of creating models and refining them. Modeling topics include model-order determination, canonical forms, numerical issues in high-order models, numerical issues in broadband models, methods of creating frequency-response models from time-domain measurements, methods of model-order reduction, model transformations and information loss, and estimating model accuracy of MIMO models. Use of MIMO models in controller design will be discussed. (0301-703) **Class 4, Credit 4**

0301-816 Design and Characterization of Microwave Systems
The primary objective is the design and experimental illustration of the fundamentals of microwave circuits and antennas. Projects will involve the design, construction and characterization a microwave system to satisfy a set of specified design criteria. Microwave measurement techniques will involve the use of network analyzers, and spectrum analyzers in conjunction with the probe station. Simulated results will be obtained using some popular commercial EM software for the design of microwave circuits and antennas. (0301-717) **Class 4, Lab 3, Credit 4**

0301-820 Modeling and Simulation of Semiconductors
Semiconductor process and device simulation techniques are introduced. Standard process simulators—ATHENA is used for modeling and simulation of process technologies - crystal growth, film deposition, oxidation, diffusion, ion implantation, dry etching, metallization, oxygen implantation, annealing, etc. Physics based modeling topics—carrier transport, Poisson's equation, current continuity equation, breakdown phenomena, device scaling, etc. are covered. Standard multi-dimensional device simulator - ATLAS is used to simulate different semiconductor devices. In conjunction with ATHENA and ATLAS, UTMOST is used to extract BSIM model parameters for circuit simulation using SPECTRE. (Graduate standing) **Class 4, Credit 4**

0301-821 Physics and Modeling of High Performance Semiconductors
Semiconductor devices based on III-V materials are introduced. Basic properties and physics of III–V materials and metal-semiconductor contacts and two-terminal Heterojunction devices are covered. Physical operation, non-idealities, modeling DC and microwave characteristics of Heterojunction Bipolar Transistors (HBT), Metal Semiconductor Field-Effect Transistors (MESFET) and High Electron Mobility Transistors (HEMT) are analyzed. Analysis of small and large-signal amplifiers is covered. (0301-360 or equivalent) **Class 4, Credit 4**

0301-836 Biorobotics/Cybernetics
Cybernetics refers to the science of communication and control theory that is concerned especially with the comparative study of automatic control systems (as in the nervous system and brain and mechanical electrical communications systems. This course will present material related to the study of cybernetics as well as the aspects of robotics and controls associated with applications of a biological nature. Topics will also include the study of various paradigms and computational methods that can be utilized to achieve the successful integration of robotic mechanisms in a biological setting. Successful participation in the course will entail completion of at least one project involving incorporation of these techniques in a biomedical application. (Permission of instructor or graduate standing) **Class 4, Lab 2, Credit 4**

0301-847 Artificial Intelligence Explorations
The course begins with the history and development of artificial intelligence. This course explores a variety of artificial intelligence techniques, their applications and limitations. Some of the AI techniques covered in this course are intelligent agents, problem-solving, knowledge and reasoning, uncertainty, decision making, learning (Neural networks and Bayesian networks), reinforcement learning, swarm intelligence, Genetic algorithms, particle swarm optimization, applications in robotics, controls, and communications. Students are expected to have any of the following programming skills: C/C++, Matlab, Java, or other high level programming language. Graduate students are required to write an IEEE format conference paper on their projects. **Class 4, Credit 4**

0301-877 Graduate Internship
Graduate internship is designed to enhance the educational experience of graduate students through full-time paid employment during the summer quarter. Students are encouraged to seek full time positions in the Electrical and Microelectronic Engineering field. Registration is optional and is recommended for summer quarters only. Before enrolling, students are required to complete all bridge courses as well as a minimum of 24 graduate credits and receive approval from the Graduate Program Coordinator.

0301-885 Principles of Robotics
An introduction to a wide range of robotics-related topics, including but not limited to: sensors, interface design, robot devices and applications, mobile robots, intelligent navigation, task planning, coordinate systems and positioning, image processing, digital signal processing applications on robots, and controller circuitry design. Prerequisite of the class is the basic understanding of signals and systems, matrix theory, and computer programming. Software assignments will be given to the students in robotic applications. Students will prepare a project, in which they will complete software or a hardware design of an industrial or a mobile robot. There will be two-hour lab additional to the lectures. Graduate students are required to write a IEEE format conference paper on their projects. (0301-204, 345, 346, 453) **Class 3, Lab 2, Credit 4**

0301-887 Digital Signal Processing
A continuation of the topics studied in 0301-554. Topics include study of the design methods for digital IIR filters via s-plane transformations, study of design methods for digital FIR filters, including emphasis on the question of linear phase response, a review of the discrete Fourier transform (DFT) and an in-depth study of fast algorithms (FFTs) for implementing the DFT, including radix 2, radix 4 and mixed radix algorithms, quantization effects in discrete systems; an introduction to digital signal processing computer chips and their use in the implementation of digital processing systems, and applications of digital signal processing, including speech processing and two-dimensional image processing. Includes several design projects in the digital signal processing laboratory. (0301-554) **Class 4, Credit 4**

0301-889 **Graduate Seminar**
The objective of this course is to introduce full time Electrical and Microelectronic Engineering BS/MS and incoming graduate students to the graduate programs, campus resources to support research, and EME research activities. Presentations from faculty, upper division MS/PhD students, staff, and off campus speakers will provide a basis for student selection of research topics, comprehensive literature review, and modeling effective conduct and presentation of research. All first year graduate students enrolled full time are required to successfully complete three quarters of this seminar. **Class 1, Credit 0 (F, W, S)**

0301-890 **Thesis**
An independent engineering project or research problem to demonstrate professional maturity. A formal written thesis and an oral defense are required. The student must obtain the approval of an appropriate faculty member to guide the thesis before registering for the thesis. A thesis may be used to earn a maximum of 9 credits.

0301-895 **Advanced Robotics**
This course explores advanced topics in mobile robots and manipulators. Mobile robot navigation, path planning, room mapping, autonomous navigation are the main mobile robot topics. In addition, dynamic analysis of manipulators, forces and trajectory planning of manipulators, and novel methods for inverse kinematics and control of manipulators will also be explored. The course is project based and students are required to prepare a well written paper exploring a novel area in robotics for presentation at the IEEE conference. (0301-685 required, 0301-514 recommended) **Class 4, Credit 4**

Industrial and Systems Engineering

0303-701 **Linear Programming**
Applied linear programming. Computational techniques for solving constrained optimization problems. Linear programming, the Simplex method and variations, duality and sensitivity testing. (1016-331 or equivalent) **Credit 4 (W)**

0303-702 **Integer and Nonlinear Programming**
An introduction to the mathematical foundations of integer programming and nonlinear optimization techniques. Study of algorithms and computer-aided solutions for applied optimization problems. (0303 701) **Credit 4 (S)**

0303-703 **Supply Chain Management**
As business competition becomes global and product life cycles shorten, the need exists for a systems approach to studying all elements of the supply chain. This course will give students breadth of knowledge in Supply Chain Management along with strategies that can be utilized in the design and operation of efficient subsystems within the supply chain. Students will understand the supply chain in the context of the business value chain and profitability goals. This course will take a macro view, without emphasizing the details of each subcomponent within the supply chain. For example, the importance of warehouse location and its impact on the overall system will be considered without looking at details associated with material handling within a warehouse. (Requires acceptance into the MML program or permission of instructor) **Class 4, Credit 4 (F)**

0303-704 **Logistics Management**
This course discusses several strategic, tactical, and operational concepts used in improving the distribution of goods and services by companies worldwide. The course emphasis is on understanding when and how these concepts are applied, as well as on using mathematical programming and optimization methods for their adequate implementation. (0303-402 or 0303-702 or equivalent). **Class 4, Credit 4 (S)**

0303-710 **Systems Simulation**
Methods of modeling and computer simulation of stochastic and dynamic manufacturing systems are discussed. A high-level simulation language such as ProModel, ARENA, etc., will be used to model the system and examine system performance. Model validation, design of simulation experiments, variance reduction techniques and random number generation will be discussed as time permits. (0303-302, 1016-352 or equivalent) **Credit 4 (W)**

0303-711 **Advanced Simulation Techniques**
An advanced course in developing simulation models using good model building, verification and validation procedures. Emphasis will be on review and use of probability distributions, simulation output data analysis for making good decisions, comparison of alternative system configurations, use of designed experiments and the use of advanced simulation techniques. Real world case studies will be examined to convey understanding and teaching of the material. Students will be asked to build models, so simulation experience and working knowledge of a simulation language will be required. (0303 710) **Credit 4 (S)**

0303-716 **Applied Linear Regression Analysis**
A first course in least squares linear regression. Topics covered include estimation of model parameters, significance testing of model parameters, detection and treatment of influential observations, model adequacy checking and variable selection techniques. May not be used as a professional elective. (1016-352 or equivalent) **Credit 4 (S)**

0303-720 **Production Control**
This course will cover the role, the steps and the analysis methods to produce goods and services in support of the production and operations management functions. Topics include: forecasting, inventory policies and models, , job shop scheduling, aggregate production planning, and ERP systems. Students will understand the importance of production control and its relationship to other functions within the organization, and the role of optimization to support production planning. Case studies and the design of actual production systems will be emphasized. (0303 701, 1016-351) **Credit 4 (W)**

0303-723 **Global Facilities Planning**
This course addresses the global planning, and design, and utilization of fixed assets associated with design of manufacturing, storage and distribution, service and support functions facilities. Topics include: strategic considerations in facilities planning to meet customer and market objectives, product, process, and schedule design; determining flow, resource, and space requirements; layout at the plant level; design of storage warehousing material handling systems design, warehousing, storage and retrieval policies, , incorporation of lean principles, and quantitative design and analysis tools. Students will understand facilities planning from a strategic and tactical perspective as well as the link between business goals, and design, and engineering activities. Visits to local companies are included. (Requires acceptance into MML program or permission of instructor) **Credit 4 (S)**

0303-727 **Advanced Manufacturing Engineering**
This course will provide an advanced treatment of manufacturing engineering in the context of industrial and systems engineering. Emphasis will be place in process design, development and engineering, using state-of-the-art solid modeling tools and materials selection software. Process tooling, gauging, and automation will be cornerstones of the course and will provide material for a variety of term projects. Advanced processing, such as electronics and microsystems, will be explored and developed in depth. Quality systems and process documentation will also be covered. (0303-343, graduate standing or permission of instructor) **Class 4, Credit 4 (F)**

0303-728 **Production Systems Management**
Students who take this course should be interested in building on their basic knowledge of contemporary production systems and developing the breadth and depth of their understanding, with a focus on the managerial, quantitative, and systems aspects. It will also address value streams other than manufacturing; specifically and logistics. A significant portion of this course is focused on lean production control systems While other ISE courses that include significant production systems content enable the student to apply the tools and principles in a competent way on the shop floor (i.e., 0303-766 Manufacturing Systems and 0303-626 Contemporary Production Systems), this course should enable the student to practice the application of the concepts in the context of systems design at the enterprise level (0303-526 or 0303-626 or equivalent). **Class 4, Credit 4 (S)**

0303-729 **Advanced Systems Integration**
Basic concepts and techniques need to specify, design and implement systems that are computer controlled. Real-time data acquisition, process control as related to computer-integrated manufacturing, and information systems topics will be introduced within the context of systems integration. Cannot be used as a professional elective for ISE majors. (0303-302 or permission of instructor) **Class 3, Lab 1, Credit 4 (W)**

0303-730 **Ergonomics and Human Factors**
A survey course of human factors and ergonomics emphasizing a systems approach in looking at human capacity for physical and mental work versus the demands placed upon the human by the task, machine and environment. Various models of human performance are covered. **Credit 4 (on demand)**

0303-731 **Advanced Topics: Ergonomics and Human Factors**
Advanced topics are selected based on current ergonomic and human factors issues and interests of students. Course is taught using a seminar format in which journal articles and other publications are read and discussed. (0303-730 or equivalent) **Credit 4 (W-even years)**

0303-732 **Biomechanics**
Theoretical fundamentals of human physiology and mechanics applied to work. Biomechanical models are developed to evaluate the effects of physical loading on the human body. Topics include musculoskeletal systems, human strength, and biomechanical modeling using biomechanical software. (0304-331, 332, 0303-730 or equivalent) **Class 4, Credit 4 (S)**

0303-733 Cognitive Engineering
Measurements of human performance. Fundamentals of human information processing and how they relate to the design of human-machine systems. (0303-730 or equivalent) **Credit 4 (on demand)**

0303-734 Systems Safety Engineering
Acquaints students with practical aspects of safety engineering. Students acquire a working knowledge of legal and technical aspects of safety. Focuses on a systems approach to safety engineering. Topics include Workers Compensation, OSHA, Consumer Product Safety Commission and various hazard analysis and utilization techniques. Students also are exposed to various theories of accident causation, research methodology and ways of evaluating safety programs and related research. Professional elective. **Class 4, Credit 4 (W, odd years)**

0303-735 Design Project Management
Training for multidisciplinary studies in project management for leadership of product/process development and design projects. (e.g., senior design) (Permission of instructor required) **Class 4, Credit 4 (F, S)**

0303-742 Artificial Intelligence Applications
An introductory course in the development and application of "intelligent" (knowledge-based) systems. An introduction to Artificial Intelligence (AI) as a tool to deal with problems that require "intelligence." Computational complexity will be used to address "hard" problems. Generic and problem-specific procedures will be used and analyzed. (0303-701 or equivalent) **Credit 4 (on demand)**

0303-756 Decision Analysis
This course presents the primary concepts of decision analysis. Topics important to the practical assessment of probability and preference information needed to implement decision analysis are considered. Decision models represented by a sequence of interrelated decisions, stochastic processes and multiple criteria are also considered. (1016-352 or equivalent) **Credit 4 (on demand)**

0303-758 Design of Experiments
This course presents the primary concepts of experimental design. Its applied approach uses theoretical tools acquired in other mathematics and statistics courses. Emphasis is placed on the role of replication and randomization in experimentation. Numerous designs and design strategies are reviewed and implications on data analysis are discussed. (1016-352 or equivalent) **Credit 4 (W)**

0303-760 Product/Process Design and Development
This course covers the principles of product, manufacturing process and supply chain development in an integrated fashion. Examines the linkages between design specifications and manufacturability, between product architectures, manufacturing system, between the manufacturing system and supply chain and between in-house and outsourced manufacturing. Major topics include: product strategies, product, architectures and manufacturing strategies; product development processes; product requirements benchmarking, concept development generation and evaluation; the application of systems engineering tools to product design and design for "X" (manufacturing/assembly/service/environment, etc.) and life cycle costing. **Credit 4 (F)**

0303-761 Rapid Prototyping
This course covers the relatively new field of rapid prototyping (RP). The course blends lectures with hands-on lab activities. Lectures cover the practice and theory behind RP processes such as stereolithography, 3D printing, and electron beam melting. The use of RP technologies in emerging application areas such as energy systems, biomedical devices, and functionally graded materials are also discussed. (Senior or graduate standing in engineering or permission of instructor) **Class 4, Credit 4**

0303-762 Systems Modeling and Decision Making
This course emphasizes how process modeling and simulation can be utilized to aid business and technical decision making. Students will learn to identify and analyze key decision making factors associated with topics such as sourcing and the supply chain, lean manufacturing systems, product and service delivery, activity based costing, call centers, and order-to-cash systems. Students will also learn how to identify performance measures for a manufacturing or service systems and use those measures in the evaluation of system performance. A high-level modeling language will be utilized to simulate systems and examine performance. (Requires acceptance into the MML program or permission of instructor) **Credit 4 (W)**

0303-764 Operations Management and Manufacturing Systems
This course introduces students to problems and analysis related to the design, planning, control, and improvement of manufacturing and service operations. Emphasis is placed on the principles of planning and designing modern manufacturing systems, consistent with corporate objectives and new product development strategies. The course utilizes case studies extensively and analytical problem sets. Topics include: enterprise and manufacturing strategies, operations strategy, architecting manufacturing systems, systems thinking, process and project analysis, materials management, production planning and scheduling, quality management computer-aided manufacturing, and process management options. The course equips students with the basic tools and techniques used in analyzing operations and manufacturing systems, as well as the strategic context for making decisions. (Requires acceptance into MPD program) **Credit 4**

0303-765 Data Bases-Information Systems
The course focuses on implementation of information systems applications using SQL web-based implementation (e.g. ORACLE). Students will design, develop and implement multiple database projects and also be expected to conduct literature searches on contemporary issues in information systems architectures. **Class 4, Credit 4 (F)**

0303-766 Manufacturing Systems
This course will provide an introduction to concepts and techniques in the design and analysis of manufacturing systems. A blend of traditional and modern approaches is used to assess and analyze the performance of a given manufacturing system as well as to provide a framework for system redesign and improvement. Topics include factory physics, queuing theory, cellular manufacturing, and lean manufacturing. (Permission of instructor) **Credit 4**

0303-771 Special Topics in Industrial Engineering
This is a variable topics course that can be in the form of a regular course or independent study under faculty supervision. **Credit 4**

0303-775 Data Structures Using C
An introductory course in data structures and algorithms using the (visual) C++ programming language. Topics include sorting, searching and lists. This course can be used as a foundation for many computer- based courses in engineering. **Class 4, Credit 4 (F, odd years)**

0303-777 Engineering Internship
This course number is used by students in the master of engineering degree program to register for an internship experience. The number of credits is to be determined by the student's faculty adviser and is subject to the approval of the Graduate Committee of the College of Engineering. **Credit variable**

0303-778 Leadership Capstone
For students enrolled in the BS/ME dual degree program. Student must either: 1) serve as a team leader for the multidisciplinary senior design project, where they must apply leadership, project management, and system engineering skills to the solution of unstructured, open- ended, multi-disciplinary real-world engineering problems, or 2) demonstrate leadership through the investigation of a discipline- related topic. **Credit 0**

0303-779 Engineering Capstone
For the Master of Engineering programs in Industrial Engineering, Engineering Management, and Systems Engineering. Students must investigate a discipline-related topic in a field related to industrial engineering, engineering management, or systems engineering. The general intent of the engineering capstone is to demonstrate the students' knowledge of the integrative aspects of a particular area. The capstone should draw upon skills and knowledge acquired in the program. (Restricted to EIEG, EIEM, EIES, EIEA) **Credit 4 (W)**

0303-780 Excellence in New Product Development
Success in today's competitive global economy depends substantially on a firm's ability to define, develop, and introduce outstanding new products more efficiently and effectively than its competitors. This course introduces students to best practices and attributes of world-class product development leaders and organizations. Critical success factors and inhibitors to the commercialization of complex products and systems are discussed, along with state-of-the-art methodologies, processes, and tools. Emphasis is placed on the role of the product development manager in leading product strategy, high performing product development teams, and transformational initiatives essential to competitiveness **Credit 4**

0303-781 Advanced Topics in Product Development
This modular course is designed to complement previous course work in the MPD program, with an emphasis on engineering concepts and tools needed by technical leaders of product development projects. The course is intended to fill gaps in the MPD program by covering important topics for product development leaders that were not covered or could use additional coverage. Successful completion of all course work in the MPD program **Credit 4**

0303-782 Product Development in the Extended Enterprise
Today's complex products and shorter product development life cycles have dramatically increased dependence on external resources. This course will examine a broad range of collaborative arrangements from traditional contracting and functional outsourcing to cross-enterprise partnerships, in the context of the product delivery process and the challenges faced by product development managers. (Enrollment in MS in Product Development) **Class 4, Credit 4**

0303-784 Systems and Project Management
Systems and Project Management ensures progress toward objectives, proper deployment and conservation of human and financial resources, and achievement of cost and schedule targets. The focus of the course is on the utilization of a diverse set of project management methods and tools. Topics include strategic project management, project and organization learning, cost, schedule planning and control, structuring of performance measures and metrics, technical teams and project management, information technology support of teams, risk management, and process control. Course delivery consists of lectures, speakers, case studies, and experience sharing, and reinforces collaborative project-based learning and continuous improvement.) **Credit 4 (W, S-MPD only)**

0303-785 Decision and Risk Benefit Analysis
This course addresses decision making in the face of risk and uncertainty. Various methodologies will be introduced that are useful in describing and making decisions about risks, with particular emphasis on those associated with the design of products. Students will be exposed to issues related to balancing risks and benefits in situations involving human safety, product liability, environmental impact, and financial uncertainty. Presentations will be made of risk assessment studies, public decision processes, and methods for describing and making decisions about the societal risks associated with engineering projects. Topics include probabilistic risk assessment, cost-benefit analysis, reliability and hazard analysis, decision analysis, portfolio analysis, and project risk management **Credit 4**

0303-786 Engineering of Systems I
The engineering of a system is an essential aspect of its development that focuses on the overall concept, performance requirements and behavioral aspects of the system. This course treats the creation of products, product platforms and product families as systems that create value for both the customer and the enterprise. Topics include value creation and strategy, product development processes, translating market requirements to system requirements, functional analysis, development of the system's architecture, development of platforms and modules, and lean product development. Students will learn several systems analysis techniques and apply them in a team-based project. (Acceptance into the MPD program or permission of instructor) **Credit 4 (W)**

0303-787 Systems Optimization
This course is an application-oriented introduction to optimization, focused on the understanding of system tradeoffs. It introduces modeling methodology (linear, integer and nonlinear programming), modeling tools (sensitivity and post-optimality analysis), optimization software, applications in production planning and scheduling, inventory planning, personnel scheduling, project scheduling, distribution systems planning, facility sizing and capacity expansion, communication systems design, and product development. (Requires acceptance into the MPD program or permission of instructor) **Credit 4 (F)**

0303-788 Engineering of Systems II
The engineering of a system is an essential aspect of its development that focuses on the overall concept, performance, requirements and behavioral aspects of the system. This course builds on the concepts discussed in Engineering of Systems I. Topics include an introduction to computer and software architecture, defining the structure and work content of the product development organization, refinement and flow-down of requirements to subsystems, performance and life cycle trade studies, interface management, robust design, and certification planning. Students will learn several systems analysis techniques and apply them in a team based project. (Requires acceptance into the MPD program or permission of instructor, 0303-786) **Credit 4 (S)**

0303-789 Systems Dynamics
Systems dynamics deals with the time-based behavior and control of nonlinear systems. This course will introduce the concepts of systemic thinking, nonlinear dynamics, and control principles as they apply to enterprise issues such as the product development process, innovation diffusion, product differentiation, supply chain dynamics, and organizational learning. Topics include casual models, system archetypes, feedback and feed forward loops, exponential growth, goal seeking behavior, instability and sensitivity analysis. A continuous time simulation tool, such as I Think, Stella or Vensim, will be utilized to model and analyze the behavior of a variety of enterprise systems. (Requires acceptance into the MPD program or permission of instructor) **Credit 4**

0303-790 Fundamentals of Sustainable Engineering
The product life cycle is reviewed from various perspectives and highlights the leverage over material, process, and environmental costs available at the design phase. An additional project is required that draws upon basic engineering knowledge. (0303-343, 0304-344). **Class 4, Credit 4 (F)**

0303-791 Lifecycle Assessment/Costing
This course will introduce students to the challenges posed when trying to determine the total costs and environmental impacts associated with a product/process design across its entire lifecycle. Various assessment and costing models and their inherent assumptions will be reviewed and critiqued. (0303-520/620) **Class 4, Credit 4 (W)**

0303-792 Design for Environment
A course on systematic approaches of designing and developing environmentally responsible products. Topics covered include: guidelines for product structure, materials selection, fastening, labeling and finishing, techniques to reduce environmental impact (such as design to minimize material usage, design for disassembly, design for recycling, design for remanufacturing, design to minimize hazardous materials, design for energy efficiency, design to regulations/standards), and environmental impact inventory methods. (0303-343, 0304-344 or equivalent) **Class 4, Credit 4 (S)**

0303-793 Applications in Sustainable Engineering
Students investigate a discipline-related topic in a field related to sustainable engineering through the completion of an individual or team-based project. The topic is chosen in conference with a faculty advisor. The general intent of the engineering capstone is to demonstrate the students' knowledge of the integrative aspects of a particular area. The capstone should draw upon skills and knowledge acquired in the program. (Graduate standing) **Class 4, Credit 4 (W)**

0303-800 Graduate Seminar
Seminar series intended to present the state of the art in industrial engineering. Other research-related topics may be presented such as library search techniques, thesis writing, etc. All MS industrial engineering students are required to register for at least 3 quarters. (Graduate standing in MS in industrial engineering) **Credit 0 (F, W, S)**

0303-801 Design for Manufacture
This course presents an overview of the factors influencing product design and the manufacturing cycle. Topics include component design and analysis, design for manufacturability as well as function and design for manual and automated assembly. The various manufacturing processes as they relate to modern trends in DFM are covered. (0303-343) **Class 4, Credit 4 (S)**

0303-886 Systems Engineering
An introduction to systemic thinking, systems architecture, and systems analysis with a focus on devices that are integrated into the larger systems. Systems engineering, systems architecture and product development processes are introduced and applied in a term-long project centered on a device of the student's choosing. Students identify customer requirements, translate them to critical design parameters, define a system architecture, then analyze the behavior, design windows, reliability and life-cycle cost trade-offs. (Enrollment in the Ph.D. microsystems engineering degree program or permission of the instructor) **Class 4, Credit 4 (W)**

0303-890 Research and Thesis
In conference with a faculty adviser, an independent engineering project or research problem is selected. The work may be of a theoretical and/or computational nature. A state-of-the-art literature search in the area is normally expected. A formal written thesis and an oral defense with a faculty thesis committee are required. Submission of bound copies of the thesis to the library and to the department and preparation of a written paper in a short format suitable for submission for publication in a refereed journal are also required. Approval of department head and faculty adviser needed to enroll. **Credit variable 0–9 (F, W, S, SU)**

0303-891 **Capstone Integrative Project**
For the MS in Manufacturing Leadership (MML) program. The purpose of the project is for students to demonstrate integrative application of knowledge and skills that they have acquired during the program. A capstone project will be oriented to the solution of manufacturing, operations, or supply chain management problem or to technically related processes. Each project will define an actual problem and solve it, or select and develop a needed process. Each project must be approved in advance by the Capstone Coordinator. A suitable project will be multi-disciplinary or multi-functional in nature and will have significant impact on one or more competitive capabilities of the organization, e.g., quality, lead time, cost, flexibility, or service. Team-based projects are strongly recommended. (Completion of 50% of course work in the MML program). **Credit 4 (W)**

0303-892 **Capstone Research Project I**
For the MS program in product development (MPD). Students in the MPD program must demonstrate intellectual leadership in the field of new product development. The general intent of the capstone project is to demonstrate the students' knowledge of the integrative aspects of new product development in the context of a corporate-oriented problem solving research project. The project should address issues of significance to multiple functions or disciplines and should draw upon skills and knowledge acquired from various courses and experience in the program. Students are encouraged to start work on the project in advance of receiving formal credit during the final two quarters of the program. Team-based projects are strongly recommended (completion of 50% of course work in the MPD) **Credit 4**

0303-893 **Capstone Research Project II**
The second course in the capstone research project sequence. (0303-892) **Credit 4**

0303-888 **Graduate Thesis Seminar I**
The first in a two course sequence that introduces students to research methods in industrial engineering. The primary focus of this two-course sequence is on conducting critical reviews of research literature, initiating background research on a thesis topic, and preparing a formal thesis proposal. At the conclusion of the first course students are expected to complete a critical literature review and plan of study for the Master of Science degree. At the end of the second course, students are expected to submit a formal thesis proposal and associated literature review. This course is specifically designed for students enrolled in the MS program offered through the department. (Matriculated in the MS program) **Class 2, Credit 0**

0303-889 **Graduate Thesis Seminar II**
The second course in a two course sequence that introduces students to research methods in industrial engineering. The primary focus of this two-course sequence is on conducting critical reviews of research literature, initiating background research on a thesis topic, and preparing a formal thesis proposal. At the conclusion of the first course students are expected to complete a critical literature review and plan of study for the Master of Science degree. At the end of the second course, students are expected to submit a formal thesis proposal and associated literature review. This course is specifically designed for students enrolled in the MS program offered through the department. (0303-888 and matriculated in the MS program) **Class 2, Credit 0**

Mechanical Engineering

0304-701 **Research Methods**
This course introduces students to research methods in mechanical engineering. A primary focus of the course is on conducting critical reviews of research literature, preparing a formal thesis proposal, and initiating background research on a thesis topic. At the conclusion of the course, the students are expected to submit a formal thesis proposal, literature review, and plan of study for the completion of the Master of Science degree. This course is specifically designed for students enrolled in the dual degree MS/BS program offered through the department. (Consent of instructor. Restricted to dual degree students.) **Class 4, Credit 4**

0304-710 **Fuel Cell Technology**
Fuel cell technology is an emerging technology for electric power on demand, and can be used for stationary power generation or for driving vehicles. Fuel cell, the heart of this technology, is an electro-chemical device that produces electricity via cell reactions from useful chemical energy stored in fuel. After learning fuel cell basics and operating principles, fuel cell performance will be considered from energy and thermodynamic viewpoints. Types discussed are polymer electrolyte membrane fuel cell (PEMFC), phosphoric acid fuel cell (PAFC), molten carbonate fuel cell (MCFC), and solid oxide fuel cell (SOFC). Modeling of one fuel cell type will demonstrate design and analysis of systems and the information and components needed to make the system successful. Also discussed: thermal system design and analysis issues, limitations, cost effectiveness and efficiency. **Class 4, Credit 4**

0304-714 **Thermal Radiation Heat Transfer**
Course focuses on the following topics: fundamentals of radiative heat transfer, the blackbody, electromagnetic theory, properties of solid materials, gray surfaces, and shape factors; energy exchange between surfaces and in enclosures when no attenuating media is present. An introductory discussion of radiative transfer in the presence of an attenuating medium is also included. (Graduate standing and departmental approval required) **Class 4, Credit 4**

0304-720 **Optimization Description**
This course is an introduction to basic optimization techniques for engineering design synthesis. It covers concepts of design variables, constraints, objective functions, penalty functions, Lagrange multipliers. Techniques include solving constrained and unconstrained optimization problems through classical approaches, steepest descent, conjugate directions, conjugate gradient, controlled random searches, sequential linear programming, as well as some heuristic methods. Numerical solutions are obtained using commercially available software. A design project is required. (0304-440) **Class 4, Credit 4**

0304-729 **Renewable Energy Systems**
This course provides an overview of renewable energy system design. Energy resource assessment, system components, and feasibility analysis will be covered. Possible topics to be covered include photovoltaics, wind turbines, solar thermal, and hydropower. Students will be responsible for a final design project. (0304-415, 514) **Class 4, Credit 4**

0304-730 **Design Project Management**
This course focuses on preparing students to take on a leadership role in design project teams. Topics include product development processes, management of design project teams, developing a business case for design projects, understanding customer needs and translating them into engineering specifications, tools for developing design concepts, tools for assessing the feasibility of design concepts, conducting engineering tradeoffs and analysis to synthesize a preliminary design. Students use the concepts and tools discussed throughout the course in a team-based environment to develop project readiness packages for subsequent use by senior design teams. (0304-261 or 0303-481 or permission of instructor) **Class 4, Credit 4**

0304-733 **Sustainable Energy Management**
This course, Sustainable Energy Management and the Built Environment, provides an overview of mechanical and associated control systems within buildings with an emphasis on sub-systems which possess the most visible energy signature in terms of energy usage, energy inefficiency, and societal/global impact. Fundamentals of system operation are explored as well as energy management techniques. Using domestic and international case studies which highlight energy management within the built environment, students will explore methods by which engineers have achieved solutions aligned with sustainability. (0304-643, 660) **Class 4, Credit 4**

0304-739 **Alternative Fuels and Energy Efficiency**
This course, Alternative Fuels and Energy Efficiency for Transportation, provides an overview of the potential alternative fuels and energy efficiency technologies for powering current and future vehicles. Alternative fuel production technologies and utilization of fuels such as biodiesel, ethanol, and hydrogen will be covered. The primary technical and environmental issues associated with these alternative fuels will be discussed. Approaches to improving vehicle efficiency will also be explored. Students will be responsible for a final design or research project. (0304-640) **Class 4, Credit 4**

0304-743 **Intermediate Control Systems**
This course builds on the fundamentals of continuous feedback control to introduce the student to computer (digital) regulation of systems in closed-loop. Discrete-time modeling and stability of signals and systems are discussed. Analog and digital control schemes are compared using s domain to z-domain conversion, and time-domain response characterization. Closed-loop system design objective specification and evaluation is conducted through numerical simulation and experimental observation. Various discrete-time controller designs are implemented on motor control modules (used previously in 0304 643) for velocity and position feedback regulation. (0304-643) **Studio Lab 4, Credit 4**

0304-745 **Micro/Nano Characterization**
This technical elective with weekly lab component focuses on tools and techniques for micro- and nano-characterization of materials surfaces and thin films. The course covers the principles and applications of four experimental techniques: quantitative imaging, x-ray diffraction, scanning probe microscopy, and micro- and nano indentation. Students will learn the physics of interaction processes used for characterization, quantification and interpretation of collected signals, and the fundamental detection limits for each technique. **Class 3, Lab 2, Credit 4 (W or S)**

0304-746 Engineering Properties of Materials
This course presents the principles behind various properties of materials from an atomic and molecular perspective. Topics from physical chemistry and solid state physics and engineering are covered. Topics include: crystallography, thermodynamics of condensed phases, and thermal, elastic, electrical and magnetic properties. This course is oriented for advance undergraduate and graduate students with previous knowledge of materials science. (0304-344) **Class 4, Credit 4**

0304-752 Tribology Fundamentals
This course provides an overview of the role of fluid-film lubrication in mechanical design, with strong emphasis on applications. Various forms of the Reynolds equation governing the behavior of lubricant films for planar, cylindrical, and spherical geometry are derived. Mobility and impedance concepts as solution methods of the Reynolds equation are introduced for the performance assessment of lubricated journal bearings under static and dynamic loading. Short, long, and finite bearing assumptions are discussed. Finite element methods for the analysis of fluid-film bearings of arbitrary geometry will be introduced. (0304-415, 437 or equivalent, finite element background desirable but not required) **Class 4, Credit 4**

0304-754 Fundamentals of Fatigue and Fracture Mechanics
This course is an introduction to the fatigue life prediction methodologies and basic fracture mechanics. Students will be introduced to linear elastic fracture mechanics, including stress intensity factor and crack tip plastic zone models. The fatigue methodologies to be covered include the Stress-Life Theory (used for machine elements), Strain-Life Theory (used for large-displacement samples and low cycle fatigue problems), and a fracture mechanics approach to fatigue analysis (used in the aircraft and space industries). (0304-437, 440) **Class 4, Credit 4**

0304-756 Aerosols in the Respiratory Tract
This course introduces the student to the fundamentals of modeling and particulate flow in biological systems. Examples are drawn from a variety of fields, including deposition of particulates in the human lung, medicine delivery, and numerical modeling and simulation techniques. Students will be introduced to the morphology of the lung, diseases, and particulate characterization. (0304-415) **Class 4, Credit 4**

0304-758 Intermediate Engineering Vibrations
This course is a continuation of the introductory vibration course, 0304-658. Advanced topics such as flexibility and stiffness influence coefficients, continuous systems modeling of strings, rods, bars and beams, and modeling using finite element method will be discussed. (0304-658) **Class 3, Lab 2, Credit 4**

0304-793 Applications in Sustainable Engineering
Students investigate a discipline-related topic in a field related to sustainable engineering through the completion of an individual or team-based project. The topic is chosen in conference with a faculty advisor. The general intent of the engineering capstone is to demonstrate the students' knowledge of the integrative aspects of a particular area. The capstone should draw upon skills and knowledge acquired in the program. (Graduate standing) **Class 4, Credit 4**

0304-799 Special Topics
Topics and subject areas that are not among the courses listed here are frequently offered under the title of Special Topics. Such courses are offered in a normal format; that is, regularly scheduled class sessions with an instructor. (Graduate standing) **Class 4, Credit 4**

0304-801 Design for Manufacture
This is a required course in the manufacturing option of the master of engineering degree program. The course is offered jointly by the departments of Industrial and Manufacturing Engineering and Mechanical Engineering and presents an overview of the factors influencing product design and the manufacturing cycle. Topics include component design and analysis, design for manufacturability as well as function and design for manual and automated assembly. Students will gain hands-on experience with the Boothroyd/Dewhurst system to quantify design efficiency through a term project. The various manufacturing processes as they relate to modern trends in DFM are covered in detail. (Graduate standing) **Class 4, Credit 4**

0304-810 Introduction to Continuum Mechanics
A rigorous basis for the study of advanced fluid mechanics and theory of elasticity is presented. Cartesian tensors. Analysis of stress and deformation. Motion of continuous medium. Applications to theory of elasticity, thermoelasticity, viscoelasticity and fluid mechanics. (0304-871) **Class 4, Credit 4**

0304-811 Theory of Elasticity/Plasticity
Stress-strain relations and formulation of boundary value problems. State of plane strain, state of plane stress. Solutions by potentials, Airy stress function. Torsion of bars with circular, elliptic, rectangular cross-sections. Stresses and displacements in thick cylinders, disks and spheres. Contact stress problems. Energy principles. (0304-810) **Class 4, Credit 4**

0304-816 Finite Elements
This is an introductory course on the modern theory of finite element analysis. Although the necessary mathematics will be kept to a minimum, the course content has been designed to provide the skills necessary to write an F. E. program and to understand the structure and capabilities of commercially available codes. Applications to problems in structural mechanics, heat transfer and fluid mechanics. (0304-870, 885) **Class 4, Credit 4**

0304-820 Advanced Optimal Design
Topics from nonlinear programming as applied to automated optimal design. Use of penalty functions for the transformation of constrained nonlinear optimization problems. Multivariate pattern and gradient based algorithms. Linear programming, Quasi-Newton's method, Newton's method and direct methods for constrained problems. Applications to the solution of practical nonlinear optimization problems will be required through available software on the mainframe computer. (0304-871) **Class 4, Credit 4**

0304-821 Advanced Vibrations
Vibration of discrete multi-mass systems using matrix methods. Normal mode theory and matrix eigenvalue extraction procedures. Matrix forced response. Practical examples using two-and-three degrees of freedom. Vibration of continuous systems. Computer simulations. (0304-758) **Class 4, Credit 4**

0304-823 Systems Modeling
This course is designed to introduce the student to advanced systems modeling techniques and response characterization. Mechanical, electrical, fluid, and mixed type systems will be considered. Energy-based modeling methods such as Lagrange's methods will be used extensively for developing systems models. System performance will be assessed through numerical solution using MATLAB/Simulink. Linearization of nonlinear system models and verification methods are also discussed. (0304-543 or equivalent) **Class 4, Credit 4**

0304-828 Special Topics
In response to student and/or faculty interest, special courses which are of current interest and/or logical continuations of regular courses will be presented. These courses will be structured as ordinary courses with specified prerequisites, contact hours and examination. (Graduate standing) **Class 4, Credit 4**

0304-830 Introduction to CFD Analysis
This graduate core course covers basic numerical techniques applicable to equations in fluid mechanics and heat transfer. Numerical methods required for programming partial differential equations are introduced. Course work involves analytical programming and design examples. Commercial software is also explored. (0304-838, 851) **Class 4, Credit 4**

0304-831 CFD Applications
This course introduces the students to some of the commercial CFD codes being used for solving thermal-fluid problems. After an introduction to in-house CFD codes, students are expected to complete an individual CFD study project including a written report and a presentation of the results as part of the course requirements. (0304 416) **Class 4, Credit 4**

0304-833 Heat Exchanger Design
This course presents an overview of the different heat exchangers used in industry including shell-and-tube, plate, tube-fin, and plate-fin heat exchangers. Analytical modeling of recuperators, regenerators, and transient performance is also covered. Thermal design methods for designing shell-and-tube and compact heat exchangers are presented. Students are required to carry out a major design project in the course. (0304-514; 0304-550 or 851) **Class 4 Credit 4**

0304-834 Boiling and Condensation
This course provides a basic understanding of the phase change phenomena associated with boiling and condensation heat transfer. This knowledge is applied in the design of industrial systems such as evaporators, condensers and distillation columns. Students are required to undertake a major design project in the course. (0304 514, 550) **Class 4, Credit 4**

0304-835 Grid Generation
This graduate elective course introduces modern topics in the theory of grid generation techniques. Although the primary focus will be on the topics of thermal/fluid sciences, the applicability of the theory holds in other fields of interest as well. Topics include algebraic and elliptic grid generation, structured and unstructured grids, and boundary element methods. Some commercially available software will be introduced. (0304-830) **Class 4, Credit 4**

0304-838 Ideal Flows
This graduate core course covers the fundamental topics in the theory of aerodynamics and high speed flows. The course discusses modern aerodynamic applications in the areas of wing and airfoil design, wind tunnel testing and compressible flows. (0304-415) **Class 4, Credit 4**

0304-840 Signal Processing
This course introduces the student to discrete-time signal processing fundamentals, analog-to-digital conversion, and computer-based data analysis. Analytical mathematical developments are supplemented with hands-on computer-based laboratory and homework assignments that promote practical understanding. Topics covered include continuous time and discrete time convolution, correlation, Fourier transformation, and power spectral estimation. Coverage includes the DFT, FFT, z-transform, autocorrelation and cross correlation functions, and an introduction to statistical data processing via ARMA models for spectral estimation. (Graduate standing) **Class 4, Credit 4**

0304-842 System Identification
This course introduces the student to continuous-time and discrete-time identification from input-output data series. Practical aspects of the "synthesis" of system character will involve data conditioning, analog-to-digital conversion, and computer-based system analysis using MATLAB. Analytical mathematical developments are supplemented with hands-on computer-based laboratory and homework assignments that promote practical understanding. Topics covered include system response functions, non-parametric and parametric model estimation, model definition and validation, and system response prediction; builds on topics covered in 0304-840, Signal Processing, and supplements this material as appropriate. (0304-823, 840) **Class 4, Credit 4**

0304-843 Advanced Control Systems
Introduction to advanced control systems, including elements of continuous, digital, and nonlinear control systems theory. Topics include continuous to digital control conversion using finite difference solutions; continuous to digital control conversions using state equation approach; stability of discrete systems; PID control design for digital systems; frequency domain control system design methods (PID, lead, lag, lead-lag compensation design) for continuous systems, and for digital systems using phase loss methods and bilinear transformations; z-transforms for discrete systems; digital control system design using root locus; deadbeat control design; nonlinear control design using feedback linearization; sliding control method; eigen-structure assignment methods; fuzzy logic; neural-net; and introduction to H-infinity control. (0304 743) **Class 4, Credit 4**

0304-844 Nonlinear Dynamical Systems
This course is an introduction to nonlinear systems theory and is intended for students in engineering and the physical sciences. Non-linear systems are classified and analyzed using both analytical and computational methods. The emphasis is on the stability and bifurcation theory of discrete and continuous nonlinear systems. Specific examples from mechanics and other areas are discussed in detail. (0304-870) **Class 4, Credit 4**

0304-846 Modal Testing and Signal Processing
This course covers the important aspects of obtaining good modal data so that the natural frequencies, damping ratios, and mode shapes of a structure can be determined. Signal processing as applied to modal analysis will be covered including the auto- and cross-correlation functions, Fourier series and transforms, sampling and filtering and DFT/FFT theory. Transducers, excitation methods and commonly used practices in setting up a modal test will be discussed. Curve fitting techniques to extract modal parameters such as SDOF, MDOF, orthogonal polynomial and time domain will be covered. (0304-658 or equivalent) **Class 4, Credit 4**

0304-847 Microscale Heat/Mass Transfer
Deals with the effects of microscale dimensions on fluid flow, and heat transfer phenomena. The basic difference associated with these phenomena at microscale levels are presented through analytical equations, presenting theoretical aspects followed by practical examples. Topics covered include microscale heat conduction, heat transfer in thin film, transport equations for single-phase flow for high Knudsen number flows, gas compressibility, effects, single phase pressure drop equations for gases and liquids, heat transfer equations, laminar to turbulent transition, slip flow, transition flow, free molecular flow, two-phase flow considerations, and practical applications in micro-scale thermal and fluid flow devices. Each student will also work on an independent analytical or experimental project. (0304-413, 415, 416, 514. Consent of instructor) **Class 4, Credit 4**

0304-848 Special Topics-Thermal Fluids
In response to student and/or faculty interest, special courses that are of current interest and/or logical continuation of regular courses will be presented. (Graduate standing) See instructor for more details. **Class 4, Credit 4**

0304-851 Convective Phenomena
This course introduces the student to the flow of real incompressible fluids. The differential approach is used to develop and solve the equations governing the phenomena of mass, momentum, and heat transfer. The material in the course provides the necessary background for a study of computational fluid dynamics. (0304-415, 514) **Class 4, Credit 4**

0304-852 Advanced Turbomachinery
This course introduces the student to some of the advanced topics in turbomachinery. Topics include airfoil theory, two-and three- dimensional flow analysis in radial and axial turbomachines, and turbomachinery flow stability characteristics. Students are expected to do a design project using FLUENT Computational Fluid Dynamics code. (0304-550, 652) **Class 4, Credit 4**

0304-864 Production Tool Design
This is a course in the core group, CAD, of the manufacturing engineering option in the master of engineering degree program. Design of production tooling, jigs and fixtures for the economical manufacture of modern parts is covered in detail. The student must do research in current publications, and complete and present a project. Project selection can usually be arranged to incorporate an assembly of parts from the student's normal work. There will be field trips to local specialty firms. (Graduate standing) **Class 4, Credit 4**

0304-865 Computer Implementation of F.E.M.
This course emphasizes the application of the finite element method to problems in the area of static and dynamic structural analysis, heat transfer, and analogous solution. A standard commercial software package is used for these applications where the general structure, operating characteristics and use of a complex program are presented. Topics include the finite element method; shape factors, element formulation, and the element library; program sequencing; general modeling methods (loads, constraints, material factors, mesh generation, interactive graphics, model conditioning); convergence, error analysis and the "patch" test, vibration and heat transfer analysis, and analogous analysis such as acoustics, illumination, etc. (0304-518 or equivalent) **Class 4, Credit 4**

0304-870 Mathematics for Engineers I
A concise introduction to the concepts of matrix and linear algebra, including determinants, eigenvalues, systems of linear equations, vector spaces, linear transformations, diagonalization, orthogonal subspaces and the Gram-Schmidt orthonormalizing procedures. The use of complex exponentials in differential equations is introduced. Fourier series, Laplace and Fourier Transforms are also presented. (Graduate standing, 1016-318) **Class 4, Credit 4**

0304-870 Mathematics for Engineers I
This course trains students to utilize mathematical techniques from an engineering perspective, and provides essential background for success in graduate level studies. An intensive review of linear and nonlinear ordinary differential equations and Laplace transforms is provided. Laplace transform methods are extended to boundary-value problems and applications to control theory are discussed. Problem solving efficiency is stressed, and to this end, the utility of various available techniques are contrasted. The frequency response of ordinary differential equations is discussed extensively. Applications of linear algebra are examined, including the use of eigenvalue analysis in the solution of linear systems and in multivariate optimization. An introduction to Fourier analysis is also provided. (1016-318, Graduate Standing) **Class 4, Credit 4**

0304-871 Mathematics for Engineers II
This is a course in partial differential equations focused primarily on separation of variable techniques, and teaches the necessary vector space theory so that the problem solving methodology may be understood completely. Algebraic vector space concepts, such as the basis, are extended to functions, and operator theory is introduced as a means of unifying the solution structure of linear algebraic and differential equation systems. Existence and uniqueness is examined by considering the null and range spaces of algebraic and differential operators, the adjoint operator, and Fredholm's Alternative. Eigenvalue analysis is extended to functions, including an examination of Sturm-Liouville theory. Solutions of Laplace's equation, the heat equation, the wave equation, and the biharmonic equation are examined in a variety of geometries (0304-870 recommended; Graduate standing required) **Class 4, Credit 4**

0304-874 Numerical Analysis
This course emphasizes the development and implementation of methods available to solve engineering problems numerically. Specific topics include root finding for algebraic and transcendental equations, systems of linear and non-linear equations, interpolation of numerical data and curve fitting, numerical differentiation and integration, ordinary and partial differential equations, including initial and boundary value problems. (Graduate standing) **Class 4, Credit 4**

0304-875 Advanced Aerodynamics
This course covers the fundamental topics of aerodynamics and high speed flows. It discusses modern aerodynamic applications in the areas of wing and airfoil design, wind tunnel testing, and compressible flows. (0304-550 or 575, 838) **Class 4, Credit 4**

0304-877 Internship
This course number is used by students in the master of engineering degree program for earning internship credits. Students must submit a proposal for the internship, to be approved by an employing supervisor and the department prior to enrolling. Students are required to submit an evaluation report at the conclusion of the internship. **Credit variable**

0304-880 Independent Study
An opportunity for the advanced student to undertake an independent investigation in a special area under the guidance of a faculty member. A written proposal is to be forwarded to the sponsoring faculty member and approved by the department head prior to the commencement of work. (Graduate standing) **Credit variable (maximum of 4 credits per quarter)**

0304-885 Advanced Mechanics of Solids
This course extends the student's knowledge of stressed mechanical components covered in Mechanics of Materials and lays the foundation for a follow-on course in finite elements. The basic relationships between stress, strain, and displacements are covered in more depth. Stress and strain transformations, plane elastic problems, and energy techniques are covered. Topics from Advanced Strength of Materials include beam bending and torsion problems not covered in Mechanics of Materials. (0304-347) **Class 4, Credit 4**

0304-888 Project with Paper
This course is used by students in the master of engineering degree program for conducting an independent project. The student must demonstrate an acquired competence in an appropriate topic within mechanical engineering. The topic is chosen in conference with a faculty advisor. The work may involve an independent research and/or a design project and/or literature search with a demonstration of acquired skill. A written paper, approved by the advisor and the department, and an oral presentation of the work are required. **Credit 4**

0304-889 Graduate Seminar
This seminar course presents topics of contemporary interest to graduate students enrolled in the program. Presentations include off campus speakers, and assistance with progressing on your research. Selected students and faculty may make presentations on current research under way in the department. All graduate students enrolled full time (whether dual degree or single degree) are expected to attend each quarter they are on campus. **Credit 0 (F, W, S)**

0304-890 Research and Thesis
In conference with an advisor, a topic is chosen. Periodic progress reports and a final written document with an oral examination are required. (Approval of a thesis proposal approved by a thesis advisor and the department) **Credit variable 5–9**

Microelectronic Engineering

0305-701 Microelectronics I
This course introduces the beginning graduate student to the fabrication of solid-state devices and integrated circuits. The course presents an introduction to basic electronic components and devices, lay outs, unit processes common to all IC technologies such as substrate preparation, oxidation, diffusion and ion implantation. The course will focus on basic silicon processing. The students will be introduced to process modeling using a simulation tool such as SUPREM. There is a lab for the on campus section (01), and a discussion of laboratory results and a graduate paper for the distance learning-section (90). The lab consists of conducting a basic metal gate PMOS process in the RIT clean room facility to fabricate and test a PMOS integrated circuit test ship. Laboratory work also provides an introduction to basic IC fabrication processes and safety. **Class 3, Lab 3, Credit 4 (S)**

0305-702 Microelectronics II
The fundamental silicon based processing that includes state-of-the- art issues such as thin oxide growth, atomistic diffusion mechanisms, advanced ion implantation and rapid thermal processing (RTP). Computer simulation tools (i.e. SUPREM) are used to model processes, build device structures, and predict electrical characteristics, which are compared to actual device structures that are fabricated in the associated laboratory for on campus and additional course work for distance learning students. A topical graduate research paper is required. Controlled experiments using poly-silicon-Insulator-Semiconductor FET processing is conducted to build and test a variety of devices employing ion implantation, CVD and plasma etching. Extensive use of CAE and SUPREM. (0305-701) **Class 3, Lab 3, Credit 4 (W)**

0305-703 Microelectronics III
This course focuses on the deposition and etching of thin films of conductive and insulating materials for IC fabrication. A thorough overview of vacuum technology is presented to familiarize students with the challenges of creating and operating in a controlled environment. Chemical Vapor Deposition (CVD) and electroplating technologies are discussed as methods of film deposition. Plasma etching and Chemical Mechanical Planarization (CMP) are studied as methods for selective removal of materials. Applications of these processes to IC manufacturing are presented. There is an associated laboratory for on campus students and additional course work distance learning students. A topical graduate research paper is required Labs include: vacuum pump-down and evaporation, DC sputtering, reactive magnetron sputtering, chemical mechanical planarization, atmospheric and low pressure chemical vapor deposition and plasma and reactive ion etching. **Class 3, Lab 3, Credit 4**

0305-704 Semiconductor Process and Device Modeling
A senior graduate level course on the application of simulation tools for design and verification of microelectronic processes and operation of semiconductor devices. Technology CAD tools include Silvaco (Athena/Atlas) process/device simulators, as well as other simulation tools for specific processes, and math programs that can be used for custom simulation. Various models that describe front-end silicon processes are explored emphasizing the importance of complex interactions and 2D effects, as devices are scaled deep submicron. Includes laboratory exercises on simulation and modeling. (0305-560, 701, 702) **Class 3, Lab 3, Credit 4 (W)**

0305-705 Quantum and Solid State Physics for Nanostructures
This course describes the key elements of quantum mechanics and solid state physics that are necessary in understanding the modern semiconductor devices. Quantum mechanical topics include solution of Schrodinger equation solution for potential wells and barriers, subsequently applied to tunneling and carrier confinement. Solid state topics include electronic structure of atoms, crystal structures, direct and reciprocal lattices. Detailed discussion is devoted to energy band theory, effective mass theory, energy-momentum relations in direct and indirect band gap semiconductors, intrinsic and extrinsic semiconductors, statistical physics applied to carriers in semiconductors, scattering and generation and recombination processes. **Class 4, Lab 0, Credit 4 (F)**

0305-706 SiGe and SOI Devices and Technologies
This course introduces students to the fundamentals of SiGe and Silicon on Insulator (SOI) devices and fabrication technologies. The course will first discuss the band structure of the SiGe material system, and how its properties of band structure and enhanced mobility may be utilized to improve traditional Si devices. Basic heterojunction theory is introduced to students. Some specific applications that are introduced include heterojunction bipolar transistors (HBTs), SiGe-channel MOS devices, and high-electron mobility transistors (HEMTs). Fabrication technologies for realizing SOI substrates that include SIMOX and SMART CUTTM technologies are described. The physics of transistors built on SOI substrates will be discussed. At the completion of the course, students will write a term paper summarizing the literature in a key topical area of this course. **Class 4, Lab 0, Credit 4 (S, alternate years)**

0305-707 Nanoscale CMOS and Beyond
This course is an in-depth study of the principles and practice of scaling-driven CMOS front and back end processing. The course discusses the Semiconductor Industry Association (SIA) International Technology Roadmap for Semiconductors (ITRS) and exposes students to the next generation of nanometer-scale CMOS with device concepts that include quantum mechanical phenomena such as channel confinement and dopant fluctuations. Front end processing includes super steep retrograde wells, high-k gate insulators, metal gate, and ultra shallow source/ drains. Back end topics include interconnect modeling and delay, Low k dielectric and copper damanscence processes. The use of novel substrates such as strained silicon, SiGe and Ge will be described. (0305-560, 701, 702, of nanometer-scale CMOS with device concepts that take advantage of 703) **Class 4, Credit 4 (W)**

0305-714 Micro/Nano Characterization
This mechanical elective with weekly lab component focuses on tools and techniques for micro- and nano-characterization of materials, surfaces and thin films. The course covers the principles and applications of four experimental techniques: quantitative imaging, x ray diffraction, scanning probe microscopy, and micro- and nano- indentation. Students will learn the physics of interaction processes used for characterization, quantification and interpretation of collected signals, and fundamental detection limits for each technique. (0304-344 or 1028-701 or 0305-460) **Class 3, Lab 2, Credit 4 (W or S)**

0305-715 Photovoltaics Science and Engineering
This course focuses on the principles and engineering fundamentals of photovoltaic (PV) energy conversion. The course will cover modern silicon PV devices, including the basic physics, ideal and non-ideal models, device parameters and design, and device fabrication. The course will discuss crystalline, multi-crystalline, amorphous devices thin films solar cells and their manufacturing. Students will be made familiar on how basic semiconductor processes are employed in solar cells manufacturing. The course will further introduce third generation advanced photovoltaic concepts including compound semiconductors, spectral conversion, and organic and polymeric devices. PV applications, environmental and economic issues will also be discussed. Evaluation will include in addition to assignments and exams, a research/term paper on a current PV topic. **Class 4, Credit 4 (W)**

0305-717 Memory Systems
This course targets the overlapping areas of device physics, VLSI Design, advanced processes, electrical characterization and circuit architecture as it applies to modern memory systems. While there are no specific set of pre-requisite courses, students should be willing to work on problems involving the previously mentioned topics. Course work will trace the design, development, fabrication, packaging and testing of SRAM, DRAM and Flash Memory, and then branch off into MRAM, FRAM and PRAM technology. The course wraps up with an exploration of future memory system candidates such as quantum, molecular and optical memory systems. Students will write a term paper on an aspect of memory systems of particular interest to them (proposed topic must still be approved by the instructor). **Class 4, Credit 4 (S, alternate years)**

0305-721 Microlithography Materials and Processes
This course covers the chemical aspects of microlithography and resist processes. Fundamentals of polymer technology will be addresses and the chemistry of various resist platforms including novolac, styrene and a acrylate systems will be covered. Double patterning materials will also be studied. Topics include the principles of photoresist materials, including polymer synthesis, photochemistry, processing technologies and methods of process optimization. Also advanced lithographic techniques and materials and processes are applied to optical lithography. There is an associated laboratory for on campus students and additional course work for distance learning students. A topical graduate research paper is required. **Class 3, Lab 3, Credit 4**

0305-722 Microlithography Systems
This course covers the physical aspects of lithography. Topics include iImage formation in optical projection, optical proximity, and high-energy systems (DUV/VUV, e-beam/SCALPE, X-ray, and EUV) are studied. Fresnel diffraction, Fraunhofer diffraction, and Fourier optics are utilized to understand diffraction-limited imaging processes, illumination, lens parameters, image assessment (resolution, alignment and overlay), phase-shift masking, and resist interactions. Lithographic systems are designed and optimized through use of modeling and simulation packages. Current status of the practical implementation of advanced technologies in industry as well as future requirements will be presented. There is an associated laboratory for on campus students and additional course work for distance learning students. A topical graduate research paper is required. **Class 3, Lab 3, Credit 4**

0305-731 Microelectronics Manufacturing I
This course focuses on CMOS manufacturing. Topics include CMOS process technology, work in progress tracking, CMOS calculations, process technology, long channel and short channel MOSFET, isolation technologies, back-end processing and packaging. There is an associated laboratory for on campus students and additional course work for distance learning.. The laboratory for this course is the student-run factory. Lot tracking, data collection, lot history, cycle time, turns, CPK and statistical process control are introduced to the students. Silicon wafers are processed through an entire CMOS process and tested. Students design unit processes and integrate them into a complete process. Students evaluate the process steps with calculations, simulations and lot history, and test completed devices. **Class 3, Lab 3, Credit 4 (W)**

0305-732 Microelectronics Manufacturing II
This course focuses on techniques used to evaluate and improve CMOS manufacturing. Topics include query processing, measuring factory performance, factory modeling and scheduling, cycle time management, cost of ownership, defect reduction and yield enhancement, reliability, 6 sigma manufacturing, process modeling and RIT's advanced CMOS process. There is a lab for the on campus section (01) and a graduate paper for the distance learning section (90). Laboratory experiences are related to the operation of the student run integrated circuit factory. Silicon wafers are processed through a complete CMOS process. (0305-731) **Class 3, Lab 3, Credit 4 (S)**

0305-760 Principles of Semiconductor Devices
This course will discuss the fundamentals underlying the operations of basic semiconductor devices employed in modern integrated circuits. The course includes modules on Semiconductor Fundamentals, P-N junction Diodes, Metal-Semiconductor Junctions, Metal-Oxide Semiconductor Capacitors, Field Effect Transistors, and Bipolar Junction Transistors presented through a series of lectures that qualitatively and quantitatively explain the operation of semiconductor devices. Each module features a segment on "deviations from ideality" that are observed in practical semiconductor devices and will provide insight into the constraints imposed by VLSI design rules and processing. This course is an online course only intended for professionals employed in various aspects of the semiconductor industry. **Class 4, Credit 4 (F, S)**

0305-770 Independent Study
This course number should be used by students who plan to study a topic on an independent basis under the guidance of a faculty member. A written proposal with an independent study form is to be submitted to the sponsoring faculty member and approved by the department head prior to the commencement of work. **Credit variable (Maximum of 4 credits per quarter)**

0305-777 Internship
This course number is used to fulfill the internship requirement for the master of engineering degree program. The student must obtain the approval of the department head before registering for this course. **Credit variable**

0305-801 Seminar/Research
Weekly seminar series intended to present the state of the art in microelectronics research. Other research-related topics will be presented such as library search techniques, contemporary issues, ethics, patent considerations, small business opportunities, technical writing, technical reviews, effective presentations, etc. Required of all MS microelectronic engineering students for one credit up to a total 4 credits. After 4 credits, graduate students are required to register each quarter for zero credits. (Graduate standing in MS in microelectronic engineering) **Credit 1–4 (F, W, S)**

0305-830 Metrology for Yield and Failure Analysis
Successful IC manufacturing must detect defects (the non-idealities) that occur in a process), eliminate those defects that preclude functional devices (yield enhancement), and functionality for up to ten years of use in the field (reliability). Course surveys current CMOS manufacturing to compile a list of critical parameters and steps to monitor during manufacturing. This survey is followed with an in depth look at the theory and instrumentation of the tools utilized to monitor these parameters. Tool set includes optical instrumentation, electron microscopy, surface analysis techniques, and electrical measurements. Case studies from industry and prior students are reviewed. Students are required to perform a project either exploring a technique not covered in class, or to apply their course knowledge to a practical problem. (0305-560, 701) **Class 4, Credit 4 (F)**

0305-870 Microelectromechanical Systems
This course will provide an opportunity for students to become familiar with the technology and applications of microeletromechanical systems (MEMS)--one of the fastest growing areas in the semiconductor business. MEMS represents the integration of microelectronic chips with microsensors, probes, lasers, and actuators. Topics include basic principles of MEMS and fabrication methodologies. The accompanying laboratory will carry out design and fabrication of MEMS structures/devices using microfabrication techniques. **Class 3, Lab 3, Credit 4 (W, S)**

0305-890 Special Topics
This is a variable credit, variable special topics course that can be in the form of a regular course or independent study under faculty supervision. Some of the topics are SOI device technology, compound semiconductors and devices, quantum devices, and Nanotechnology. **Class 4, Lab 0, Credit 4**

0305-899 Thesis
The master's thesis in microelectronic engineering requires the student to prepare a written thesis proposal for approval by the faculty; select a thesis topic, adviser and committee; present and defend thesis before a thesis committee; submit a bound copy of the thesis to the library and to the department; prepare a written paper in a short format suitable for submission for publication in a journal; complete course work and thesis within a seven-year period; register for one credit of Continuation of Thesis each school term (except summer quarter) after the 45 credits required for the master's degree until the thesis is completed. (Graduate standing in MS in microelectronic engineering) **Class 0, Lab 0, Credit variable 0 to 9 (F, W, S, SU)**

Computer Engineering

0306-710 Network Modeling, Design and Simulation
This course covers theories for network design and modeling and case studies to apply the theories. Mathematical models, such as queuing theory, graph theory, and optimization techniques for analyzing network topology, traffic, and algorithms are introduced. State-of-the-art network problems and solutions are discussed and analyzed using the various network theories as well as network simulation tools (e.g., OPNET). Students are expected to actively research technical papers and participate in in-class discussions. Assignments include homework, exams, paper readings, projects, and individual presentations. (0306-381, 694; or permission of instructor) **Class 4, Credit 4**

0306-715 Wireless Networks
As interest in wireless technology is booming, wireless networks are enjoying very fast growth. This course covers fundamental techniques in design and operation of first, second, and third generation wireless networks: cellular systems, medium access techniques, radio propagation models, error control techniques, handoff, power control, common air protocols (AMPS, IS-95, IS-136, GSM, GPRS, EDGE, WCDMA, cdma2000, etc), radio resource and network management. As an example for the third generation air interfaces, wireless internet and sensor networks are discussed in detail since they are expected to have a large impact on future wireless networks. This course is intended for graduate students who have some background on computer networks, but it is also open to senior undergraduates. (0306-694) **Class 4, Credit 4**

0306-720 Electronic Design Automation
The creation of large, complex electronic systems has grown beyond the capabilities of any number of designers without computer support. Successful completion of large design projects requires that computers be used in virtually all aspects of design. This course explores some of the basic design automation tools and algorithms in order to understand their capabilities, limitations and internal operations. Topics covered include review of the VHDL hardware description language, simulation techniques, design synthesis, placement and routing, and design verification methods. Laboratory projects in the use and creation of design automation tools are required. (0306-351, 0306-561 or equivalent; 0306 630/730 recommended) **Class 3, Lab 3, Credit 4**

0306-722 Advanced Computer Architectures
This course emphasizes the impact of VLSI and communication issues on computer architecture. Topics include highly concurrent, multiprocessor and reconfigurable computer systems as well as data flow architectures. Modeling techniques for system verification are included. (0306-551) **Class 4, Credit 4 (F)**

0306-724 High Performance Architecture
This course is an in-depth study of state-of-the-art high performance computer architectures. The primary objective of the course is to understand the architectural features used in modern processors and the corresponding impact on performance. The course material is derived from current and recent micro-architecture research publications. The course includes programming assignments and a term paper. (0306-551) **Class 4, Credit 4**

0306-730 VLSI Design
An introduction to the design and implementation of Very Large Scale Integration (or VLSI), including NMOS and PMOS devices, CMOS circuits and digital subsystems. The procedures for designing and implementing digital integrated systems will be covered including the Mead and Conway structured design approach consisting of the use of stick diagramming, scaling of CMOS design rules and techniques for estimating time delays. Emphasis will be placed on the use of static CMOS circuits and regular structures such as programmed logic arrays in custom and standard cell-based designs. The use of workstations with Mentor Graphics design tools for circuit simulation and physical layouts will be stressed. Graduate level laboratory design projects will be required. (0306-561, 460 or equivalent) **Class 4, Lab 2, Credit 4 (F, S, SU)**

0306-731 VLSI Design Projects
A second course in the design and implementation of Very Large Scale Integration (VLSI) circuits and systems. Emphasis will be placed on the design and use of dynamic precharge and precharge-evaluate CMOS circuitry including Domino, NORA and Zipper CMOS logic, and sub- systems. Basic requirements of a clocking system and a general clocking strategy for timing design in both static and dynamic CMOS circuits will be investigated. Topics on the design and use of a standard cell library in the implementation of large system designs will be covered. The use of workstations with Mentor Graphics design tools and Synopsys synthesis tool suite will be required in laboratory projects leading to the design, VHDL synthesis and testing of an integrated circuit device. (0306-730) **Class 4, Lab 2, Credit 4 (S)**

0306-732 Low Power Design
This course covers the theory and practical aspects of low-power integrated circuit design in CMOS technology. Topics include: estimation and modeling power dissipation in CMOS circuits at different design abstractions, power optimization techniques with emphasis on transistor and system level, energy efficient SRAM cells and cache designs, low power design methodology, effect of device scaling, process variations and their impact on power optimization, and post-CMOS logic gates. Assignments and projects focus on designing low-power circuits using Synopsys CAD tools. Presentations and term papers based on recent energy efficient research articles are required. (0306-630/730, 351, 0306-561 or equivalent) **Class 4, Credit 4**

0306-740 Analytical Topics for Computer Engineers
This course begins by reviewing signal and system analysis techniques for analyzing linear systems. It includes Fourier techniques and moves on to present fundamental computational techniques appropriate for a number of applications areas of computer engineering. A section on numerical linear algebra covers techniques for analyzing discrete time signals and systems. Other course topics include symbolic logic and optimization techniques. (0306-451 and 1016-265, 306, 331, 345 or equivalent) **Class 4, Credit 4**

0306-741 Design for Testability
This course will introduce the concepts of failure mechanisms and fault modeling in digital circuits. It describes various test strategies for the digital systems. Techniques to integrate design and test for VLSI circuits will be included. Design for autonomous test, SCAN-PATH concepts and testability analysis will be discussed. Built-in self-test (BIST) techniques will be detailed. Concepts of easily testable logic will be introduced. In addition, testability bus and the boundary-scan techniques will be included for system level testability. (0306-730, 561) **Class 4, Credit 4**

0306-756 Multiple Processor Systems
Introduces basic concepts of parallel and high-performance computing and current methodologies and trends in the design and programming of multiprocessor systems. Theoretical models of parallel computing and performance metrics are studied and contrasted with practical parallel system architectures, programming environments, and benchmarking techniques. Parallel architectures are classified according to mode and degree of parallelism, memory organization, and type and topology of interconnection networks used in the design. In depth study of various architectures with representative samples of current commercial machines is included. Students complete programming assignments on a parallel computer illustrating practical issues. A review and analysis of a commercial parallel processor system or an active research topic is required; written review is presented in class. (0306-551) **Class 4, Credit 4**

0306-758 Fault Tolerant Digital Systems
This course addresses the following advanced topics: formal models and concepts in fault diagnosis, test generation, design for testability techniques, design techniques to achieve fault tolerance, system evaluation techniques, design of practical fault-tolerant systems, and fault-tolerant design of VLSI circuits and systems. (0306-561, 550) **Class 4, Credit 4**

0306-759 Principles of Digital Interfacing
The objective of this course is to provide students with basic concepts of interfacing to microcomputer bus systems, including various peripheral components currently available. Students will gain experience in the actual implementation of microcomputer systems. The course is hardware oriented, but some software will be required to make the experimental systems operational. (0306-561, 560) **Class 3, Lab 3, Credit 4 (F)**

0306-761 Engineering Design of Software
An advanced course moving the student beyond computer programming to the engineering of complex software systems. At the end of this class, students will be able to make the right selection of design methodologies or architectures, produce executable structure models that can be verified by computer, formulate a design that meets all functional and performance requirements, and perform trade-off analyses that enhance decision making. Students work in teams on large-scaled software projects. **Class 4, Credit 4**

0306-762 Concurrent and Embedded Software Design
This course introduces methods for developing and designing concurrent software, which consists of many cooperating processes. Formal logical formulas are used to characterize sets of states and sets of program behaviors. The software is then analyzed by manipulating these logical formulas. Several classical concurrent programming problems such as critical section, producers and consumers, and resource allocation are examined. Practical examples and exercises are used to illustrate key are used to illustrate key points and evaluate design tradeoffs. (0306-761 or instructor permission) **Class 4, Credit 4**

0306-763 Embedded and Real-time Systems
A first course in an elective sequence begins by presenting a general roadmap of real-time and embedded systems. Conducted in a studio class/lab format with lecture material interspersed with lab work, this course introduces a representative family of microcontrollers exemplifying unique positive features as well as limitations of microcontrollers in embedded and real-time systems. Microcontrollers will be used as external, independent performance monitors of more complex real-time systems. Much of the material focuses on a commercial real-time operating system, using it for programming projects on development systems and embedded target systems. Fundamental material on real-time operating systems will be presented, including scheduling algorithms, priority inversion, and hardware-software co-design. (4010-361 and 0306-250 or equivalent, 4003-440 recommended) **Class 4, Credit 4**

0306-764 Modeling of Real-time Systems
This course introduces the modeling of real-time software systems. It takes an engineering approach to the design of these systems by analyzing a model of the system before beginning implementation. UML will be the primary modeling methodology. Non-UML methodologies will also be discussed. Implementations of real-time systems will be developed manually from the models and using automated tools to generate the code. **Class 4, Credit 4**

0306-772 Special Topics in Computer Engineering
Topics and subject areas that are not among the courses listed here are frequently offered under the title of Special Topics. Such courses are offered in a normal format; that is, regularly scheduled class sessions with an instructor. **Credit variable (no regular course schedule)**

0306-775 Robotics
This course deals with mobile robotics. The development of the field and an overview of the different approaches to mobile robot guidance (knowing where we are and where we want to go) navigation (formulating a plan to get where we want to go) and control (following a desired path) will be given. The emphasis of the course will be on algorithms and techniques and relevant projects will be assigned. (0306-451) **Class 4, Credit 4**

0306-776 Robust Control
One of the most useful qualities of a properly designed feedback control system is robustness, i.e., the ability of the closed-loop control system to continue to perform satisfactorily despite large variations in the (open-loop) plant dynamics and the environment. This new approach has been successfully applied to high performance servo drive systems, unmanned aerial vehicles, visual feedback systems and mobile robots among others. This course will provide an introduction to state-of-the-art techniques for analysis and design of robust feedback systems. MATLAB will be used extensively for analysis, design and simulation. (0306-553 or equivalent, 1016-331 or equivalent is recommended) **Class 4, Credit 4**

0306-784 Digital Image Processing Algorithms
Emphasizes both theory and implementation of image processing algorithms. Two-dimensional sampling, transforms, and filtering are introduced and used for image enhancement, compression, restoration, segmentation, and applications in color and video processing. Project assignments involve Matlab implementation of algorithms and paper reviews. (0306-451, 1016-345 or instructor's permission) **Class 4, Credit 4**

0306-785 Computer Vision
This course covers both fundamental concepts and the more advanced topics in Computer Vision. Topics include image formation, color, texture and shape analysis, linear filtering, edge detection and segmentation. In addition, students are introduced to more advanced topics, such as model based vision, object recognition, digital image libraries and applications. Homework, literature reviews and programming projects are integrated with lectures to provide a comprehensive learning experience. (0306-451, 1016-345) **Class 4, Credit 4**

0306-790 Graduate Seminar in Computer Engineering
The purpose of the Graduate Seminar in Computer Engineering is to prepare graduate students to effectively conduct their thesis research. Current literature topics in the computer engineering discipline are reviewed through interactive presentations and discussions. Professional communications are stressed for the purpose of giving presentations and writing thesis documents and technical papers. Student assignments include literature surveys, in class presentations, and critical analysis reports. (Graduate standing or permission of instructor) **Class 1, Credit 0**

0306-794 Data and Computer Communications
Provides a unified view of the broad field of data and computer communications and networking. Emphasis is on the basic principles underlying the technology of data and computer networks. Critical issues in data communication networks as well as the current and evolving standards in computer communication architecture are discussed. The topology, access control and performance of various types of networks are studied in detail. A comprehensive student project is required. (1016-345 or permission of instructor) **Class 4, Credit 4 (F, W)**

0306-795 Networking Security
This course covers a set of advanced topics in wireless and wired network security design. It targets deep-level network security protocols design. The topics include Applied Cryptography fundamentals, Internet security (IPSec, Kerbos, Email security, etc.), Wireless LAN security, Sensor Network, security, and Ad hoc network security. Class projects include Java/C-based RC4/Hash design, Milinx-based TCP security experiments and Wireless security research. (0306-694 or equivalent) **Class 4, Credit 4**

0306-890 Thesis
Thesis research investigates an independent problem to demonstrate professional maturity. A formal written thesis and an oral defense are required. The student must obtain the approval of an appropriate faculty adviser to guide the thesis before registering. Thesis may be used to earn a minimum of 1 and a maximum of 9 credits. **Credit variable**

Quality and Applied Statistics

0307-702 Statistics for Data Mining
This course provides an introduction to the statistical thinking, terminology, principles, and methods needed to gain a reasonable understanding of the statistical principles used in standard data-mining techniques. Topics include normal, binomial, t, and chi-square distributions; estimation, hypothesis-testing, and statistical intervals; lift charts and ROC curves; linear regression, logistic regression, classification trees, naïve Bayes, mixtures of distributions, and the EM algorithm; cross validation, and bagging. This course does not count as credit for either the CQAS advanced certificates or MS degree (1016-351 or equivalent) **Credit 4**

0307-711 Fundamentals of Statistics I
For those taking statistics for the first time. Topics include organizing observed data for analysis, understanding of variability, graphical methods, and summary statistics; simple, conditional, and joint probabilities; combinations, permutations; binomial, Poisson, and normal distributions; sampling distributions and the Central Limit Theorem. This course does not count as credit for either the CQAS advanced certificates or MS degree. **Credit 3 or 4**

0307-712 Fundamentals of Statistics II
Continuation of 0307-711. Topics include estimation, confidence intervals, and hypothesis testing; tests for independence and analysis of categorical data; two-sample problems; designed experiments with one or two factors; introduction to analysis of variance, simple and multiple linear regression, and correlation. This course does not count as credit for either the CQAS advanced certificates or MS degree. (0307-711 or equivalent) **Credit 3 or 4**

0307-714 Principles of Applied Statistics
Review of fundamental probability theory; review of key distributions in statistics; syntheses of key ideas; use of simulations; probability plotting; linear combinations of random variables; hypothesis testing; importance of assumptions; confidence intervals and other statistical intervals; goodness-of-fit tests; multiple comparisons. This course does not count as credit toward either the CQAS advanced certificate or MS degree. (0307-712 or equivalent) **Credit 3**

0307-721 Statistical Process Control
A practical course designed to provide in-depth understanding of the principles and practices of statistical process control. Topics include statistical concepts relating to processes, Shewhart charts for measurement and attribute data, CUSUM charts, EWMA charts, measures of chart performance, tolerances, specifications, process capability studies, short-run control charts. (0307-712 or equivalent) **Credit 3 or 4**

0307-731 Statistical Acceptance Control
How to apply modern process-oriented sampling plans to assess performance of product and processes. Topics include single, double, multiple and sequential sampling plans, variables sampling, techniques for sampling continuous production, skip-lot plans, chain plans, AOQL schemes, AQL sampling systems and recent contributions to the literature. (0307-712 or equivalent) **Credit 3 or 4**

0307-742 Statistical Computing
This course focuses on the programming language used in SAS statistical software to read in raw data, create and manipulate SAS data sets, and create SAS macros. This course covers the material required for "SAS Base Programmer" certification. Students seeking employment in statistical professions are encouraged to attain this certification. Corresponding Minitab commands and macro programming will also be covered. (0307-712 or equivalent) **Credit 3**

0307-751 Mathematics for Statistics
This is a survey of the mathematical tools of some of the more rigorous statistics courses of the MS program. The topics include partial and higher-order differentiation, various methods of integration, the gamma and beta functions, and a brief overview of linear algebra, all in the context of application to statistics. (The course assumes calculus prerequisites for the program have been met; it is not a substitute for the program's calculus requirements.) (0307-712 or equivalent) **Credit 3**

0307-770 Design of Experiments for Engineering and Science
This course covers the fundamentals of the logical and economical approach to the design and analysis of engineering, scientific and industrial experiments. It integrates the essential organizational aspects of experimentation with proven statistical approaches. Designs covered include the two-level factorial and fractional factorial, response surface designs (CCD), blocking designs when randomization is restricted, and nested designs to uncover sources of variation. The appropriate analysis methods complement the designs. Simulation modeling and robust design show the power and applicability of the information derived from the designed experiments. This course is intended for non-CQAS students. It does not count as credit for either the CQAS advanced certificates or MS degree. (1016-314 or 1016-319 or 1016-351 or 0307-712 or equivalent) **Credit 4**

0307-772 Applied Survey Design and Analysis
This course is an introduction to sample survey design with emphasis on practical aspects of survey methodology. Topics include survey planning, sample design and selection, survey instrument design, data collection methods, and analysis and reporting. Application areas discussed will include program evaluation, opinion polling, customer satisfaction, product or service design, and evaluating marketing effectiveness. Data collection methods to be discussed will include face-to-face, mail, Internet and telephone. (0307-712 or equivalent) **Credit 3 or 4**

0307-781 Quality Management
This course focuses on ASQ's Certified Quality Manager body of knowledge and introduces process improvement methodologies, including the Six-Sigma framework. Topics include quality standards and awards, organization for quality, customer satisfaction, continuous improvement, team management, quality costs, project management, and process improvement methodologies. **Credit 3 or 4**

0307-782 Quality Engineering
This course, in conjunction with 0307-781, covers the non-statistical elements in ASQ's Certified Quality Engineer body of knowledge. Topics include quality philosophies, elements of a quality system, quality planning, supplier management, quality auditing, quality and management tools, process and material control, measurement systems, and safety and reliability. **Credit 3 or 4**

0307-801 Design of Experiments I
Topics include completely randomized designs, randomized complete block designs, Latin square designs, incomplete block designs; general factorial designs, including fixed, random, and mixed-effects models and expected mean squares; nested designs; split-plot designs. (0307-712 or equivalent) **Credit 3 or 4**

0307-802 Design of Experiments II
How to design and analyze experiments, with an emphasis on applications in engineering and the physical sciences. Topics include the role of statistics in scientific experimentation; general principles of design, including randomization, replication, and blocking; replicated and unreplicated two-level factorial designs; two-level fractional-factorial designs; response surface designs; evolutionary operation. (0307-801) **Credit 3 or 4**

0307-803 Design and Analysis of Experiments III
A continuation of the DOE sequence, covering more advanced, but applied, topics and providing a strong foundation for handling complex and nonstandard situations. Topics include design and analysis of general, complete balanced designs, including continued study of variance components, mixed models, split-plot, and arbitrarily complex "no-name" designs; restricted and unrestricted forms of the model; design and analysis of general unreplicated designs; optimal designs for non-standard situations, using D optimality and related criteria. (0307-802, 841; 0307-742 suggested) **Credit 3**

0307-821 Theory of Statistics I
This course introduces the student to the fundamental principles of statistical theory while laying the groundwork for study in the course sequel and future reading. Topics include classical probability, probability mass/density functions, mathematical expectation (including moment-generating functions), special discrete and continuous distributions, and distributions of functions of random variables. (1016-273 or equivalent and any of 0307-362/714, 1016-352 or equivalent) **Credit 3**

0307-822 Theory of Statistics II
Building on foundations laid in the first course, this second course in statistical theory answers some of the "How?" and "Why?" questions of statistics. Topics include the sampling distributions and the theory and application of point and interval estimation and hypothesis testing. (0307-821) **Credit 3**

0307-824 Probability Models
An introduction to stochastic processes, this course is intended to encourage a greater appreciation of statistical theory. Topics include Poisson processes and their relationship to uniform, exponential, gamma and beta distributions; the basics of queuing theory; and discrete-time Markov chains. Characteristic functions and using Taylor series to approximate the mean and variance of functions of one or more random variables are among miscellaneous topics. (0307-821) **Credit 3**

0307-830 Multivariate-Analysis Theory
Multivariate data are characterized by multiple responses. This course concentrates on the mathematical and statistical theory that underlies the analysis of multivariate data. Some important applied methods are covered. Topics include matrix algebra, the multivariate normal model, multivariate t-tests, repeated measures, MANOVA and principal components. (Basic matrix algebra; 0307-712 or equivalent; 0307-801 is useful; 0307-822 recommended; 0307-742 suggested) **Credit 3**

0307-831 Multivariate-Analysis Applications
This course includes some theory, but concentrates on the applications of multivariate analysis methods. The course relies heavily on the use of computer software. Topics include principal components, factor analysis, canonical correlation, discriminant analysis, cluster analysis and scaling. (Basic matrix algebra; 0307-712 or equivalent, 0307-830 is useful; 0307-742 suggested) **Credit 3 or 4**

0307-834 Multivariate Statistics for Imaging Science
This course introduces multivariate statistical techniques and shows how they are applied in the field of Imaging Science. The emphasis is on practical applications, and all topics will include case studies from imaging science. Topics include the multivariate Gaussian distribution, principal components analysis, singular value decomposition, orthogonal subspace projection, cluster analysis, canonical correlation and canonical correlation regression, regression, multivariate noise whitening, least squares energy minimization, and signal-to-noise optimization with generalized eigenvector (matched filter). This course is intended for students from the Imaging Science department. It does not count as credit for either the CQAS advanced certificates or CQAS MS degree. (Basic matrix algebra; 0307-712 or equivalent; 0307-841 or equivalent recommended) **Credit 4**

0307-841 Regression Analysis I
A course that studies how a response variable is related to a set of predictor variables. Regression techniques provide a foundation for the analysis of observational data and insight into the analysis of data from designed experiments. Topics include happenstance data versus designed experiments, simple linear regression, the matrix approach to simple and multiple linear regression, analysis of residuals, transformations, weighted least squares and introduction to dummy variables. (0307 712 or equivalent; 0307-801 is useful) **Credit 3 or 4**

0307-842 Regression Analysis II
A continuation of 0307-841. Topics include dummy variables, orthogonal polynomials, selection of best linear models, regression applied to analysis of variance problems, the geometry of least squares, ridge regression, generalized linear models, nonlinear estimation, and model building. (0307-841; 0307-742 suggested) **Credit 3 or 4**

0307-846 Statistical Data Mining I
This course is designed to give the student the foundational tools to help discover and navigate the increasingly popular field of statistical data mining. We provide a gentle yet thorough introduction to supervised learning with topics such as multiple linear and nonlinear regression, pattern recognition using techniques such as logistic regression and support vector machines. We also cover unsupervised learning, featuring cluster analysis, feature selection, dimensionality reduction and latent variable models. The course culminates with modern techniques of model selection and model aggregation. (702, or 714 and 841, or permission of instructor) **Class 3, Credit variable 3–4**

0307-851 Nonparametric Statistics
This course emphasizes how to analyze certain designs when the normality assumption cannot be made, with an emphasis on applications. This includes certain analyses of ranked data and ordinal data. The course provides a review of hypothesis testing and confidence interval construction. Topics include sign and Wilcoxon signed-rank tests, Mann-Whitney and Friedman tests, runs tests, chi-square tests, rank correlation, rank order tests and Kolmogorov-Smirnov statistics. (0307-801) **Credit 3**

0307-856 **Interpretation of Data**
How to use statistics in troubleshooting processes and interpreting data. Topics include coordination of use of statistical measures, employing control charts in data analysis, outlier tests, analysis of small-sample data, narrow-limit gauging, analysis of means for variables and attributes data, identification of assignable causes. (0307-801) **Credit 3**

0307-862 **Reliability Statistics I**
A methods course in statistical aspects of reliability. Topics include applications of normal, log-normal, exponential and Weibull models to reliability problems; censored data; probability and hazard plotting; series systems and multiple-failure modes; maximum likelihood estimation; introduction to accelerated-life models and analysis. (1016-282 or equivalent, 0307-801, 841. 0307-822 is strongly recommended as a prerequisite or corequisite) **Credit 3**

0307-873 **Time Series Analysis and Forecasting**
A course in statistical methods for modeling and forecasting of time series data with emphasis on model identification, model fitting and diagnostic checking. Topics include survey of forecasting methods, regression methods, moving averages, exponential smoothing, seasonality, analysis of forecast errors, Box-Jenkins models, and transfer function models. (0307-841) **Credit 3 or 4**

0307-883 **Quality Engineering by Design**
This course introduces the Taguchi approach to off-line quality control including loss function, signal-to-noise utility function, parameter design and tolerance design, leading to improved products and processes at lower costs. During the presentations of the Taguchi concepts, full attention is given to the controversial aspects of these methods, the basis for the controversies, and alternatives to the methods that follow better statistical protocol. Students get to see the power of robust design in a set of carefully constructed exercises that illustrate the major components of parameter design and tolerance design. (0307-802; 0307-742 suggested) **Credit 3**

0307-884 **Categorical Data Analysis**
The course develops statistical methods for modeling and analysis of data for which the response variable is categorical. Topics include: contingency tables, matched pair analysis, Fisher's exact test, logistic regression, analysis of odds ratios, log linear models, multi-categorical logit models, ordinal and paired response analysis. (0307-841) **Class 3, Credit 3-4**

0307-886 **Sample Size Determination**
This course presents procedures to determine the proper sample size needed for the most commonly applied statistical methods. Topics include confidence intervals and hypothesis tests for the parameters of applied distributions and approximations to distributions. Sample size determination for designed experiments is covered extensively. (0307-818) **Credit 3**

0307-889 **Independent Study Project**
Credit will be assigned at the discretion of the candidate's instructor and will depend on the extent of the project. A written proposal is required of the candidate and may be modified at the discretion of the instructor before approval is given to proceed. (Consent of instructor) **Credit 1, 2, 3, 6 or 9**

0307-891 **Special Topics in Applied Statistics**
This course number provides for the presentation of subject matter of important specialized value in the field of applied statistics not offered as a regular part of the statistics program. (Consent of instructor) **Credit 3**

0307-894 **Capstone**
This course is designed to provide a capstone experience for MS students at the end of the graduate studies, and will require a synthesis of knowledge obtained from earlier course work (0307-742, 802, 822, 842 and consent of instructor) **Credit 3**

0307-895 **Statistics Seminar**
This course, required for full-time students, offers opportunities for additional learning through formal seminars, informal presentations, and special projects. **Credit 0**

0307-896 **Thesis**
For students working for the MS degree who are writing a research thesis. (Consent of department chair) **Credit 3, 6 or 9**

0307-899 **Individual Achievement Project**
Research project under faculty supervision for students working for the MS degree. (Consent of faculty supervisor) **Credit 1–9**

Microsystems Engineering

0308-701 **Lasers**
This course introduces students to the design, operation and applications of lasers (Light Amplification by Stimulated Emission of Radiation). Topics: Ray tracing, Gaussian beams, Optical cavities, Atomic radiation, Laser oscillation and amplification, Mode locking and Q switching, and Applications of lasers. Graduate students will have additional requirements. (0301-482) **Class 4, Credit 4**

0308-702 **Introduction to Nanotechnology and Microsystems**
This course will introduce first year Microsystems Engineering students to microsystems and nanotechnology. Topics include, micro and nano systems; MEMS, bioMEMS, MOEMS, and NEMS; nanomaterials; nanopatterning; characterization and analytical techniques; self-assembly approaches; nanoelectronics and nanophotonics; nanomagnetics; organic electronics; and microfluidics. The course will be taught by faculty in the individual fields of nanotechnology and microsystems. **Class 4, Credit 4**

0308-703 **Material Science for Microsystems Engineering**
To provide an introduction to the operating principles of optoelectronic devices used in various current and future information processing and transmission systems. Emphasis in this course will be on the active optoelectronic devices used in optical fiber communication systems. Topics include pulse propagation in dispersive media, polarization devices, optical fiber, quantum states of light, fundamental of lasers, semiconductor optics, light-emitting diodes, laser diodes, semiconductor photon detectors, optical modulators, quantum wells, and optical fiber communication systems. (0301-482) **Class 4, Credit 4**

0308-704 **Quantum Mechanics for Engineers**
This course gives students comprehensive understanding of the foundations of quantum mechanics. The course also provides practical solution techniques which can be applied to a variety of nanoscale problems. Topics include: Waves and Schrodinger's equation; Time-dependent Schrodinger equation; Operator approach to quantum mechanics; Dirac Notation; Solution approaches and approximation methods; Time-dependent perturbation theory with applications to absorption and Fermi's golden rule. If time allows: Angular momentum and the Hydrogen Atom; Spin. (1016-306 or equivalent, 0301-453 or equivalent) **Class 4, Credit 4**

0308-711 **Microsystem Fundamentals**
This course covers the fundamentals of microsystems with emphasis on a broad range of applications. The course covers the underlying principles of micro-actuators and micro-sensors; analysis and modeling of micro-devices; scaling laws; microfluidics; photonics; microsystems fabrication processes; microelectromechanical (MEMS) and micro-optoelectromechanical (MOEMS) systems analysis; applications in the fields of telecommunications and sensing will be presented. **Credit 4, Lecture**

0308-712 **Nonlinear Optics**
This course introduces nonlinear concepts applied to the field of optics. Students learn how materials respond to high intensity electric fields and how the materials response: enables the generation of other frequencies, can focus light to the point of breakdown or create waves that do not disperse in time or space (solitons), and how atoms can be cooled to absolute zero using a laser. Students will be exposed to many applications of nonlinear concepts and to some current research subjects, especially at the nanoscale. Students will also observe several nonlinear-optical experiments in a state-of-the-art photonics laboratory. (0301-482) **Class 4, Credit 4**

0308-720 **Independent Study**
This course number should be used by students who plan to study a topic on an independent basis under the guidance of a faculty member. A written proposal with an independent study form is to be submitted to the sponsoring faculty member and approved by the program director prior to the commencement of work. **Credit 4**

0308-721 **Micro-optics**
This course covers the propagation and diffraction of light and micro-optical components. Subjects covered: diffraction, Fourier optics, diffractive optical elements analysis and design, fabrication of micro-optic components and micro-optics for microsystems applications. (0301-474 or equivalent) **Class 4, Credit 4**

0308-731 **Integrated Optical Devices and Systems**
This course covers principles, analysis and design of integrated optical devices and systems. The integration of various active and passive optoelectronic devices in a system is the focus of the course. Topics include optical waveguides, optical couplers, semiconductor lasers, modulators, optical detectors, micro-optical resonators, photonic crystals, optical signal processing systems, design tools, fabrication techniques, and the applications of optical integrated circuits. Some of the current state-of-the-art devices and systems will be investigated by reference to journal articles. **Class 4, Credit 4**

0308-751 Microsciences and Microsystems Design
This course covers fundamental issues and design concerns used to construct microelectromechanical Systems (MEMS) devices. Subjects include: micro fluid science, microscale heat transfer, mechanical behavior of microstructures, as well as design, simulations and optimization of micro devices. Course is intended for engineering students, for Microsystems Engineering and other related disciplines. (1017-313) **Class 4, Credit 4**

0308-771 Optoelectronics
This course provides an introduction to the operating principles of optoelectronic devices used in various digital transmission and information processing systems. Emphasis is on the generation (via lasers) and detection of optical signals. Topics covered: (1) geometrical optics, interferometry, and polarization; (2) photons in semiconductors, semiconductor photon sources (light-emitting diode and laser diode), semiconductor photon detectors, and modulators; (3) optoelectronic systems and related engineering applications. (0301-482) **Class 4, Credit 4**

0308-786 MEMS Design
Microelectromechanical systems (MEMS) are widely used in aerospace, automotive, biotechnology, instrumentation, robotics, manufacturing and other applications. There is a critical need to synthesize and design high-performance MEMS that satisfy the requirements and specifications imposed. Integrated approaches must be applied to design and optimized MEMS, which integrate microelectromechanical motion devices, ICs, and microsensors. This course covers synthesis, design, modeling, simulation, analysis, control and fabrication of MEMS. Synthesis, design and analysis of MEMS will be covered including CAD. (5th year BS/MS, MS and PhD students) **Class 4, Credit 4**

0308-798 Microfluidic MEMS
The course begins with an overview of microfluidic technology to provide a framework and to clarify the relationship of microfluidics to microelectromechanical systems (MEMS) and microsystems in general Three major topics comprise the course: 1) selected elements of dic dynamics theory, and the scaling and application of that theory to microscale dimensions; 2) design, fabrication, and characterization of microfluidic devices and microsystems including exploration of major alternative fabrication technologies, process integration and materials issues, and device- and system-level packaging/encapsulation challenges; 3) applications, including microvalves, micropumps, microflow control sensor, and devices for chemical and biochemical valves, micropumps, microflow control sensor, and devices for chemical and biochemical analysis. **Class 4, Credit 4**

0308-799 Nano and Microengineering
This course focuses on analysis and synthesis of nano- and micro electromechanical systems and devices. Synthesis, design, optimization, analysis, control and fabrication of nano and microsystems will be covered. Utilizing basic physical laws of nano and micro-engineering, distinct systems and devices will be examined. The application of nano and microengineering in nanocomputers, avionics, security and transportation will be emphasized. Specific applications included are: super fast data processing and computing, data storage, imaging, molecular intelligent automata, etc. **Class 4, Credit 4**

0308-804 MEMS Evaluation
This course focuses on evaluation of MEMS, microsystems and microelectromechanical motion devices utilizing MEMS testing and characterization. Evaluations are performed using performance evaluation matrices, comprehensive performance analysis and functionality. Applications of advanced software and hardware in MEMS evaluation will be covered. (0301-786, 0305-870) **Class 4, Credit 4**

0308-811 Microsystem Design and Packaging
Design considerations; design process; mechanical design; photonic design; modeling; system integration; packaging technologies; microsystems packaging; assembly of microsystems; testing; design case studies. (0308-711) **Class 4, Credit 4**

0308-821 Micro-Optics and Photonics
Light propagation; passive optical components; micro-optics; digital devices; laser diodes; photodiodes; micro-optical systems; design case studies. (0308-711) **Class 4, Credit 4**

0308-831 Micro and Nano-Photonics
This course covers the generation and propagation of light in guided media. Subjects covered: two and three-dimensions slab wave guides, coupled-wave analysis, wave guide modeling and design, photonic crystals structures, photonic band gap devices in one and two dimensions and fabrication of photonic wave guides. (0308-721) **Class 4, Credit 4**

0308-841 Advanced Microphotonics
This course covers the latest advances in the field of microphotonics as published in the current literature. Subjects covered will include: silicon photonics as applied to light generation, detection and guiding, photonic crystals and microring resonators. The class format will be based on reviewing, analyzing and critiquing recent published research results in this field. Active student participation is required. (0308-721) **Class 4, Credit 4**

0308-890 Dissertation and Research
Research in an appropriate topic as arranged by doctoral candidate and dissertation advisor in fulfillment of the dissertation requirement. Department approval required. **Credit 0–4**

0308-990 Doctoral Dissertation I
Research in an appropriate topic as arranged by doctoral candidate and dissertation advisor in fulfillment of the dissertation requirement. Departmental approval required. **Credit 4**

0308-991 Doctoral Dissertation II
Research in an appropriate topic as arranged by doctoral candidate and dissertation advisor in fulfillment of the dissertation requirement. **Credit 8**

College of Health Sciences and Technology

Richard Doolittle, Acting Dean

Programs of study

Master of Science degrees in:		Page
	Clinical Chemistry*	121
	Health Systems Administration	121

Master of Fine Arts degree in:		
	Medical Illustration	123

Advanced Certificates in:		
	Elements of Health Care Leadership	123
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*This program has been approved for discontinuance. No new students will be admitted for the 2011-12 academic year.

RIT recently established the College of Health Sciences and Technology to respond to the growing need for well-educated professionals in the heath care field.

The United States faces a looming shortage of many types of health care professionals, including nurses, physicians, dentists, pharmacists, and allied health workers. The college, housed in the Institute of Health Sciences and Technology, serves as an independent academic and research entity designed to provide a focused, interdisciplinary, and systems approach to innovative health care education, applied/translational research, and community outreach. The institute incorporates three major thrusts: the College of Health Sciences and Technology, a Health Science Research Center, and a Health Science Community Collaboration and Outreach Center.

The college is offers clinically related and biomedical research-based programs to meet both the present and future needs of the health care system. The college's faculty and staff are committed to delivering high quality educational programs. Building on a foundation of liberal arts and basic sciences, students will gain advanced knowledge in theoretical science and practical applications in experiential learning environments. These experiences prepare students to serve as practitioners, scientists, and leaders through their contribution to, and the provision of, high quality patient care, health care service, and/or applied, translational biomedical research.

Admission requirements

The college offering the program makes all decisions on graduate admission. Please refer to each individual program for information regarding specific admission criteria. For general graduate admission information, please refer to the Admission section of this bulletin.

Financial aid and scholarships

Please refer to the Financial Aid and Scholarship section of this bulletin for information regarding financial aid, scholarships, grants, loans, and graduate assistantships.

Faculty

Faculty members in the college have considerable experience in their respective fields of discipline. Basic science and clinical faculty work side-by-side to provide students with a comprehensive learning experience to prepare them for their chosen health care related career.

Facilities and resources

In addition to facilities shared with the College the Science and the College of Imaging Arts and Sciences, the Center for Bioscience Education and Technology (CBET) provides a comprehensive environment to support academic, community, and career-training programs in the emerging life and medical sciences. The facility consists of multi-purpose, high-tech laboratories and classrooms for work-force development, academic programs, con-

tinuing education programs, research, K-12 student workshops, and secondary school training programs.

Study options

Most graduate programs offer a variety of study options, including full-time, part-time, and online study. Please refer to each individual program for specific information regarding these options.

Clinical Chemistry, MS

http://www.rit.edu/cos/medical/clinical_chemistry.html

James C. Aumer, Interim Director
(585) 475-2526, jcascl@rit.edu

ADMISSION TO THIS PROGRAM HAS BEEN SUSPENDED. NO NEW STUDENTS WILL BE ADMITTED FOR THE 2011-2012 ACADEMIC YEAR.

The clinical chemistry program is designed for full- or part-time graduate study. Required courses are offered regularly during the late afternoon or evening in order to accommodate the work schedules of part-time students.

The program is designed to provide a focused educational experience for individuals preparing for careers in clinical chemistry. The design of the program provides technical and managerial proficiencies in either the diagnostic laboratory or a related industry.

Curriculum

The program includes a core curriculum and electives that are chosen to reflect the student's background and career goals. A minimum of 50 quarter credit hours beyond the bachelor's degree is required.

Required courses

1009-702	Biochemistry: Biomolecular Conformation and Dynamics
1009-703	Biochemistry: Metabolism
1008-711, 621	Instrumental Analysis and Lab
1016-719	Biostatistics
1023-705	Mechanisms of Disease
1023-820, 821, 822	Advanced Clinical Chemistry I, II, III
0102-740	Organizational Behavior and Leadership
Plus one of the following courses:	
1023-877	External Clinical Chemistry Research
1023-879	Internal Clinical Chemistry Research

All students are required to carry out and defend original research as part of the program requirements. Research is carried out under the direction of a faculty member and is reviewed and defended before a graduate committee appointed by the program director.

Students in the clinical chemistry program come from diverse educational backgrounds and have a variety of professional goals. The program focuses on the activities of the diagnostic clinical laboratory, developmental research in pathology, and diagnostic testing, as well as industrial activities related to clinical laboratory products and instruments.

Admission requirements

To be considered for admission to the MS program in clinical chemistry, candidates must fulfill the following requirements:

- Hold a bachelor's degree in chemistry, biology, medical technology, nuclear medicine technology, or a related field from an accredited college or university,
- Submit transcripts (in English) from all previously completed undergraduate and graduate course work,
- Submit a statement outlining the candidate's research/project interests, career goals, and suitability to the program,
- Have an undergraduate cumulative GPA of 3.0 or higher,
- Submit two letters of recommendation, and
- Complete a graduate application.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language (TOEFL). A minimum score of 575 (paper-based), 233 (computer-based), or 90-91 (Internet-based) is required. International English Language Testing System (IELTS) scores will be accepted in place of the TOEFL exam. Minimum scores will vary; however, the absolute minimum score required for unconditional acceptance is 6.5. For additional information about the IELTS, please visit www.ielts.org.

All students who do not speak English as their primary language are required upon arrival to take the Michigan Test of English Proficiency, administered by the English Language Center. If a student's score is below standard, the center will make recommendations for additional course work. Successful completion of this work is a program requirement for the degree. This may mean students will need additional time and financial resources to complete the degree program.

Health Systems Administration, MS

http://www.rit.edu/healthsystems

Linda Underhill, Graduate Program Chair
(585) 475-7359, lmuism@rit.edu

Program overview

The MS in health systems administration is designed to provide strategic skills for today's health care management. Now, as never before, health care is rapidly transforming. The pace of technology and innovation are changing how, when, and where health care is provided, and who is providing it. Concurrently, health care customers have high expectations for quality and responsiveness to their needs—delivered in a cost-effective manner.

To provide these strategic skills to health care management, the MS in health systems administration builds on a foundation of courses in policy and law formation, health care economics, innovation, and leadership. Additional options are provided through

course selections, building an integrated program that meets the individual challenges of participating students.

The program is available online, allowing students to pursue their degree while maintaining full-time employment in locations around the world. Another distinct advantage is the diversity of our student population, allowing for creative discussion and comprehension of global health care issues and how these relate to the standards and practices of the American health care system. The ability to share information and ideas, and to contrast and compare strategies, allows students a level of creativity and scope of practice not found in the traditional classroom.

RIT provides excellent online learning support that leads the student through registration and use of distance learning tools. In addition, for select subject areas, the health systems administration program plans special learning sessions that blend presentation styles. This could be through attendance at seminars in locations throughout the country or on the RIT campus. These formats provide a combination of both distance learning and interaction with presenters who provide a strategic view of health care delivery models.

Curriculum

The program requires 48 credit hours at the graduate level and can be completed in approximately two years by taking two courses per quarter. Students may take longer to complete the course work by reducing their workload to one course per quarter. However, students must complete their degree requirements within seven years of the date of the oldest course identified on their RIT course records. Students must maintain a 3.0 average throughout their academic career. Toward the end of their program of study, students will complete a capstone course focusing on a business plan/case for an innovative topic related to their work environment. The paper is developed and written within a course that is taken during the last year of study for the degree. Upon matriculation, each student works with the program chair for advice and direction to develop a plan of study.

Required core courses

0626-714	Data Analysis/Metrics
0625-842	Breakthrough Thinking, Creativity and Innovation (Capstone)
0635-840	Health Systems Policy and Law
0635-820	Health Systems Economics and Finance
0624-770	Service Leadership
0635-712	Library Research
0635-718	Research Writing

Concentrations

Elements of heath care leadership

0635-830	Health Systems Planning
0635-882	Bioethics
0625-842	Customer Relationship Management
0625-750	Elements of Service

Senior living management

0635-716	Law and Policy in Senior Living
0626-891	Human Capital Strategies
0625-842	Customer Relations Management
0635-798	Aging in America

Health systems finance

0635-815	Finance for Operations
0635-798	Risk Management
0635-881	Strategies for Health Care Accountability
0635-881	Health Insurance Reimbursement

Electives

Students must also complete a total of 12 credit hours of electives. Students may fulfill electives from other concentrations or from other graduate courses offered in the School of International Hospitality and Service Innovation with permission of their adviser and program chairs.

Thesis/Capstone/Comprehensive exam options

All students must complete a thesis, a capstone project, or a comprehensive exam to complete their degree program. In conferring with their academic adviser, students may choose a thesis or capstone project topic that complements the candidate's undergraduate training, career experiences, and graduate interests. Both the thesis or capstone project is a formal document that reflects the candidate's professional preparation and should be of an applied research genre. Graduate faculty will assist the student in selecting a relevant thesis/project topic.

The comprehensive exam focuses on knowledge of the core competencies, theory and foundation principles, and application of this knowledge to a variety of scenarios.

Admission requirements

To be considered for admission to the MS program in health systems administration, candidates must fulfill the following requirements:

- Hold a baccalaureate degree at a regionally accredited college or university,
- Have a cumulative GPA of 3.0 or above (or superior endorsement),
- Submit two letters of reference from individuals who have the opportunity to observe the applicant's work output,
- Submit official transcripts (in English) of all previously completed undergraduate and graduate course work,
- Complete an interview with the program chair (for those without health care experience), and
- Complete a graduate application.

It is recommended that applicants have a minimum of three years of experience in a health care or health-related organization as either a practitioner or manager. Applicants who do not meet this requirement may be asked to complete certain undergraduate courses as a bridge for the content knowledge required for the graduate program. They may also be required to complete a graduate level internship in health care prior to graduation.

All credentials must be submitted and reviewed by faculty prior to the completion of 12 credit hours of graduate work in the program.

Medical Illustration, MFA

Program overview

The MFA program in medical illustration enables students to exhibit critical and creative thinking and problem solving through the accurate translation of medical and scientific concepts into effective visual support for instruction or advertisement. Students utilize effective research techniques and demonstrate efficient use of time and resources during concept and development of projects to satisfy course assignments. Entrance requirements include one year of biology and three of the following areas of study: histology, embryology, immunology, genetics, pathology, or cellular physiology.

Curriculum

The degree requirements in the MFA medical illustration program include:

COURSE	QTR. CR. HRS.
Major	36
Minor	15
Electives	15
Humanities	10
Thesis	14
Total	**90**

Admission requirements

To be considered for admission to the MFA in medical illustration, candidates must fulfill the following requirements:

- Hold a baccalaureate degree in a field of the arts, sciences, or education from a regionally accredited college (The undergraduate degree should include 75 quarter credit hours (50 semester hours) in studio courses,
- Demonstrate, through the quality of the undergraduate record and creative production, a genuine, professional potential,
- Submit transcripts (in English) of all previously completed undergraduate and graduate course work, and
- Complete a graduate application.
- International students, whose native language is not English, must submit scores from the Test of English as a Foreign Language. Minimum scores of 550 (paper-based) or 80 (Internet-based) are required. Scores from the International English Language Testing System may be submitted in place of the TOEFL. A minimum score of 6.5 is required. Those applicants coming from countries where the baccalaureate degree is not awarded for programs in the practice of art may be admitted to graduate study if the diploma or certificate received approximates the standards of the BFA, BA, or BS degrees, and if their academic records and portfolios indicate an ability to meet graduate standards.

Elements of Health Care Leadership, Adv. Cert.

Program overview

The elements of health care leadership certificate strives to meet the changing needs of health care professionals.

The certificate prepares professionals in a particular areas of expertise, updates a set of skills, or assists in a career change. It may serve as a stand-alone certificate or, at a later date, if a student decides to pursue the MS program in health systems administration, three of the four courses may be applied toward the program's requirements. To meet the needs of working professionals, courses are taught online.

Curriculum

The advanced certificate in health care leadership is comprised of the following courses:

0635-882	Bioethics
0635-830	Health Systems Planning
0625-842	Customer Relationship Management
0625-750	Elements of Service

Senior Living Management, Adv. Cert.

Program overview

The senior living management certificate strives to meet the changing needs of health care professionals.

The certificate prepares professionals in a particular area of expertise, updates a set of skills, or assists in a career change. It may serve as stand-alone certificate or, at a later date, if a student decides to pursue the MS program in health systems administration, three of the four courses may be applied toward the program's requirements. To meet the needs of working professionals, courses are taught online.

Curriculum

The advanced certificate in senior living management is comprised of the following courses:

0635-716	Law and Policy in Senior Living
0635-798	Aging in America
0625-842	Customer Relationship Management
0626-735	Human Capital Strategies

College of Health Sciences and Technology

Health Systems Administration

Linda Underhill, RD, BS, MS, Rochester Institute of Technology; Ph.D., State University of New York at Buffalo—Graduate Program Chair; Associate Professor

Medical Illustration

Glen Hintz, BA, Lafayette College; MS, The Medical College of Georgia—Associate Professor

James Perkins, BA, Cornell University; MFA, Rochester Institute of Technology; ABD, University of Rochester—Associate Professor

Health Systems Administration

0635-712 **Library Research Methods**
This course is to instruct the learner how to conduct research using the tools the RIT library can provide. Fundamentals include use of on-line search engines and databases. (Required for HSA graduate students, available for HSM graduate students) **Credit 1**

0635-715 **Information Systems in Health Administration**
Theory and use of computers and information systems in health care delivery and administration is covered in depth. The information needs of clinical and administrative personnel are examined with an emphasis on developing and evaluating comprehensive information systems for health care organizations. **Credit 4**

0635-714 **Data Analysis**
This course will allow the learner to read and evaluate statistical information presented in evaluation reports used in health care management. (Required for HSA students, available for HSM graduate students) **Credit 2**

0635-716 **Law Policy Senior Retirement Living Options**
Retirement living in the United States has evolved to be a significant industry. Legislation and regulations govern the continuum of care for the independent as well as corporate organizations that provide senior living. The purpose of this course is to review the federal and state regulations governing senior retirement living, discussion of senior living models and the leadership requirements to operate and manage such facilities. **Credit 4**

0635-718 **Writing Research**
In preparation for writing a capstone project this course provides guidelines and practice in producing researched writing for analysis, definition, comparison and/or benchmarking. (Required for HSA Students, available for HSM graduate students) **Credit 1**

0635 723 **Lean Sigma Applications in Health Care**
This course teaches the principles of Lean-Sigma and the application of its process improvement methodologies (and tools) in a health care environment. The history of lean and key principles of six sigma will be discussed. The merging of these two powerful process improvement methodologies will be examined in the context of health care. The Toyota Production System (TPS) and its key leadership principles will be analyzed. The curriculum examines the current challenges encountered in the healthcare industry and the application of Lean Sigma to improve overall performance specifically in the clinical, administrative and service segments.(Elective for HSA graduate students) **Credit 4**

0635-752 **Clinical Information Systems**
This course will present an overview of several of the evolving clinical information systems present in the healthcare marketplace. A sampling of computerized systems including those found in the hospital, payer, nursing home, physician office, and other healthcare settings will be explored. Emphasis will be placed on the understanding of the changes involved in transitioning from manual systems to computerized systems in each of the above named areas. In particular, the student will be exposed to a variety of current technologies, which are being deployed in these areas. The benefits of the use of such technology will be analyzed and the requirements for planning and deployment of such systems will also be studied. (Health care information systems 0635-715-90, introductory technology/systems course or relevant experience. Computer systems hardware and software in health care recommended)

0635-753 **Health Administration Applications**
This course presents an overview of the various types of application used in the health administration arena. Emphasis will be placed on understanding the terminology and functionality of the basic software components that make collect and utilize health care data for administrative support and decision-making as well as insurance, billing and reimbursement. Students will examine the software infrastructure needed to support health care enterprises such as hospitals and smaller health care entities. The goal of this course is to provide students with a sufficient application familiarity so they can make meaningful IT and IT decisions. **Class 4, Credit 4**

0635-754 **Ehealth**
This course will give students a broad overview of essential concepts in, and applications of, web based technologies in healthcare. EHealth topics covered will include review, discuss and analyze industry trends explore emerging ECare solutions and investigate EHealth ethical guidelines and governmental regulations established to ensure privacy, standardization and health content reputability. **Credit 4**

0635-777 Health Systems Administration Internship
This is a health systems administration internship. Consists of a professional placement in an appropriate health care organization of at least 240 hours. Required for students without health care work experience. Can be taken in place of electives. Students will arrange with their program chair or assigned adviser, negotiate any arrangement necessary for on-site supervision and develop a written proposal. Students will present an oral evaluation of their experiences at the final course seminar. **Variable credit 2–8**

0635-796 Risk Management in Health Systems
This course identifies the risk inherent within health care- institutions, organizations, agencies and for individual providers. The management of risk is explored as part of a strategic response of an organization or individual within health care. Specifically the risk inherent within health care organizations; in communications and sharing of data; in the embracing of new technologies and drug treatment therapies; and the expectations of corporate compliance will be discussed. The role of quality assurance will be reviewed as a strategy to control risk. **Credit 4**

0635-798 Special Topics
Experimental courses are offered under this number. Titles appear in each quarter's course listing. **Credit 1–5**

0635-815 Finance for Operation
This course is an introductory course that examines the responsibilities of the finance function in health care entities and its relations to the operating responsible centers (or departments). Subject matter is broad enough to include both not-for-profit and for profit organizations in the allied health field. While this is a distance learning course, students are invited to participate in the first two on-campus lectures (attendance is optional, and those not attending will receive a videotape of the campus sessions). Topics include terminology and measurement, cost finding and allocation, budgeting and the budgeting process, report, reimbursement, interpretation of financial statements, and facilities and materials management. Students must be matriculated in the health systems masters program or have permission of the department chairperson. **Credit 4**

0635-820 Health Systems Economics and Finance
Investigation of the efficiency, effectiveness and equity of the economics of health care and a conceptual and practical knowledge of health care finance. Reviews sources of funding, the accounting and reporting process, and the influence of third-party payers on the provision of health care through applied exercises. Provides an integrated overview of managerial economics, financial management, and product management for distinct health care organizations composing the overall health care system. (Accounting Concepts for Managers) **Credit 4**

0635-830 Health Systems Planning
A review of the methodology of planning effectively for health care systems. The use of data systems, forecasting, and identifying and analyzing problems is explored, along with the process of strategic planning, setting priorities, developing projects, and allocating resources. Students will prepare actual business plans and applications for new health care programs to regulatory agencies. (Permission of program chair) **Credit 4**

0635-840 Health Systems Policy and Law
An examination of the roles and responsibilities of policy makers on the health care system. Compares and contrasts the regulatory functions of varying levels of government and the political process as it relates to health care systems. Examination of control issues and regulatory dynamics, the legislative process, and regulatory trends in the United States. Assessment of health systems' strategies and responses to regulatory oversight. An overview of legislation as it applies to health facilities and administrative law using case studies. **Credit 4**

0635-881 Health Insurance Reimbursement
An in-depth look at characteristics of successful managed care plans. The course will familiarize the student with all essential elements of managed care, using the tools needed to model and compare various managed care structures. **Credit 4**

0635-882 Bioethics
An overview of what ethics means, the principal ethical theories, and their application to specific bioethical issues. The course will familiarize students with ethics and ethical principles, the role of ethics in professional life, what is bioethics and an appreciation of ethical issues and arguments surrounding contemporary bioethical issues such as death, rationing health care and managed care. **Credit 4**

0635-890 Health Systems Administration Independent Study
Provides for independent study or research activity in subject areas not included in any existing course in the degree program, but having special value to students. Proposals approved by a supervising faculty member and the program chair are required prior to registration. This course may be taken more than once. **Variable credit 4–8**

0635-896 Health Systems Administration Thesis
An independent research project on a specific health system administration topic or problem, developed by the student with input from a faculty thesis adviser. The research must culminate in a formal written thesis and oral defense. Approval by the program chair and a faculty thesis adviser is required for this course. **Variable Credit 4–8**

Medical Illustration

2020-707 Contemporary Media for Interactive Portfolio
Students will create an interactive portfolio of their artwork and/or animations designed to attract potential clients and employers. The portfolio will be available for viewing on the World Wide Web and as a CD or DVD. It will include interactive navigation and be able to download vitae and promotional materials to site visitors. (2020-711) **Credit 3**

2020-710 Anatomic Illustration Mixed Media
Students will learn to use raster painting software to modify scanned artwork and create new images from scratch. Students will also use page layout applications to combine digital images with text and other graphic elements. Course work emphasizes creation of illustrations to support medical education, for advertising, and to editorialize health and medical concepts. **Credit 3**

2020-711 Computer Animation and Interactivity I
This course continues advancement of animation skills used in Medical Illustration Topics II (2020-784). Students will create an interactive lesson using computer illustrations and two-dimensional computer animations designed for delivery via the World Wide Web. Course work will also require students to create "puzzles" and other games requiring interactive learner participation. (2020-784) **Credit 3**

2020-712 Computer Animation and Interactivity II
This course introduces variables as a tool in constructing tests designed to measure learner comprehension. Students will create interactive lessons that use animation and interactive teaching strategies to deliver instructional objectives to a specific audience. Learner interaction with the symbols and control of animation remains a prime focus of the course. (2020-784) **Credit 3**

2020-731 Human Gross Anatomy I
A two-quarter sequence devoted to the study of the human body. Detailed dissection of a human cadaver is supplemented with lectures on the structure and function of the major organ systems. Dissection focuses on the muscles of the torso, the contents of the thorax and abdomen, and the upper limb. **Credit 4**

2020-732 Human Gross Anatomy II
The second half of a two-quarter sequence devoted to the study of the human body. Detailed dissection of a human cadaver is supplemented with lectures on the structure and function of the major organ systems; with a detailed dissection of the head and neck and moves on to the pelvis, perineum, and lower limb. (2020 731) **Credit 4**

2020-761 3-D Modeling of Organic Forms
This course introduces students to NURB, Polygon, and Subdivision modeling techniques for creating virtual three-dimensional organic subjects. Accurate portrayal of the subject, including form, texture, and color are emphasized. Developing models from student drawings is required. **Credit 3**

2020-762 3-D Animation of Organic Forms I
Course work focuses on accurate animation of organic and/or biomedical subjects using three-dimensional computer modeling. All animations are intended for display on the World Wide Web. Projects are three dimensional animations that teach or portray an assigned topic.(2020-761 recommended) **Credit 3**

2020-763 3-D Animation of Organic Forms II
Students are introduced to three-dimensional computer animation using character rigging. Assignments focus on creating joint skeletons and binding three-dimensional surfaces to these "joints". Course work introduces manipulating surface deformations in response to movements and surface material. All animations are intended for display on the World Wide Web. Projects are "applied animations" that teach or portray an assigned topic. (2020-762 or permission of instructor) **Credit 3**

2020-767 **Molecular Illustration**
Accurate representations of molecular structures are essential to illustrate recent advances in biotechnology, medical genetics, and pharmacology. This course provides a basic overview of molecular biology and introduces the principles of molecular illustration. Students will locate three-dimensional molecular model files on the Internet and manipulate these models to create two- and three dimensional, and animated representations of molecules and biochemical processes. **Credit 3**

2020-781 **Medical Illustration Topics I**
A introductory course; designed to acquaint the illustration student with art techniques commonly used in medical illustration and with the medical library and audio-visual television supporting milieu in which the medical illustrator works. **Credit 3**

2020-782 **Medical Illustration Graphics**
A course emphasizing the use of computer software and hardware as a resource for generating titles, charts and graphs, schematics, and illustrations as vehicles to meeting instructional and communicative needs. Students will learn the various techniques available and will apply those techniques while designing pamphlets, in-house publications and poster exhibits. **Credit 3**

2020-783 **Anatomical Studies**
Sketches drawn from human dissection are translated into instructional illustrations using watercolor wash, pen, and ink. Emphasis will be on rapid but accurate sketching and observation in the laboratory, with a representation of form and structure in living tissue for publication. **Credit 3**

2020-784 **Medical Illustration Topics II**
A introduction to two-dimensional computer animation as it applies to contemporary methods of instruction in medicine and allied health. Students will research current topics in health care and develop an interactive lesson that matches the instructional objectives of their topic. **Credit 3**

2020-785 **Surgical Procedures I**
The application of creating instructional aids designed to increase learner understanding of surgical procedures and concepts. Sketches are to be drawn while observing the surgery, consulting with the surgeon for accuracy of detail and development. The final preparation of the artwork will match its intended use (publication, slide graphic, computer graphic, etc.) **Credit 3**

2020-786 **Surgical Procedures II**
A continuation of the concepts begun in Surgical Procedures I (2020-785); specifically, combining anatomical knowledge with surgical observation to construct a concise and accurate surgical series. Students will concentrate on communicating essential surgical concepts to a specific audience, as well as ensuring that their artwork will meet the demands of reproduction. **Credit 3**

2020-890 **Research and Thesis-Medical Illustration**
The development of a thesis project initiated by the student and approved by a faculty committee. Primarily a creative production, the thesis must also include a written report and participation in a graduate thesis show. (Approval required) **Credit 0–14 (offered every quarter)**

Clinical Chemistry

1023-705 **Mechanisms of Disease**
Mechanisms of cellular injury, the healing process, atherosclerotic heart disease, hypertension, infectious disease, and many other disease states are presented. **Class 4, Credit 4 (S)**

1023-724 **Scientific Writing for Clinical Research**
Managing a clinical research or clinical trials program means managing information and communication. This course will develop familiarity and provide experience with the government regulations, standard operating procedures (SOPs), and documents used to communicate processes and results in clinical research projects. (Graduate standing in the MS in Professional Studies program with a concentration in Clinical Research Management or by permission of the instructor) **Class 4, Credit 4 (W)**

1023-725 **Product Development in the Pharmaceuticals**
This course is designed as an overview of the product development process. The course will describe activities used to bring these different types of products from concept through testing to product approval. Regulatory requirements for product approval in the USA as well as international requirements will be discussed. Overall product development will be outlined with an emphasis on clinical research activities toward market approval. Students will learn the activities and requirements to get products through clinical research to FDA approval. (Permission of instructor) **Class 4, Credit 4 (W)**

1023-726 **Good Clinical Practices**
This course is designed to provide the student with an understanding of the regulatory framework that governs clinical research activities. The general principles of good clinical practice and the responsibilities of the key figures involved in a clinical research study will be discussed. The history of the regulations and significant milestones in U.S. Food and Drug Law will also be presented. (Permission of instructor) **Class 4, Credit 4 (S)**

1023-727 **Ethical Foundations and Issues in Human Subject Research**
A comprehensive course in clinical research ethics. The course will present the history of ethical issues in research involving human subjects and the resulting development of regulatory requirements globally. Critical processes such as informed consent and institutional review boards will be reviewed extensively. Current issues such as conflict of interest and research involving genetic material will also be discussed and understanding the role of good science as good ethics will be included. **Class 4, Credit 4 (F)**

1023-728 **Clinical Trial Design**
This course is designed to provide graduate and upper-level undergraduate students with the basic principles behind the design of clinical research trials to effectively test medical hypotheses. The critical components of a well designed clinical research protocol will be explored. Students will be exposed to the different types of clinical trials used in the industrial, government and academic sectors for pharmaceutical, medical device, or biologic interventions. (1023-724 and 1023-725) **Class 4, Credit 4**

1023-820 **Advanced Clinical Chemistry I**
Electrolytes, acid-base physiology, renal function, trace metals, lipids, carbohydrate metabolism, enzymes, and various standard methods are covered. **Class 4, Credit 4 (offered alternate years)**

1023-821 **Advanced Clinical Chemistry II**
A study of the concepts and applications of therapeutic drug monitoring, pharmacokinetics, toxicology, inherited disorders of metabolism, liver function tests, protein measurement, hepatitis, hemoglobinopathies, vitamins, and gene probes. **Class 4, Credit 4 (offered alternate years)**

1023-822 **Advanced Clinical Chemistry III**
A survey of endocrinology and of the immunoassay methods used in performing endocrine assays. The endocrine systems covered include the thyroid, the adrenals, calcium metabolism, growth hormone, the human reproductive system, and the fetal-placental unit. Basic principles of clinical trials will also be presented. **Class 4, Credit 4 (offered alternate years)**

1023-870 **Clinical Chemistry Seminar**
A seminar offered for 1 credit to graduate students presenting final research outcomes to their graduate committee. **Credit 1**

1023-872 **Special Topics: Clinical Chemistry**
In response to student and/or faculty interest, special courses that are of current interest and/or logical continuations of regular courses are presented. These courses are structured as ordinary courses with specified prerequisites, contact hours and examinations. **Class variable, Credit variable (offered upon sufficient request)**

1023-877 **External Clinical Chemistry Research**
Research carried out in a laboratory outside of the College of Science. Prior to the initiation of external research, a proposal from the student as well as a commitment of support and direction from the laboratory are evaluated. **Credit variable**

1023-879 **Clinical Chemistry Research**
Research carried out in the College of Science laboratories under the direction of RIT faculty members. The amount of credit awarded for such projects is determined after evaluation of a research proposal. **Credit variable**

1023-899 **Clinical Chemistry: Independent Study**
Individual projects or studies carried out under the direction of a faculty member. Study objectives and design are developed through faculty-student interaction with evaluation and credit to be awarded determined after review of a study proposal. **Credit variable**

1023-999 **Clinical Chemistry Graduate Co-op**
Cooperative work experience for MS clinical chemistry students. **Credit 0**

The College of Imaging Arts and Sciences

Lorraine Justice, Dean
http://cias.rit.edu

Programs of study

The College of Imaging Arts and Sciences offers the most comprehensive graduate imaging programs in the world, encompassing design, science, technology, engineering, management, crafts, and fine arts. The college is a diverse, world-class collaboration of six schools: School for American Crafts, School of Art, School of Design, School of Photographic Arts and Sciences, School of Film and Animation, and School of Print Media. Its scope gives students a perspective that can be found nowhere else—a place where some students create fine art using centuries-old methods while others push the edges of digital creativity. At no other university can students explore so many different aspects of the imaging fields to a high level of professional excellence. In addition, the college offers expertise in the professional operations of running a studio or gallery.

Both graduate students and our alumni have received numerous prestigious awards:

- Students have won the Graduate Film Honorarium of the Princess Grace Award.
- A computer graphics design alumnus was awarded a Golden Globe.
- An emerging filmmaker received the overall grand prize in the Adobe Flash Point Student Design Contest for multimedia projects.
- Computer graphics design students have won awards in the Macromedia Student Web Design Contest.
- Graphics design alumni have received awards of excellence from the Society of Technical Communications, both locally and internationally.
- Students have received "finalist" designations in the People's Choice Awards at the Macromedia International User Conference and Exhibition.
- A computer graphics design graduate received honors from *Communication Arts* and *I.D.* magazines for her interactive thesis project.
- An industrial design student received an award from Volvo of North America for his winning child car seat in the Design for Automobile Safety Competition at the World Traffic Safety Symposium.
- Students from the School of Print Media have won the best paper award from Technical Association of the Graphic Arts.
- Current students and alumni have been peer-selected speakers at the Society for Photographic Education's national conference.

Admission requirements

The college offering the program makes all decisions on graduate admission. Please refer to each individual program for information regarding specific admission criteria. For general graduate admission information, please refer to the Admission section of this bulletin.

Portfolio guidelines: All of the graduate programs in the schools of American Crafts, Art, Design, and the MFA program in imaging arts-photography (in the School of Photographic Arts and Sciences), require the submission of a portfolio that is used to assess applicants' performance and academic capabilities. Please refer to each individual program for specific information regarding portfolio guidelines and requirements.

Financial aid and scholarships

Please refer to the Financial Aid and Scholarship section of this bulletin for information regarding financial aid, scholarships, grants, loans, and graduate assistantships.

Faculty

RIT's world-class faculty are noted for their excellence, from creating award-winning sculptures and visual communications to receiving international recognition as innovators in their fields. They excel in the practice of their profession, using state-of-the-art equipment and studio facilities supporting both course work

and research. Their role as mentors is evidenced in the national awards won by their students.

Policy regarding student work

The School for American Crafts, School of Art, and School of Design, reserve the right to retain student work for educational use or exhibition for a period of time not to exceed one and a half quarters beyond the year the object has been made.

Facilities

The college has extensive facilities and resources to support graduate study in the arts.

- Thirty fully equipped photographic studios.
- More than twenty fully ventilated darkrooms.
- Extensive professional 16mm film and digital video field production equipment, including newly renovated film and animation facilities, 60 digital film editing stations, three animation labs, three stop-motion studios, two sound stages, and prop shop.
- More than $40 million worth of printing and publishing equipment in 17 laboratories.
- Wallace Library, rich in photography, graphic arts publications, and contemporary periodicals in design, arts, crafts for study, and research; ARTstor, an online image collection; and electronic reserve course materials.
- Cooperative efforts with George Eastman House International Museum of Photography and Film, with access to the museum's collections of photography, rare books, motion pictures, and technology.
- Cutting-edge print media labs include:
  - Prepress and Publishing Lab, featuring 25 fully configured and networked dual-processor Macintosh G5 workstations, the latest graphics and imaging software, scanners, and a complete selection of output devices.
  - Design and Color Lab, containing 25 fully configured and networked flat-screen "superdrive" Macintosh G5 computers loaded with the latest design, imaging, and multimedia software.
  - Advanced Publishing Lab, containing 14 fully configured and networked Macintosh G5 computers loaded with cutting-edge graphics, imaging, and database publishing software.
  - Color Proofing Lab, featuring the Kodak Approval digital color proofing system in addition to other state-of-the-art color proofing systems.
  - Desktop Scanning Lab, a facility that reflects the growing range of image-capture tools available to professionals, including high-end flatbed and drum scanners.
  - Color Measurement Lab, addressing the growing industry focus on managing color and containing spectrophotometers, colorimeters and color profiling, and color analysis software.
  - Digital Printing Lab, one of the few educational facilities in the world that houses a full array of digital color printing equipment.
  - Print Science Laboratory, a materials research and teaching laboratory housed in the Gannett Building; home to the materials and process course, among other print science courses, and the activity center for materials research in the field of printing.
  - Printing Applications Laboratory, a state-of-the-art research laboratory that serves both the School of Print Media and the industry. It houses the Printing Materials Application Laboratory, a Heidelberg Speedmaster six-color press, a Creo Trendsetter, and a Goss 2000 Sunday Production press.
- Library of the Kodak Research Laboratories.
- The Melbert B. Cary Jr. Graphic Arts Collection, containing more than 20,000 volumes of rare books and additional resources that illustrate fine printing, the history of printing, book design and illustration, papermaking, binding, and other aspects of the graphic arts.
- Bevier Gallery and the School of Photographic Arts and Sciences (SPAS) Gallery, the college's on-campus exhibition spaces.
- Gallery r, the university's off-campus, student-managed contemporary art gallery, is overseen by the School of Art. The gallery actively educates and encourages viewers to examine the relevance of art and cultural exposure in their own lives. Gallery r is an educational laboratory presenting art to the widest possible audience and maintaining a select collection of student and alumni artwork for on-site consignment and sales.
- The college houses archives, as well as exhibition and display spaces. Exhibitions regularly feature the work of contemporary painters, designers, photographers, illustrators, graphic artists, filmmakers, and faculty and student work.
- A comprehensive art library and a variety of educational resources are available in RIT's library.

Study options

Nonmatriculated students:
Students who have a baccalaureate degree and who wish to take particular courses may be admitted as nonmatriculated students to courses for which they are qualified. They may receive graduate credit, but it may not be submitted toward degree requirements. Students deficient in admission requirements or competence may take undergraduate courses, as advised, to qualify for admission.

School for American Crafts

chttp://cias.rit.edu/crafts/

Admission requirements

Please refer to each individual program for specific admission requirements.

Portfolio guidelines : Portfolios submitted to the School for American Crafts should consist of at least 20 examples of the applicant's best visual work. The work can be presented as a digital portfolio of stand-alone computer files that will run on a MAC or PC. Applicants also may submit 35mm slides displayed in 8 ½" x 11" vinyl protective slide pages. For additional information on submitting a portfolio please visit www.rit.edu/emcs/ptgrad/grad_portfolio.html.

Ceramics and Ceramic Sculpture, MFA

Program overview

The MFA is a professional degree for practicing artists, craftspeople, or designers who desire to leave a lasting impression on their fields by devotion to their work and high standards of discipline and artistic ideals. The MFA is generally a two-year, full-time program that involves the presentation of a thesis. The thesis includes written documentation and the formal exhibition of a body of work.

The ceramics studio embraces the contemporary spectra of aesthetic ideas and innovative techniques to educate and train professional artists/craftspeople. It strives to support students' career goals with pragmatic information and suitable facilities and equipment.

Our structured courses address specific issues inherent to utilitarian pottery, vessel aesthetics, ceramics sculpture, and mixed media. The ceramics program also receives substantial reinforcement from the other craft studios because they, too, explore similar formats and concerns that face artists and craftspeople in the 21st century.

Curriculum

MFA in Ceramics and Ceramic Sculpture

COURSE	QTR. CR. HRS.
Major	42
Humanities	10
Graduate Forum	3
Electives (optional minor)	15 (18)
Thesis	18
Total	**90**

Admission requirements

To be considered for admission to the MFA program in ceramics and ceramic sculpture, candidates must fulfill the following requirements:

- Hold a baccalaureate degree in a field of arts, sciences, or education from a regionally accredited institution in the United States,
- Submit transcripts (in English) of all previously completed undergraduate and graduate course work (the undergraduate degree should include 75 quarter credit hours [50 semester hours] in studio courses),
- Demonstrate, through the quality of the undergraduate record and creative production, a genuine, professional potential, and
- Complete a graduate application.
- International students, whose native language is not English, must submit scores from the Test of English as a Foreign Language. Minimum scores of 550 (paper-based) or 80 (Internet-based) are required. Scores from the International English Language Testing System are accepted in place of the TOEFL. A minimum scores of 6.5 is required. Applicants coming from countries where the baccalaureate degree is not awarded for programs in the practice of art may be admitted to graduate study if the diploma or certificate received approximates the standards of the BFA, BA, or BS degrees, and if their academic records and portfolios indicate an ability to meet graduate standards.

Additional information

Studio residence program

The School for American Crafts offers a craft residence program. Participants are accepted in the ceramics, glass, metals, and wood studios.

Residence positions are limited and are awarded after the review of all applicants' portfolios, transcripts, and references. An interview is required. Accepted studio residents are required to register for at least two credits of independent study during every quarter of residence. These two credits can be taken as an audit, thus reducing the tuition cost to the resident.

Accepted residents are expected to be present in their assigned studio during class hours and to contribute up to 10 hours of work per week in the main studio. These work hours will be coordinated and overseen by the major faculty in the area. In exchange, the school will provide workspace, access to facilities, and supportive instruction. The resident is invited to participate in the full range of studio activities.

Participants may be those seeking additional studio experience prior to undergraduate or graduate study, early career professionals, or teachers on leave who wish to work again in an academic studio environment. The major faculty in the area will make decisions concerning appropriate candidates.

Inquiries should be made to the Residence Program, College of Imaging Arts and Sciences, School for American Crafts, Rochester Institute of Technology, 73 Lomb Memorial Drive, Rochester, NY 14623-5603.

Glass, MFA

Program overview

This two-year program is structured on the basis of individual needs, interests, and professional preparation, as may be determined through individual/group discussions. A rapid series of exploratory works is developed during the first year, with emphasis on broadening technical and aesthetic understanding. The second year's focus will be on developing a body of work based on a sustained interest from the first year's investigation. The final work must be supported by a written thesis, a high-quality portfolio, and an exhibition.

The MFA is a professional degree for practicing artists, craftspeople, or designers who desire to leave a lasting impression on their fields by devotion to their work and high standards of discipline and artistic ideals. The MFA is generally a two-year, full-time program that involves the presentation of a thesis. The thesis includes written documentation and the formal exhibition of a body of work.

MFA in Glass

	QTR. CR. HRS.
Major	42
Humanities	10
Graduate Forum	3
Electives (optional minor)	15 (18)
Thesis	18
Total	**90**

Admission requirements

To be considered for admission to the MFA program in ceramics and ceramic sculpture, candidates must fulfill the following requirements:

- Hold a baccalaureate degree in a field of arts, sciences, or education from a regionally accredited institution in the United States,
- Submit transcripts (in English) of all previously completed undergraduate and graduate course work (the undergraduate degree should include 75 quarter credit hours [50 semester hours] in studio courses),
- Demonstrate, through the quality of the undergraduate record and creative production, a genuine, professional potential, and
- Complete a graduate application.
- International students, whose native language is not English, must submit scores from the Test of English as a Foreign Language. Minimum scores of 550 (paper-based) or 80 (Internet-based) are required. Scores from the International English Language Testing System are accepted in place of the TOEFL. A minimum scores of 6.5 is required. Applicants coming from countries where the baccalaureate degree is not awarded for programs in the practice of art may be admitted to graduate study if the diploma or certificate received approximates the standards of the BFA, BA, or BS degrees, and if their academic records and portfolios indicate an ability to meet graduate standards.

Additional information

Studio residence program

The School for American Crafts offers a craft residence program. Participants are accepted in the ceramics, glass, metals, and wood studios.

Residence positions are limited and are awarded after the review of all applicants' portfolios, transcripts, and references. An interview is required. Accepted studio residents are required to register for at least two credits of independent study during every quarter of residence. These two credits can be taken as an audit, thus reducing the tuition cost to the resident.

Accepted residents are expected to be present in their assigned studio during class hours and to contribute up to 10 hours of work per week in the main studio. These work hours will be coordinated and overseen by the major faculty in the area. In exchange, the school will provide workspace, access to facilities, and supportive instruction. The resident is invited to participate in the full range of studio activities.

Participants may be those seeking additional studio experience prior to undergraduate or graduate study, early career professionals, or teachers on leave who wish to work again in an academic studio environment. The major faculty in the area will make decisions concerning appropriate candidates.

Inquiries should be made to the Residence Program, College of Imaging Arts and Sciences, School for American Crafts, Rochester Institute of Technology, 73 Lomb Memorial Drive, Rochester, NY 14623-5603.

Metalcrafts and Jewelry Design, MFA

Program overview

The MFA is a professional degree for practicing artists, craftspeople, or designers who desire to leave a lasting impression on their fields by devotion to their work and high standards of discipline and artistic ideals. The MFA is generally a two-year, full-time program that involves the presentation of a thesis. The thesis includes written documentation and the formal exhibition of a body of work.

Curriculum

The program gives the student a broad exposure to metal working techniques, expands the student's knowledge of applied design, strengthens perceptual and philosophical concepts, and develops an individual mode of expression. This sequence leads to the master's thesis, inaugurated by the student and overseen by the faculty. This program is structured on the basis of individual needs, interests, and background preparation, as may be determined through faculty counseling.

MFA in Metalcrafts and Jewelry Design

COURSE	QTR. CR. HRS.
Major	42
Humanities	10
Graduate Forum	3
Electives (optional minor)	15 (18)
Thesis	18
Total	**90**

Admission requirements

To be considered for the MFA program in metalcrafts and jewelry design, candidates must fulfill the following requirements:

- Hold a baccalaureate degree in a field of arts, sciences, or education from a regionally accredited institution in the United States,
- Demonstrate, through the quality of the undergraduate record and creative production, a genuine, professional potential,
- Submit official transcripts (in English) of all previously completed undergraduate and graduate course work (undergradu-

ate degree should include 75 quarter credit hours [50 semester hours] in studio courses), and
- Complete a graduate application.
- International students, whose native language is not English, must submit scores from the Test of English as a Foreign Language. Minimum scores of 550 (paper-based) or 80 (Internet-based) are required. Scores from the International English Language Testing System are accepted in place of the TOEFL. A minimum score of 6.5 is required. For those applicants applying from countries where the baccalaureate degree is not awarded for programs in the practice of art may be admitted to graduate study if the diploma or certificate received approximates the standards of the BFA, BA, or BS degrees, and if their academic records and portfolios indicate an ability to meet graduate standards.

Additional information

Studio residence program

The School for American Crafts offers a craft residence program. Participants are accepted in the ceramics, glass, metals, and wood studios.

Residence positions are limited and are awarded after the review of all applicants' portfolios, transcripts, and references. An interview is required. Accepted studio residents are required to register for at least two credits of independent study during every quarter of residence. These two credits can be taken as an audit, thus reducing the tuition cost to the resident.

Accepted residents are expected to be present in their assigned studio during class hours and to contribute up to 10 hours of work per week in the main studio. These work hours will be coordinated and overseen by the major faculty in the area. In exchange, the school will provide workspace, access to facilities, and supportive instruction. The resident is invited to participate in the full range of studio activities.

Participants may be those seeking additional studio experience prior to undergraduate or graduate study, early career professionals, or teachers on leave who wish to work again in an academic studio environment. The major faculty in the area will make decisions concerning appropriate candidates.

Inquiries should be made to the Residence Program, College of Imaging Arts and Sciences, School for American Crafts, Rochester Institute of Technology, 73 Lomb Memorial Drive, Rochester, NY 14623-5603.

Woodworking and Furniture Design, MFA

Program overview

The MFA is a professional degree for practicing artists, craftspeople, or designers who desire to leave a lasting impression on their fields by devotion to their work and high standards of discipline and artistic ideals. The MFA is generally a two-year, full-time program that involves the presentation of a thesis. The thesis includes written documentation and the formal exhibition of a body of work.

Curriculum

Applicants to this program come from diverse backgrounds such as architecture, interior design, industrial design, art history, law, and teaching, as well as undergraduate wood programs. In the first year, students identify issues in their technical and aesthetic background and, along with faculty, create a program of study to address these areas. Simultaneously, they discover directions in their work that are promising for further exploration. Based upon this experience, students develop a thesis proposal and, in the second year, create a comprehensive body of work. This work culminates in the end-of-the-year graduate thesis exhibition in the college gallery and a written thesis in support of the work.

MFA in Woodworking and Furniture Design

COURSE	QTR. CR. HRS.
Major	42
Humanities	10
Graduate Forum	3
Electives (optional minor)	15 (18)
Thesis	18
Total	**90**

Admission requirements

To be considered for admission to the MFA program in woodworking and furniture design, candidates must fulfill the following requirements:
- Hold a baccalaureate degree in a field of arts, sciences, or education from a regionally accredited institution in the United States,
- Demonstrate, through the quality of the undergraduate record and creative production, a genuine, professional potential,
- Submit transcripts (in English) of all previously completed undergraduate and graduate course work (candidates undergraduate degree should include 75 quarter credit hours [50 semester hours] of studio courses), and
- Complete a graduate application.
- International students, whose native language is not English, must submit scores from the Test of English as a Foreign Language. Minimum scores of 550 (paper-based) or 80 (Internet-based) are required. Scores from the International English Language Testing System are accepted in place of the TOEFL. An IELTS score of 6.5 is required. For international students coming from countries where the baccalaureate degree is not given for programs in the practice of art may be admitted to graduate study if the diploma or certificate received approximates the standards of the BFA, BA, or BS degrees, and if their academic records and portfolios indicate an ability to meet graduate standards.

Additional information

Studio residence program

The School for American Crafts offers a craft residence program. Participants are accepted in the ceramics, glass, metals, and wood studios.

Residence positions are limited and are awarded after the review of all applicants' portfolios, transcripts, and references. An interview is required. Accepted studio residents are required to register for at least two credits of independent study during every quarter of residence. These two credits can be taken as an audit, thus reducing the tuition cost to the resident.

Accepted residents are expected to be present in their assigned studio during class hours and to contribute up to 10 hours of work per week in the main studio. These work hours will be coordinated and overseen by the major faculty in the area. In exchange, the school will provide workspace, access to facilities, and supportive instruction. The resident is invited to participate in the full range of studio activities.

Participants may be those seeking additional studio experience prior to undergraduate or graduate study, early career professionals, or teachers on leave who wish to work again in an academic studio environment. The major faculty in the area will make decisions concerning appropriate candidates.

Inquiries should be made to the Residence Program, College of Imaging Arts and Sciences, School for American Crafts, Rochester Institute of Technology, 73 Lomb Memorial Drive, Rochester, NY 14623-5603.

School of Art

http://cias.rit.edu/art

Admission requirements

Please refer to each individual program for specific admission requirements.

Portfolio requirements: Portfolios submitted to the School of Art should consist of at least twenty examples of the applicant's best visual work. The work can be presented as a digital portfolio of standalone computer files that will run on a MAC or PC. Applicants also may submit 35mm slides displayed in 8 ½" x 11" vinyl protective slide pages. For additional information on submitting a portfolio please visit www.rit.edu/emcs/ptgrad/grad_portfolio.html.

Fine Arts Studio, MFA

http://cias.rit.edu/art/

Program overview

The MFA program in fine arts studio offers intensive study in painting, printmaking, sculpture, new forms, and related media, leading to mastery in the fine arts field on a professional level. Students will explore advanced techniques in painting, sculpture, new forms, and nontoxic printmaking. These may be pursued singly and combined, or brought together with nontraditional media to create new forms. Faculty guidance focuses upon research strategies that support sequential studio production, leading to individual solutions.

Critical discussion is developed from the traditions of fine art and contemporary directions in our culture. These contemporary and historical concepts stimulate and provoke the development of an individual approach to expression. Along with engaging in critical dialogues, students progress toward the production of a body of work and a report for the master's thesis.

Gallery r, an art gallery in downtown Rochester operated by School of Art students, helps solidify the learning experience by bringing the work of students to the greater Rochester community.

Curriculum

The degree requirements for the MFA in fine arts studio includes:

	QTR. CR. HRS.
Major	33
Minor	15
Studio Electives	15
Humanities	8
Forms of Inquiry	2
Graduate Forum	3
Thesis	14
Total	**90**

Visual Art—All Grades, MST

Program overview

The MST in visual art leads to initial/professional New York state certification in visual arts for grades K through 12. This certification allows applicants to teach in New York state public schools. The program features pedagogical studies, studio inquiry, and student teaching. The purpose of the MST is to offer a unique graduate experience that prepares students to meet the national, state, and regional need for teachers of the visual arts. The MST is a program designed for accomplished art educators and advocates for art and learning in all grades. The program is nationally accredited and is for teachers in art education who hold a BFA or BA (art major) degree. Classes begin in each September and conclude in May. Graduates of teacher education programs at RIT have a 96 percent pass rate on the NY State Teacher Certification examinations.

Curriculum

The degree requirements in the MST program include:

COURSE	QTR. CR. HRS.
Psychology	4
Education	16
Methods and Materials in Art Education, Seminar in Art Education, Practice Teaching Studio Electives	28
Total	**48**

Admission requirements

To be considered for admission to the MST program in visual art (all grades), candidates must fulfill the following requirements:

- Hold a baccalaureate degree in an art field from a regionally accredited college or university in the United States, with a major concentration in art, art education, or industrial arts education,
- Have a minimum of 54 credit hours (36 semester hours) in drawing, painting, design, or the crafts. If the applicant holds a BA or BFA degree and seeks the MST degree in visual arts, the undergraduate program must have adhered to the studio course distribution required by the New York State Department of Education.

Non-toxic Intaglio Printmaking, Adv. Cert.

Program overview

This advanced certificate offers technical training and retraining for artists and printmaking professionals seeking a comprehensive working knowledge of non-toxic intaglio printmaking techniques, including a study of methodology and aesthetic applications.

Curriculum

The program features three courses for a total of 12 credit hours.

COURSE		QTR. CR. HRS.
2021-741	Non-Toxic Intaglio Printmaking I	4
2021-742	Non-Toxic Intaglio Printmaking II	4
2021-743	Non-Toxic Intaglio Printmaking II	4
Total		**12**

Admission requirements

To be considered for admission to the advanced certificate in non-toxic intaglio printmaking, candidates must fulfill the following requirements:

- Hold a BFA, MFA, or be recognized as a master printer or professional printmaker,
- Submit a letter of intent,
- Submit a current resume,
- Submit a slide portfolio (between 10–20 slides),
- Submit three references with contact information, and
- Complete an application.

School of Design

http://cias.rit.edu/design

The School of Design offers three professional MFA degree programs: computer graphics design, graphic design, and industrial design. These unique programs allow for advanced study that integrates creativity, philosophy, history, theory, applied concepts, and technology. Students who seek to advance their skills or change careers find our programs to be challenging and professionally based. The school sponsors guest lecturers, interdisciplinary projects, and special events to encourage personal and professional growth.

The school also offers three cross-disciplinary courses for all graduate students: Design Theory and Methods Seminar (2010-711), Design History Seminar (2010-713), Design Issues Seminar (2010-726). These cross-disciplinary courses foster a sense of community among students and faculty, and encourage dialogue and interaction related to philosophy, process, practice, history, goals, and responsibilities across the design disciplines.

The MFA programs in graphic design and industrial design require a fall entry. Computer graphics design prefers a fall entry but can be flexible, depending upon the student's qualifications/experience. The application deadline is February 15. Applications reviewed and accepted after the deadline are based upon available space. Applicants may be placed on a waiting list.

Admission requirements

Please refer to each individual program for specific admission requirements.

Portfolio guidelines: Portfolios submitted to the School of Design should contain samples of the applicant's work, including a combination of drawings, two- and three-dimensional design, photo imaging, website design, product renderings, CAD drawings, page layouts, etc. Visual content is dependent upon the applicant's experience and the program for which the applicant is applying. The portfolio should consist of 15 to 20 samples of the applicant's best work. Slides, CD-ROMs, DVDs, or a combination is acceptable. They must be stand-alone files that will run on a MAC or PC.

Computer Graphics Design, MFA

Chris Jackson, Graduate Program Director
(585) 475-5823, chjpgd@rit.edu

Program overview

This internationally recognized program offers concentrations in interactive design for Web, DVD, and mobile devices; three-dimensional digital graphics; motion graphics; game art and design; and information visualization. The curriculum combines knowledge of design theory, methodology, and aesthetics with skills in two- and three-dimensional computer graphics, interactive techniques, and interface design. Students utilize cutting-edge technology to produce a vast array of dynamic work for the screen (computer, broadcast, mobile).

The program focuses on practical and experimental approaches to the expression of unique visions. Students create interactive websites, applications for mobile devices (tangible interfaces and iPhone), opening title credits for movies and television broadcast, interactive graphic novels, immersive three-dimensional environments, and computer games realized from their imaginations. Resources in the Digital Studio are accessible 24 hours a day, seven days a week and include three-dimensional digitizers, physical computer interfaces, motion capture systems, three-

dimensional printers, monitor tablets, and a wide variety of software applications.

As part of the entrance requirements, applicants must demonstrate an understanding of basic design principles and visual computer skills. Software skills must include Adobe Photoshop and Illustrator. A portfolio of the applicant's best work is submitted in the form of a CD-ROM or DVD (in Macintosh or Windows platforms). A portfolio of 15-20 examples must demonstrate a good sense of design, typography, and illustration in a standalone format, and/or video, or a combination of these. Images saved in PDF format are preferred. Use the QuickTime movie format (.mov) for videos. Flash SWF files and HTML websites are accepted and encouraged.

Curriculum

MFA in Computer Graphics Design

	QTR. CR. HRS.
Major Studio Courses	46
Elective/Minor	16
Academic Courses	14
Thesis	14
Total	**90**

Graphic Design, MFA

Chris Jackson, Graduate Program Director
(585) 475-5823, chjpgd@rit.edu

Program overview

Graphic design is a professional major that addresses a range of advanced visual communication problems, with an emphasis on meaning, form, and function. In a professional studio setting, students work with faculty on the understanding and implementation of theories, principles, and methods related to concept development, design process, context, history and criticism, research, evaluation, visual aesthetics, typography, systems thinking, information design, inter - and cross-disciplinary collaboration, as well as social and ethical responsibility.

Course assignments and thesis projects incorporate both theory and application in the solution of hypothetical and actual graphic design problems. Courses within this major evidence a balanced approach toward the integration of digital media and traditional processes. Final design outcomes focus on small- and large-scale, two- or three-dimensional printed artifacts and environmental graphic design solutions, with opportunities to develop relevant for time-based and/or interactive digital applications as well. Special lectures, guest speakers, exhibitions, and workshops complement studio and seminar goals. Students have ongoing access to resources such as the Graphic Design Archive and the Cary Graphic Arts Collection, the Artists' Books Collection, and the collections of the Vignelli Center for Design Studies.

Curriculum

MFA in Graphic Design

	QTR. CR. HRS.
Major	28
Design Core	9
Minor	15
Electives	14
Liberal Arts	12
Thesis	12
Total	**90**

Industrial Design, MFA

Stan Rickel, Graduate Program Director
(585) 475-4745, srrfaa@rit.edu

Program overview

The master of fine arts degree program in industrial design is for career enhancement or redirection. The educational experience is project-oriented, requiring research into design methods and technologies. Cross-disciplinary collaboratives provide an experiential dimension.

The first year of study includes seminar courses in design history, issues, research, theory, and methods, which are common to all graduate students in the School of Design. In addition, studio courses involve extensive design work with respect to environmental issues, the meaning of artifacts, and critical analysis. Extensive course work using three-dimensional software for product modeling and animation fills out the program.

In the second year, students conduct research and develop a thesis project, which is presented in a graduate thesis exhibition or presentation and is documented in a written thesis report.

Curriculum

MFA in Industrial Design

	QTR. CR. HRS.
Major	39
Electives/Minor†	21
Design Core	12
Liberal Arts	4
Thesis	14
Total	**90**

† Minors are declared within the College of Imaging Arts and Sciences and in other colleges at the university. This is done with approval from the individual program's graduate adviser/coordinator. The minor should support the goal of the MFA degree.

School of Print Media

www.rit.edu/printmedia

The graphic communication industry is large, extremely varied, and continues to be driven by changes in technology. With state-of-the-art facilities and technology, internationally renowned

faculty, and an unequaled offering of courses, the School of Print Media is widely considered the premier provider of graphic communication education in the world. Our programs offer students the tools necessary to be successful as a manager, researcher, and leader in the graphic communication industry.

Graduates from the school are working as professionals in production management, marketing, technical sales, research and development, quality assurance, administration, education, and other areas. A graduate degree from the School of Print Media attracts leading employers from every graphic discipline and has had a greater than 95 percent placement rate for the past several years.

Admission requirements

Please refer to each individual program for specific admission requirements.

Print Media, MS

Patricia Sorce, Administrative Chair
(585) 475-2313, psorce@mail.rit.edu

Program overview

The print media program provides an in-depth understanding of technical printing and imaging concepts, as well as exposure to high-level research methods. Although this program provides broad exposure to the graphic communication industry, it allows students an opportunity to specialize in a relevant technical or business area. The program is oriented toward individuals in technical and management positions within the printing and publishing industry, and offers flexibility in tailoring the program to meet individual needs. Recent students have focused on information technology, material science, imaging science, typography, digital archiving, variable data content, and business, depending upon interest and aptitude.

Curriculum

MS in Print Media

COURSE		QTR. CR. HRS.
2081-701	Research Methods and Trends	4
2081-711	Tone and Color Analysis	4
2081-716	Materials and Processes in Print Media	4
2081-747	Cross Media Workflow	4
0106-782	Statistical Analysis of Decision Making	4
2081-890	Thesis	8
	Electives	4
	Minor Concentration	16
Total		**48**

Minor concentration and elective options

Minor concentration courses are selected by the student to develop additional expertise in a particular area of interest. The degree offers flexibility in terms of tailoring the program to meet individual needs. The electives and minor concentration courses are comprised of selected courses offered by the College of Imaging Arts and Sciences or other RIT colleges. All courses must be preapproved by the graduate program chair.

Proposed plan of study

COURSE		QTR. CR. HRS.
Fall Quarter		
0106-782	Statistical Analysis Decision Making	4
2081-711	Tone and Color Analysis	4
2081-716	Materials and Processes in Print Media	4
Winter Quarter		
2081-701	Research Methods and Trends in Graphic Media	4
2081-747	Cross Media Workflow	4
	Elective	4
	Minor Concentration	4
Spring Quarter		
	Minor Concentration	4
	Minor Concentration	4
	Elective	4
Summer Quarter (options)		
	Graduate Research Assistantships	
	Graduate Assistantships	
Fall Quarter		
2081-890	Thesis	8
	Minor Concentration	4
Winter Quarter		
2081-890	-99 Continuation of Thesis	
	Full-Time Equivalency	
Spring Quarter		
2081-890	-99 Continuation of Thesis	
	Full-Time Equivalency	

Thesis

All students in the on-campus print media graduate program are required to complete a research thesis that demonstrates original thinking and creativity in the search for new knowledge in the graphic communication industry. Students select projects that align with their research adviser's area of research expertise. Research assistantships often are available to help fund research.

School of Film and Animation

cias.rit.edu/~sofa

The School of Film and Animation offers the master of fine arts degree with options in scriptwriting, 2D computer animation, 3D computer animation, and live action production. The core curriculum is the actual production of motion media every quarter, including one major project for each of the three years (third year is typically devoted to a professional quality thesis production). Regardless of concentration, all students are required to do the basics (technical and aesthetic) of working with motion picture film, video, and digital media. Students may enrich their studies by taking courses across concentration lines within the School of Film and Animation, or courses from RIT programs including computer science, photography, art, design, theater, music, and business. Our faculty are highly experienced, award winning professionals. Our extensive facilities, including a Green Screen sound stage, are readily available, state-of-the-art, and kept up

to date. Our graduates have an admirable record in establishing fulfilling careers. We accept a relatively small number of students, allowing much individual attention and the opportunity for students to discover their unique creative strengths and artistic goals.

Admission requirements

Please refer to each individual program for specific admission requirements.

Portfolio guidelines: The review committee for the School of Film and Animation seeks a portfolio that contains work that is original in concept and content; not necessarily motion media, but visual or aural. Examples include films/video, photos, drawings, paintings, sculpture, stop motion puppets, scripts, storyboards, and original music. Therefore links to websites and/or multiple film reels, tapes, DVD's, or CD's will not be reviewed. The film or videos should total 15 minutes or less. A complete work is preferable to a "demo real." If there are no short works, then a 15-minute excerpt of a longer piece is acceptable. Portfolios should include an inventory sheet or table of contents. Videos should be on mini-DV, DVCAM, DVD, or DVDROM. The movie files on a DVDROM must be in Quicktime, MPEG2, MPEG4, or H.264 format. No AVI or other digital video architecture files, NISC or ATSCH(HD) only. Still images should be on DVDROM or CDROM and jpeg or tiff format. 35mm slides are acceptable but must be in sleeves. No boxes or carousel trays. No more than 30 images. Sound design should be no longer than 10 minutes and on CD format.

Film and Animation, MFA

Program overview

The MFA program enjoys state-of-the-art facilities. Students can create computer animation that is unique. It is the only such program housed in a School of Film and Animation with full production facilities, as well as the additional support of highly specialized faculty in photography, imaging science, computer science and information technology, and printing.

Goals

The program's goals provide students with the opportunity to use animation, filmmaking, and other imaging arts as a means to:

- pursue a career and earn a livelihood.
- enrich their personal lives and society as a whole.
- encourage a sense of community, creativity, scholarship, and purpose.

Curriculum

Degree requirements

The MFA degree in film and animation provides students with four options:

(1) The live action (film production) option allows students to develop and refine their creative approach to fictional narrative, documentary, and experimental work.

(2) Scriptwriting is an opportunity for students to complete short films with a concentration in creating feature length screenplays.

(3) 2D animation concentrates on traditional forms drawn by hand, a mixture of both traditional and digital, or all digital origination. There is also the possibility of concentrating on stop motion puppet animation.

(4) 3D computer animation focuses on advanced 3D modeling, lighting, texturing, and animating in a 3D space.

All four options require two years of course work and a thesis project. A complete film is required of all the first year students, a complete film or script is required in the second year, and a more ambitious thesis film or feature length script is required of the third year.

A minimum of 90 quarter credit hours of graduate work is outlined. The 90 hours do not include undergraduate work required by action of the MFA admission committee in accepting a particular applicant, nor do they include undergraduate prerequisites for graduate courses.

Computer and traditional animation

Course work includes exercises and major projects in both two- and three-dimensional computer animation, as well as courses in filmmaking technique and interactivity.

The computer animation degree encompasses 91 quarter credit hours of course work in the following areas of study:

MFA option in 2D animation

	QTR. CR. HRS.
Concentration	54
History and Aesthetics	12
Programming	4
Electives	11
Research and Thesis	12
Total	**93**

MFA option in 3D animation

	QTR. CR. HRS.
Concentration	45
History and Aesthetics	10
Programming	4
Electives	19
Research and Thesis	12
Total	**90**

Distribution of work within these guidelines is subject to modification based upon the candidate's background, abilities, and interests. An individualized course of study will be prepared with the advice of the graduate faculty and made a matter of record. Modifications in this prescribed program thereafter must be approved and recorded.

MFA option in live-action production

The program incorporates courses in film, digital video, and scriptwriting. Students produce fiction, documentary, and experi-

mental films. A concentration in scriptwriting is also available. The film degree encompasses 91 quarter credit hours of course work in the following areas of study:

MFA option in live-action production

	QTR. CR. HRS.
Concentration	45
History and Aesthetics	17
Electives	18
Research and Thesis	12
Total	**92**

MFA option in scriptwriting

	QTR. CR. HRS.
Concentration	43
History and Aesthetics	16
Electives	20
Research and Thesis	12
Total	**91**

Distribution of work within these guidelines is subject to modification based upon the candidate's background, abilities, and interests. An individualized course of study will be prepared with the advice of the graduate faculty and made a matter of record. Modifications in this prescribed program thereafter must be approved and recorded.

Electives

Elective courses are available in animation, film, video, multimedia, screenwriting, printmaking, painting, sculpture, communication design, museum studies, crafts, bookmaking, typography, color photography, new media, studio photography, advertising photography, perception, sensitometry, computer graphics, art history, and archival preservation and conservation. There are also opportunities for independent studies, internships, and concentrations.

Thesis

Specific instructions pertaining to the thesis are available in the "MFA Guide for Students and Faculty: Policy Regarding Student Work." The School of Film and Animation reserves the right to retain copies of student-produced films to be used for educational purposes, to show to prospective students, and as examples of student productions.

Admission requirements

To be considered for admission to the MFA in film and animation, candidates must fulfill the following requirements:

- Hold a baccalaureate degree from an accredited college or university,
- Submit a portfolio of work that demonstrates the applicant's skills, visual sophistication, and aesthetic awareness,
- Submit transcripts (in English) of all previously completed undergraduate and graduate course work,
- Submit two letters of recommendation,
- Submit a statement of purpose detailing why the candidate wants to attend graduate school and what they will bring to the program, and
- Complete a graduate application.

Scores from the Graduate Record Exam (GRE) are not required for admission. Applicants who are capable of good academic work as well as artistic visual expression, and who demonstrate an interest in the exploration of new artistic ideas and experiences, will be favored. The graduate faculty makes recommendations based on the above interlocking criteria.

Students who are evaluated to have MFA potential but need additional study in preparation for graduate courses will be advised to take such courses either prior to entrance or during their first year of study. The graduate faculty will make recommendations.

All correspondence concerning applications or catalogs should be addressed to the Office of Graduate Enrollment Services. Students interested in the program should have their application process completed by February 1. Application received later than February 1 are considered on a space-available basis.

Portfolio

The review committee is looking for work that is original in concept and content. It does not need to necessarily be motion media, but should be visual or aural. Examples include films/videos, photos, drawing, paintings, sculpture, stop motion puppets, script, storyboards and original music.

The applicant must present what they consider to be the best of their work, not all their work. Therefore links to websites and or multiple film reels tapes, DVDs, or CDs will not be reviewed. The film or videos should total 15 minutes or less. A complete work is preferable to a "demo reel". If there are no short works then a 15-minute excerpt of a longer piece is acceptable.

Please provide an inventory sheet or table of contents. Videos should be on mini-DV, DVDCAM, DVD or DVDROM. The movie files on a DVDRM must be in QuickTime, MPEG2, MPEG4, or HG.264 format. No AVI or other digital video architecture files, NTSC or ATSC(HD) only. Still images should be on DVDROM or DCROM and be jpeg or tiff format. 35mm slides are acceptable but must be in sleeves. No boxes or carousel trays. No more than 30 images. Sound design should be no longer than 10 minutes and on CD format.

Additional information

Faculty

The program is supported by a staff of 18 full-time faculty members and a variety of adjunct faculty members. The program may also borrow faculty and utilize courses from the schools of Photographic Arts and Sciences, Print Media, Art, Design, American Crafts, and the College of Liberal Arts.

Transfer credit

Graduate-level course work taken prior to admission should be submitted for approval upon entrance into the program. Up to 12

quarter credit hours (8 semester hours) of graduate work with a grade of B or better is transferable and may be counted toward the MFA degree, with the approval of the graduate faculty.

Grades and time limit

The average of all grades for graduate credit taken at the university must be at least a B (3.0) to qualify for the MFA degree. Thesis hours are usually complted over several quarters. Acceptance or rejection of the thesis is made by the candidate's thesis board and the graduate faculty. All course work, including an accepted thesis, must be completed within seven years of entrance into the program.

Screenings

Screenings are required for all student-produced films and are coordinated through the professor or the thesis chair.

School of Photographic Arts and Sciences

http://cias.rit.edu/photography/

Admission requirements

Please refer to each individual program for specific admission requirements.

Portfolio guidelines: The portfolio submitted for the MFA program in imaging art-photography in the School of Photographic Arts and Sciences must consist of twenty examples of the applicant's best work. Portfolio materials should be presented on a CD-ROM and/or DVD. For more detailed information, refer to the graduate admissions requirements.

Grades and time limit

The average of all grades for graduate credit taken at the university must be at least a B (3.0) to qualify for the MFA degree. Thesis hours are usually completed over several quarters. All course work, including an accepted thesis, must be completed within seven years of entrance into the program.

Thesis

The thesis exhibition/project must be an original body of work appropriate to the major commitment of the degree candidate. A written thesis will be prepared for inclusion in the Wallace Library. Specific guidelines are available in the "MFA Guide for Students and Faculty: Policy Regarding Student Work."

Policy regarding student work

The School of Photographic Arts and Sciences reserves the right to retain at least one original piece of work from a student's MFA thesis show for inclusion in the MFA Collection, to be used for educational, promotional, and exhibition purposes. Graduates must also leave the school a CD containing 20 images of thesis work completed for the master's degree.

School of Photographic Arts and Sciences (SPAS) Gallery

The SPAS Gallery supports the exhibition of graduate thesis work, student work, and the works of contemporary image-makers. It maintains a calendar of exhibitions, public lectures, and receptions. Importantly, it also provides real world experience for interested graduate students, where they learn firsthand about gallery operations, installation, and communications.

Imaging Arts–Photography, MFA

Therese Mulligan, Chair,
School of Photographic Arts and Sciences
(585) 475-2884, mtmpph@rit.edu

Program overview

The master of fine arts program in imaging arts emphasizes a broad interpretation of photography as a conceptual art form, with the intention of inspiring and nurturing the individuality of each student as a creative, productive artist. The program encourages graduate study in photography and related media as a means to personal, aesthetic, intellectual, and career development.

The MFA curriculum provides a flexible pattern of study that is continually sensitive to the needs of each student, building upon the strengths each individual brings to the program. Successful completion of the program enables a student to seek careers in education, museum or gallery work, or as a self-employed professional.

Program goals

The program's goals provide students with the opportunity to use the still and moving image as a means to

- pursue a professional career and earn a livelihood.
- enrich their personal lives and society as a whole.
- encourage a sense of community, creativity, scholarship, and purpose.

Curriculum

MFA in Imaging Arts-Photography

	QTR. CR. HRS.
Concentration	40
History and Aesthetics	15
Electives	19
Research Seminar, Graduate Seminar, Research and Thesis	16
Total	**90**

Distribution of work within these guidelines is subject to modification based upon the candidate's background, abilities, and interests. An individualized course of study will be prepared with the advice of the graduate faculty and made a matter of record. Modifications in this prescribed program thereafter must be approved and recorded.

Art electives

Elective courses are available in animation, video, multimedia, film, printmaking, painting, sculpture, communication design, crafts, bookmaking, typography, color photography, new media, studio photography, advertising photography, computer graphics, art history, and archival preservation and conservation. There also are opportunities for independent studies and internships.

Thesis

The thesis exhibition/project must be an original body of work appropriate to the major commitment of the degree candidate. A written thesis will be prepared for inclusion in Wallace Library. Specific guidelines are available in the "MFA Guide for Students and Faculty: Policy Regarding Student Work."

Admission requirements

To be considered for admission to the MFA program in imaging arts-photography, candidates must fulfill the following requirements:

- Hold a baccalaureate degree (or equivalent) from an accredited college or university,
- Present a portfolio of work that demonstrates skills, visual sophistication, and aesthetic awareness,
- Submit transcripts (in English) of all previously completed undergraduate and graduate course work,
- Submit three letters of recommendation,
- Submit a personal statement of purpose detailing the attributes a candidate brings to graduate study, including expectations and professional goals they wish to achieve,
- Particiate in a personal interview (optional), and
- Complete a graduate application.

Applicants who are capable of graduate level academic work, as well as artistic visual expression, and who demonstrate an interest in the exploration of new artistic ideas and experiences will be recommended.

Portfolio

The portfolio, along with written records of achievements and recommendations, serves to inform the faculty of the applicant's readiness for advanced graduate study. It provides a visual statement of the applicant's performance to date in terms of his or her skills, aesthetic development, and maturity.

Applicants should send 20 images on a CD and/or DVD, representing a cohesive body or bodies of recent work. An artist's statement accompanies the portfolio, addressing the work being presented and its creative process.

Admission selection for the fall quarter is made in the spring from among all portfolios and completed applications received. Applicants should be certain that portfolios are postmarked no later than January 15 to ensure review of the application. Acceptance occurs only once a year for a fall admission.

Portfolio instructions

- Submit no more than 20 images on CDs and/or DVDs. (Size each digital file to no more than a maximum of 1400 pixels at its longest side, at 72ppi.)
- Number images 1 to 20 in the order the applicant wishes them to be projected.
- Include a numbered page detailing the CD and/or DVD image information.
- Include the title of the work, date, size, and medium.
- Include a one-page artist statement discussing submitted work and applicant's creative process.
- Include a self-addressed, stamped envelope for return of the portfolio. (The school cannot return portfolios lacking sufficient postage or inadequate packaging. The school will retain the work of admitted applicants.)
- Submit the portfolio with the application material to the Office of Graduate Enrollment Services.

Additional information

Faculty

Ten full-time faculty members, all critically regarded for their artistic work in exhibition and publication, contribute to the MFA program. The faculty brings individual expertise and dedication to their work with graduate students, encouraging intellectual inquiry of contemporary art-making practices and aesthetics. The MFA program is also supported by a staff of 40 full-time faculty members from the schools of Photographic Arts and Sciences, Print Media, Art, and adjunct faculty members from George Eastman House International Museum of Photography and Film, as well as noted regional, national, and international practitioners, critics, and historians.

Transfer credit

Graduate-level course work taken prior to admission should be submitted for approval upon entrance into the program. Up to 12 quarter credit hours (8 semester hours) of graduate work with a minimum grade of a B or better is transferable toward the degree, with the approval of the graduate coordinator.

Degree requirements

The MFA normally requires a minimum of two years of full-time resident graduate study. A minimum of 90 quarter credit hours of graduate work is outlined below. These minimums may be exceeded by intent or necessity to cover particular areas of study.

The 90 hours do not include undergraduate work required by action of the MFA admission committee in accepting a particular applicant or undergraduate course prerequisites for graduate courses.

Graduate Faculty

Lorraine Justice, BFA, Edinboro University; MFA, Ph.D., The Ohio State University—Dean

Graduate Studies

Michael Amy, BA, Vrige Universiteit Brussel; MA, Ph.D., New York University—Associate Professor

Roberley Bell, BFA, University of Massachusetts at Amherst; MFA, State University of New York College of Ceramics at Alfred University—Professor

Heidi Nickisher, BA, University of California at Santa Barbara; MA, California State University, Fullerton—Lecturer

Clarence Burton Sheffield Jr., BS, University of Utah; MA, University of Colorado at Boulder; Ph.D., Bryn Mawr College—Associate Professor

Sarah Sutton, BA, John Carroll University; MFA, Kent State University—Visiting Assistant Professor

Sarah Thompson, BA, University of California at San Diego; MA, Ph.D., University of California at Santa Barbara—Assistant Professor

School of Art

Donald Arday, BFA, Cleveland Institute of Art; MFA, Syracuse University—Professor; Administrative Chair, School of Art

Bob Cole, BA, MS, University of Maryland—Professor

Robert Dorsey, BFA, Rochester Institute of Technology; MFA, Syracuse University—Associate Professor

William Finewood, BA, State University College at Geneseo; MFA, Syracuse University—Associate Professor

Robert Heischman, BFA, Miami University; UCFA, Ruskin School of Art—Professor

Glen R. Hintz, BA, Lafayette College; MS, The Medical College of Georgia—Associate Professor

Keith Howard, Painting Diploma, National Art School (Australia); MA, New York University—Associate Professor

Elizabeth Kronfield, BFA, Bowling Green State University; MFA, University of Georgia—Assistant Professor

Thomas R. Lightfoot, BA, BFA, University of Connecticut; MFA, Institute Allend; MA, Ed.D., Columbia University Teachers College—Associate Professor

James Perkins, BA, Cornell University; ABD, University of Rochester; MFA, Rochester Institute of Technology—Associate Professor

Luvon Sheppard, BFA, MST, Rochester Institute of Technology—Professor

Alan D. Singer, BFA, The Cooper Union; MFA, Cornell University—Professor

Carole Woodlock, BFA, Alberta College of Art; MFA, Concordia University—Associate Professor; MST Program Coordinator, Art Education

School of Design

Deborah Beardslee, BFA, Syracuse University; MFA, Virginia Commonwealth University—Associate Professor

Alex Bitterman, BS, M. Arch, State University of New York at Buffalo; Ph.D., University of New York at Buffalo— Associate Professor, Graphic Design

Peter Byrne, BFA, Alberta College of Art and Design; MFA, York University—Associate Professor; Graphic Design

Nancy A. Ciolek, BFA, MFA, Indiana State University—Associate Professor

Daniel DeLuna, BFA, Ball State University; MFA, Pratt Institute—Assistant Professor, Computer Graphics Design

Lorrie Frear, BFA, MFA, Rochester Institute of Technology—Assistant Professor, Graphic Design

Joyce Hertzson, BFA, Rhode Island School of Design, MFA, Indiana University—Professor

Chris B. Jackson, BFA, Alfred University; MFA, Rochester Institute of Technology—Associate Professor; MFA Coordinator, Computer Graphics Design

Patti J. Lachance, BFA, Herron School of Art at Indiana and Purdue Universities at Indianapolis; MFA, Rochester Institute of Technology—Associate Professor; Administrative Chairperson, School of Design

Alex Lobos, BA, Universidad Rafael Landivar; MFA, University of Notre Dame—Assistant Professor, Industrial Design

Bruce I. Meader, BFA, MFA, Carnegie Mellon University—Associate Professor, Graphic Design

R. Roger Remington, BFA, Rochester Institute of Technology; MS, University of Wisconsin—Professor, Graphic Design

Stan Rickel, BID, Pratt Institute; MID, Syracuse University—Program Chair, Industrial Design; Associate Professor

Marla Schweppe, BA, University of Kansas; MA, The Ohio State University—Professor; Director of Visualization; Computer Graphics Design

Kim Sherman, BS, State University College at Cortland; MFA, Rochester Institute of Technology—Lecturer, Industrial Design

School for American Crafts

Andy Buck, BA, Virginia Commonwealth University; MFA, Rhode Island School of Design—Professor, Wood

Juan Carlos Caballero-Perez, BFA, MFA, Rochester Institute of Technology—Assistant Professor, Metals

Robin Cass, BFA, Rhode Island School of Design; MFA, State University of New York at Alfred—Professor, Glass

Wendell Castle, BFA, MFA, University of Kansas—Professor; Artist-in-Residence, Chair in Contemporary Crafts

Richard Hirsch, BS, State University College at New Paltz; MFA, Rochester Institute of Technology—Professor, Ceramics

Albert Paley, BFA, MFA, Temple University; Ph.D. (honorary), University of Rochester—Artist-in-Residence, Charlotte Fredericks Mowris Chair in Contemporary Crafts

Michael Rogers, BA, MA, Western Illinois University; MFA, University of Illinois—Professor, Glass

Richard Tannen, BS, Cornell University; Certificate of Mastery, Boston University—Professor, Wood

Leonard A. Urso, BFA, MFA, State University College at New Paltz—Professor, Metals

School of Film and Animation

Cat Ashworth, MA, State University of New York at Buffalo—Associate Professor

Charles Bandla, BA, State University College at Fredonia; MFA, Rochester Institute of Technology—Visiting Assistant Professor

Carl (Skip) Battaglia, BA, Boston College; MS, Syracuse University—Professor

Jack Beck, BA, Denison University; MFA, University of Iowa—Associate Professor; Live Action Production Program Chair

Adrianne Carageorge, BA, Florida State University; MFA, Ohio University—Associate Professor

Bob Deaver, BS, University of California; MFA, Academy of Art University—Visiting Assistant Professor

Richardo Figueroa, BS, MS, University of Puerto Rico-Mayaguez—Assistant Professor

Mark Foggetti, BFA, Rochester Institute of Technology—Senior Lecturer

Tom Gasek, BFA, Rochester Institute of Technology; MFA, Art Institute of Boston at Lesley University—Assistant Professor

Brian Larson, BFA, Colorado State University; MFA, Miami International University—Assistant Professor

Howard Lester, BA, Cornell University; MFA, University of California at Los Angeles—Professor; MFA Coordinator

David Long, BS, University of Texas; MS, University of Rochester—Assistant Professor; Program Chair, Digital Cinema

Stephanie Maxwell, BA, University of California at Los Angeles; MFA, San Francisco Art Institute—Professor; Program Chair, Animation

Naomi Orwin, BA, University of Chicago; MA, Institute of Transpersonal Psychology—Assistant Professor

Mark Reisch, BFA, Savannah College of Art and Design; Certificate in Advanced Studies of Animation, Emeryville-AnimationMentor.com—Visiting Assistant Professor

Alan Rhodes, BFA, University of Washington; MFA, State University of New York at Buffalo—Assistant Professor

David Sluberski, BA, State University College at Fredonia—Lecturer

Malcolm Spaull, BS, St. Lawrence University; MFA, Rochester Institute of Technology—Professor; Administrative Chair

School of Photographic Arts and Sciences

Patti Ambrogi, MFA, Visual Studies Workshop—Associate Professor

Gregory Halpren, BA, Harvard University; MFA, California College of the Arts—Assistant Professor

Angela M. Kelly, MA, Columbia College—Associate Professor

Susan Lakin, BFA, Art Center of Design; MFA, University of California—Associate Professor

Dan Larkin, BFA, Rochester Institute of Technology; MFA, Bard College—Associate Professor

Therese Mulligan, BA, University of Missouri; MA, Michigan State University; Ph.D., University of New Mexico—Professor; Administrative Chair

Oscar Palacio, MFA, Massachusetts College of Art and Design; MA, University of Miami—Assistant Professor

Willie Osterman, MFA, University of Oregon—Professor

Christine Shank, MFA, Miami University; MFA, Texas Woman's University—Assistant Professor

Carla Williams, BA, Princeton University; MFA, University of New Mexico—Assistant Professor

Ken White, BA, Princeton University; MA, MFA, University of New Mexico—Associate Professor

School of Print Media

Charles Bigelow, BA, Reed College; MFA, University of California, Los Angeles; Certificate of Advanced Studies, Harvard University—Melbert B. Cary Distinguished Professor

Barbara Birkett, BA, Aquinas College; MBA, Rochester Institute of Technology; CPA, Maryland—Associate Processor, Print Media Management; Undergraduate Program Chair

Robert Y. Chung, BS, Eastern Washington State University; MS, Rochester Institute of Technology—Gravure Research Professor, Color Management

Twyla J. Cummings, BS, MS, Wright State University; Ph.D., Union Institute and University—Associate Professor, Paul and Louise Miller Professor, Print Media Management

Franziska Frey, MS, University of Zurich; Ph.D., Swiss Federal Institute of Technology—Associate Professor, McGhee Professor, Materials and Digital Imaging

David Pankow, BA, MA, Brooklyn College; MLS, Columbia University—Professor; Curator, Melbert B. Cary Jr. Graphics Art Collection

Frank J. Romano, BA, City University of New York—Emeritus Professor, Electronic Publishing

Franz Sigg, BS, MS, Rochester Institute of Technology—Research Associate, Test Targets

Patricia Sorce, BA, Kent State University; MS, Ph.D., University of Massachusetts—Associate Professor, Roger K. Fawcett Professor, Administrative Chair; Print Media Management

Scott Williams, BS, Purdue University; Ph.D., Montana State University—Associate Professor, Material Science and Engineering

001-723 **The College Teacher**
A graduate level course for students who are thinking about entering teaching at the college level. Students will learn about the teacher's role and responsibilities within the college structure; course development, course presentation, and course evaluation. Students will have the chance to develop and present instruction. **Credit 3**

Graduate Study

2037-785 **Forms of Inquiry**
The exploration and organization of forms of inquiry is required for all MFA students. It aims to expose students to a broad range of critical issues related to the conception and production of art, to inspire and provoke critical reflection, and facilitate the development of a preliminary thesis topic. Presentations, discussions, and written assignments will examine concerns as they relate to contemporary art, crafts, and design. **Credit 2**

Art History

2039-713 **Displaying Gender**
This course brings together two of the most significant strains of recent art historical scholarship: the study of gender in representation and the critical examination of exhibitions and museums with particular focus given to key examples of curatorial practice from the late 19th century to the present day. Through readings, possible museum visit(s), class discussions, and guided individual research, questions of gender in exhibitions will be considered in relation to other aspects of identity including sexuality, race, and class. **Credit 3**

2039-714 **Art and Architecture of Ancient Rome**
In this course, students will examine the visual culture of ancient Roman civilization from the foundations of Roman culture through the Late Imperial era. Roman culture was heavily reliant on images as a means of transmitting concepts of lineage, status, power, and politics; students will learn how these images may have been perceived in the context of Roman social and political history, and how style may have been used as an ideological tool. **Credit 3**

2039-715 **Thinking About Making**
A discussion based course seeks to bridge the gap between studio practice and contemporary art history. The course will explore very current work and ask questions about what is art, who is the audience, what is "our" art making practice and how does that fit within the larger context of the current state of the global art world. How do we measure success and artistic failure? The course emphasizes observation, critical analysis, and written interpretation. **Credit 3**

2039-716 **Florence and Rome: 1400–1470**
Significant commissions for painting, sculpture and architecture in Florence and Rome from 1400–1470 will be studied. Artists studied will include Filippo Brunelleschi, Lorenzo Ghiberti, Donatello, Luca della Robbia, Michelozzo, Leon Battista Alberti, Masaccio, Fra Angelico, Fra Filippo Lippi and Paolo Uccello. Questions for consideration will include: the nature and meaning of the Early Renaissance, developments in artistic theory and practice, the importance of Antique and Medieval precedents, the increasing attention to the effects of nature, the role of the patron, and the relevance of documents, literary sources and visual precedents for our interpretation of images. **Credit 3**

2039-717 **Florence and Rome: 1470–1520**
Significant commissions for painting, sculpture and architecture in Florence and Rome from 1470–1520 will be studied. Artists studied will include Sandro Botticelli, Antonio and Piero del Pollaiuolo, Leonardo da Vinci, Domenico del Ghirlandaio, Bernardo Pinturicchio, Bramante, Michelangelo and Raphael. Patrons studied will include Lorenzo the Magnificent, the Florentine Republic, Popes Sixtus IV, Alexander VI, Julius II and Leo X. Questions for consideration will include: the nature and meaning of the High Renaissance, developments in artistic theory and practice, the importance of Antique and Medieval precedents, the increasing attention to the effects of nature, the role of the patron, and the relevance of documents, literary sources and visual precedents for our interpretation of images. **Credit 3**

2039-718 **Florence and Rome: 1520–1590**
Significant commissions for painting, sculpture and architecture in Florence and Rome from 1520–1590 will be studied. Artists studied will include Michelangelo, Jacopo Sansovino, Jacopo Pontormo, Agnolo Bronzino, Baccio Bandinelli, Benvenuto Cellini, Giorgio Vasari, Bartolommeo Ammannati and Giambologna. Patrons will include Grand Dukes Cosimo and Francesco de'Medici of Florence, and Popes Clement VII, Paul III, Julius III and Sixtus V. Questions for consideration will include: the nature and meaning of the Late Renaissance in Italy, developments in artistic theory and practice, the importance of Antique, Medieval, Early Renaissance and High Renaissance precedents, the rising status of the artists, the role of the patron, and the relevance of documents, literary sources and visual precedents for our interpretation of images. **Credit 3**

2039-725 **Art in 15th Century Venice**
The subject of this course is 15th century painting, sculpture and architecture in Venice and the Veneto. As we examine different types of paintings, sculptures and architecture works we will understand how these types evolved and they were used in Venice and the Veneto over the course of the 15th century. Questions for consideration will also include: the myth of Venice, the importance of Antique, Byzantine, Islamic and western medieval precedents for developments in Venetian art and architecture, the introduction of Florentine Gothic and Renaissance art and ideas into Venice, the impact Venice had upon the art and architecture of the Veneto, and vice versa, and the cultural exchange between Venice and the north. **Credit 3**

2039-731 **Dada and Surrealism**
This course examines the widely influential Dada and Surrealist movements in Europe and the United States from 1916 through the post-World War II period as well as their relevance to contemporary concerns. Emphasis is on identifying the major works of artists involved in these movements as well as their philosophical foundations, critical implications and ideological contexts (e.g. Freud, Breton, Leiris and Bataille), A broad range of works and practices (paintings, performance, installations, literary texts, photography, film, and ephemeral objects) will be studied, and the work of certain key artists (Heartfield, Schwitters, Duchamp, Picabia, Picasso, Dali, Ernst, Giacometti, Man Ray, Bellmer, Cornell, Magritte, Miro, Picasso) will be analyzed in depth. **Credit 3**

2039-733 **The Image**
The image remains a ubiquitous, controversial, ambiguous and deeply problematic issue in contemporary critical discourse. Yet, it is also a key concern of visual culture, and a connecting problem across the entirety of CIAS (the College of Imaging Arts and Sciences) here at RIT where the production and consumption of images is paramount. This course will examine recent scholarship devoted to the image and the ideological implications of the image in contemporary culture. Topics will include: the modern debate over word vs. image, the mythic origins of images, subversive, traumatic, monstrous, banned and destroyed images (idolatry and iconoclasm), the votive and effigy, the mental image, the limits of visuality, the moving and projected image, the virtual image, image fetishism, the valence of the image, as well as criteria by which to assess their success or failure (their intelligibility) and their alleged redemptive and poetic power. **Credit 3**

2039-734 **Gothic Art**
This course will examine architecture, sculpture, painting, and decorative arts in Europe from the mid-twelfth century to the Renaissance. Students will analyze the visual culture of the period in relation to the historical, social, and political contexts of its production. Primary issues to be considered include the design and construction of Gothic buildings, the format, function, and creation of manuscripts, art and religious practice, the status and organization of artists, artistic patronage, regional styles, and cross-media influences. **Credit 3**

2039-738 **Body in Art**
This course is an inquiry into the artistic investigation of the literal human body and the texts that give them meaning. The class will focus on the history, theory and problems of performance art in the latter part of the 20th century. (2039-227 or permission of instructor) **Credit 3**

2039-739 **The Gothic Cathedral**
This course will examine the Gothic cathedral and related art production (stained glass, sculpture, and metalwork) from the twelfth through the fifteenth century. The cathedrals of the late middle ages represent the greatest efforts of medieval art production; students will study these buildings within their cultural contexts and examine the meanings such buildings conveyed to their intended audiences. The class will explore the design, structure, and construction of Gothic churches throughout Europe, and will also examine the decorative programs of sculpture, stained glass, and liturgical objects integral to the meaning and function of these structures. Issues to be considered include the production of cathedrals; the stylistic variations of Gothic; the relationship between function and form; and the urban context of Gothic cathedrals. **Credit 3**

2039-740 Symbols and Symbol Making
This course explores the links between psychoanalytic theory and art history with special focus on the work of Sigmund Freud, Carl Jung and their successors. A central aim is to examine the way in which psychoanalytic theory has been employed by art historians and theorists as a mode of interpretation, as well as to study how, why, and what several of the most notable psychoanalysts have written about art. Topics include the interpretation of dreams, transference, the Oedipal myth, melancholia, narcissism, abjection, the structure of the unconscious, the fetish, Archetypes and the Collective Unconscious, as well as outsider art: the art of the insane. Key theorists to be discussed include: Freud, Jung, D.W. Winnicott, Melanie Klein, Jacques Lacan, Otto Rank and Julia Kristeva; individual artists such as: Albrecht Dürer, Leonardo da Vinci, Edvard Munch, Max Ernst, Jackson Pollock, Louise Bourgeois, Mary Kelly and

2039-743 Edvard Munch
The Norwegian artist Edvard Munch (1863–1944) continues to generate a great deal of popular interest, critical scholarship, and reflection. A painter, printmaker, photographer, and filmmaker, Munch was also a prolific writer, well acquainted with the symbolist poets and playwrights, as well as the broad intellectual drift of the fin-de-Siécle. He is the one Scandinavian artist included within the Modernist canon and his image, The Scream (1893), is an icon of the modern age. Munch traveled widely throughout Europe and his work was exhibited in North America. This course will examine recent scholarship devoted to Munch and the critical issues that his work addresses. It will also place him within the broader cultural context of Scandinavian and European modernism, while examining his impact on subsequent generations. (2039-227 or permission of instructor) **Credit 3**

2039-744 The Gothic Revival
This class covers the Gothic Revival of the eighteenth, nineteenth centuries, and twentieth centuries. Issues to be examined include the question of stylistic revival vs. stylistic survival; the origin and meanings of Gothic as a stylistic category; the impact of antiquarianism on the Gothic Revival in the eighteenth century; Gothic and eighteenth-century modes of vision; Gothic in the private and public spheres; Gothic s associations with science, gender, nationalism, and morality; the Gothic Revival and the Pre-Raphaelites, and major figures within the movement such as A.W.N. Pugin and John Ruskin. **Credit 3**

2039-755 Latin American Art
This is a survey course of the historical development of the art of Latin America from colonial times to the present. Included will be a consideration of painting, sculpture, architecture, graphic, and photographic arts. Potential themes to be addressed include the dependence on the European neo-classical academic model; indigenism; nationalism and the resurgence of popular art; the role of the visual arts in the construction of history; the conflicts and tensions involved in the search for a cultural identity. **Credit 3**

2039-763 The Russian Avant-garde
The radical move away from classical forms of representation in the late 19th and early 20th centuries is how one understands the avant-garde. Russian art from mid 1890 through 1922 were extreme departures from art practices of the earlier 19th century. We will examine the avant-garde social and political underpinnings. In Russia, Peredvizhniki artists painted images that represented the social world; a group of realist painters who are misunderstood and seen as the forerunners of Soviet Social Realism. We will try to amend this misunderstanding and connect this group of artists to the Russian formal and political avant-garde of the early 20th century and to the latter non-conformist artists of the second half of the 20th century that coincides with Perestroika and the eventual demise of the Soviet Union. **Credit 3**

2039-764 Romanesqe Art
This class will examine medieval European artistic production including architecture, architectural and free-standing sculpture, metalwork, painting, and manuscript illumination in the eleventh and twelfth centuries. The visual culture of the period will be analyzed in relation to the historical, social, and political context of its production. Primary issues to be considered include architectural structure, art and religious practice, the status and organization of artists and builders, art as an expression or enforcer of identity, the question of regional styles, contact with other cultures, and the relationship between Romanesque art and the past. **Credit 3**

2039-768 Scandinavian Modernism
This course examines the decorative arts and visual culture of modern Scandinavia from 1860 to the present, with special emphasis on the social, economic, and political impulses that have shaped them. Scandinavian Modern design plays a significant role in the postwar epoch; it is equated with such leading brands as Volvo, Saab, Ericsson, Nokia, H&M, Electrolux Orrefors, Georg Jensen, ARTEK, and IKEA and the idea of progressive, social democracy. The myths and realities of its success will be examined, as well as its impact on contemporary design. **Credit 3**

2039-772 Passion for Porcelain
This course offers an examination of techniques and materials together with a historical overview of European ceramics, with particular attention paid to porcelain. It includes study of Renaissance and early modern lead-glazed earthenware and stoneware as a prelude to the consideration of the history of porcelain, from its origins in China and the Far East to the heyday of its European development in the eighteenth century factories of Meissen and Seres. **Credit 3**

2039-776 Renaissance Painting in Flanders
Students will study the history of Renaissance painting in the Southern Netherlands from the beginning of the 15th century to the end of the 16th century. We will consider the meaning of the Renaissance in Flanders, the observation and recording of natural appearances, "hidden symbolism" and sacramental themes in Early Netherlandish painting, the connections between Flemish, German, and Italian Art, the development of new genres in the 16th century, "originality" and "artistic progress". The Master of Flemalle, Jan van Eyck, Rogier van der Weyden, Petrus Christus, Dieric Bouts, Hugh van der Goes, Hans Memling, Gerard David, Quinten Metsys, Hieronymus Bosch, Joachim Patinier, Pieter Aertsen and Pieter Breughel the Elder, are among the artists to be studied. **Credit 3**

2039-789 Medieval Craft
In this course, we will explore the history of craft production throughout the Middle Ages. While modern scholars have often divided art from craft, this distinction did not exist in medieval Europe: artists were craftspeople, producing objects that were both practically and symbolically functional. This class will focus on the decorative arts including stained glass, ivories, textiles, and metalwork to produce a more integrated picture of medieval visual culture. Students will study both practical aspects of production and the reception and meaning of these objects within medieval society. **Credit 3**

2039-794 Illuminated Manuscripts
Students in this course will examine the history of illuminated manuscripts, learning about the working methods of artists as well as the cultural significance of the illuminated book. Issues of production, style, function, and patronage will be introduced, and students will explore the relationships between images, texts, and readers. **Credit 3**

2039-833 Art and Technology: from the Machine Ages
This course explores the link between art and technology in the twentieth century with special focus on the historical, theoretical, and ideological implications. Topics include the body in the industrial revolution, utopian, dystopian, and fascist appropriations of the machine, engendering the mechanical body and machine-eroticism, humanism, the principles of scientific management and the paranoiac machine, multiples, mass production, and the art factory, industrial design and machines for living, the technological sublime, cyborgs, cyberpunk and the post human. Key theorists and artists will also be covered. **Credit 3**

2039-841 Conceptual Art
This course examines the widely influential mid-1960s art movement that questioned the fundamental nature of art itself by renunciating the material art object as well as the phenomenon of art making. The definition of art as well as its institutional framework was thereby expanded and the idea, concept, or intellectual dimension of the work was underscored. Students will be acquainted with the philosophical foundations and critical implications of this global movement across a wide spectrum of works and practices (paintings, performance, installations, books and texts, photography, film, and video) and its relevance to contemporary concerns. **Credit 3**

2039-843 What is Postmodernism?
This course will cover the art, politics, culture and the critical texts that formed the discourses, and their resulting debates, about contemporary society after World War II and especially so after the social unrest of 1968. What is Postmodernism? features the question itself. Here it is not necessarily as important to find out what postmodernism is or is not as it is to ask the question in the first place. To ask the question is to accentuate the idea that the question itself is what we are dealing with. How and why and by whom, are questions asked and answered? What is the difference when we ask the same question about Postmodernism in the historical sense rather than a stylistic one? What if the question were to be asked from within the discourse of architecture or music or biology? Would the answers be the same? Would the questions be the same? **Credit 3**

2039-852 **Art and Activism**
This course focuses on artists using their work for the purpose of changing society; work by artists that cause critics, art historians, other artists and the viewing public to ask if what they are doing is art. We will examine art to be a form of activism and persuade artists to be responsible for the way they represent the world. What is Art? What should Art be? What should Art do? But is It Art? are some questions asked when art proposes to make a political or social change, for example when art becomes action. Although these questions may not seem immediately answerable, it is our responsibility to ask them and then attempt to answer them as best we can. The artists we will discuss are concerned with problems in our society that affect gender, race, sexuality, poverty, labor issues, and the environment. Most of these artists can be classified as angry and confrontational or at least evoking a form of contestation. **Credit 3**

2039-859 **Art and Architecture in Central Italy: 1250–1400**
The subject of this course is painting, sculpture and architecture in Central Italy from the middle of the 13th century to the end of the 14th century. We will approach this material in more or less chronological order as we focus upon different types and media, including the altarpiece, the private devotional image, the pulpit, the tomb, the chapel, the monastic church, the cathedral, the town-hall, the private palace, and the urban setting. Questions for consideration will include: Franciscan devotion, the rivalry between Siena and Florence, early humanist thinking about the arts, Giotto as the paradigmatic Florentine painter, the nature and meaning of the Italian proto-Renaissance, and the impact of the Black Death upon the arts. **Credit 3**

2039-869 **Baroque Rome**
This course will focus upon Italian artists working in Rome from circa 1590 to circa 1660. Although we will explore painting, sculpture and architecture in this sequence and more or less chronologically, we will often have the chance to consider how these different media coalesce to create an overwhelming visual experience. We will pay particular attention to major commissions given to Annibale Carracci, Michelangelo da Caravaggio, Gianlorenzo Bernini and Francesco Borromini, as we seek to define the nature and meaning of the Roman Baroque. **Credit 3**

School of Art

Art Education

2011-701 **Art Education Methods and Materials I**
The course will explore the process of teaching art in the public/ private school classroom and focus on specific information and theories relevant to the teaching of visual art. Students will be encouraged to explore highly structured as well as highly experimental approaches to teaching art. Projects will include lesson planning, unit planning, investigating new technologies, urban education, action research, and other relevant topics, such as: human development, students with disabilities, multiple intelligences, assessment processes, and personal inquiry as reflective practice. (Course is restricted to MST art education majors) **Credit 5**

2011-702 **Art Education Methods and Materials II**
This course is a continuation of Methods and Materials I. Students will further explore the process of teaching art in the public/private school classroom and focus on specific information and theories relevant to the teaching of visual art with the specific goals defining a teaching methodology that meets State and National Standards. Students will be encouraged to explore highly structured as well as highly experimental approaches to teaching art. Projects will include lesson-planning, unit planning, investigating new technologies, urban education, action research, and other relevant topics, such as: human development, students with disabilities, multiple intelligences, assessment processes and personal MST majors) **Credit 5**

2011-820 **Seminar in Art Education**
This course supports the student who is currently student teaching. In this course students will explore the day-to-day issues they experience in their student teaching experiences. The focus will be on making connections with theory, state and national standards, and reflecting on student experience to address overall goals of the program. Students focus on the following areas to meet NYSED requirements: content/subject matter knowledge, pedagogical knowledge, teaching skills, curriculum development, assessment, and professional skills. The development of a teaching portfolio occurs in conjunction with a culminating project. On-line technology is utilized in addition to slide lectures, videotapes and other forms of media. **Credit 3**

2011-860 **Practice Teaching**
The student teaching experience is the single most important activity of the MST program. It is designed to provide the student with experiences and challenges which will help them to further develop into the art teacher they are becoming. Two student teaching placements are arranged for each student for the duration of seven weeks each. Students are assigned a collaborating teacher and a college supervisor for each setting. A student Teaching Handbook is provided. (Course is restricted to MST majors) **Credit 9**

Illustration

2019-706 **Illustrative Design I Graduate**
This course is an introduction to the principles and methods used to incorporate illustration with typography and layout. Students will conceptualize, organize, and execute illustrations within a design context, and will emphasize the use of graphic elements such as symbols, charts, and type to be incorporated into illustrations. Layout terminology and illustration production methods will be included. Projects will expose students to various examples of real world assignments what will demand the use of traditional illustration methods as well as computer-based production media; emphasizing the language of visualization and the relationship and coordination of concept, illustration, and word. **Credit 3**

2019-711 **Digital Illustration I Graduate**
Graduate students will be introduced to the principles of visualization used to create digital illustrations. Students will apply their ability to conceptualize effective solutions to digital illustration renderings. Assignments encourage a high level of creative conceptual development, with theory and practice in the use of digital techniques. The goal is to advance conceptual problem solving methodology and the language of visualization for professional illustration production. Color systems, digital terminology, and pre-press file formats will be covered. **Credit 3**

2019-723 **Digital Editorial I Graduate**
Graduate students will introduce students to editorial illustration. Importance will be placed on interpretation of editorial subject matter and preparation of digital imagery for print reproduction. Students will apply approaches to creative illustration while creatively interpreting editorial text. Students may use vector and raster-based software applications and a variety of input and output devices. Stylistic issues, conceptual strategies, production restrictions, and color systems will also be covered. **Credit 3**

2019-733 **Illustration Portfolio Preparation Graduate**
A final preparatory course for visual artists. Its purpose is to provide students with information, strategies, and guided instruction to organize and create their final portfolio. The course will include individual critique and analysis of work created in prior studio classes and progress to the definition of a career agenda. Projects will be individually assigned based on the quality of each student's body of work and their career intentions. Presentation methods, formatting, and stylization will also be addressed. The final culminating projects will be finished hard copy and digital portfolios. In addition to the portfolio document, students will be instructed in job-seeking strategies including interviewing dynamics, resume writing, and correspondence. **Credit 3**

2019-742 **Digital Narrative II Graduate**
This course expands upon the translation of verbal concepts to pictorial narrative introduced in Digital Narrative I. Particular emphasis will be placed on illustration sequences including story line illustration, and thematic series pictorials. Importance will be placed on the digital representation of narrative story telling with reference to style, content, and interpretation. Assignments will involve vector and raster-based software applications and a variety of input and output devices. Conceptual strategies, production methodologies, narrative composition, and color systems will also be covered. **Credit 3**

2019-761, 762, 763, 764 **Illustration Graduate Elective**
Individual drawing projects related to graduate students' major area of study and opportunity to refine drawing skills on the graduate level. Elective offerings are Adobe PhotoShop, Personal Focus, and Figure in Motion. **Credit 3** per quarter

Medical Illustration

2020-707 **Contemporary Media for Interactive Portfolio**
Students will create an interactive portfolio of their artwork and/or animations designed to attract potential clients and employers. The portfolio will be available for viewing on the World Wide Web and as a CD or DVD. It will include interactive navigation and be able to download vitae and promotional materials to site visitors. (2020-711) **Credit 3**

2020-710 Anatomic Illustration Mixed Media
Students will learn to use raster painting software to modify scanned artwork and create new images from scratch. Students will also use page layout applications to combine digital images with text and other graphic elements. Course work emphasizes creation of illustrations to support medical education, for advertising, and to editorialize health and medical concepts. **Credit 3**

2020-711 Computer Animation and Interactivity I
This course continues advancement of animation skills used in Medical Illustration Topics II (2020-784). Students will create an interactive lesson using computer illustrations and two-dimensional computer animations designed for delivery via the World Wide Web. Course work will also require students to create "puzzles" and other games requiring interactive learner participation. (2020-784) **Credit 3**

2020-712 Computer Animation and Interactivity II
This course introduces variables as a tool in constructing tests designed to measure learner comprehension. Students will create interactive lessons that use animation and interactive teaching strategies to deliver instructional objectives to a specific audience. Learner interaction with the symbols and control of animation remains a prime focus of the course. (2020-784) **Credit 3**

2020-731 Human Gross Anatomy I
A two-quarter sequence devoted to the study of the human body. Detailed dissection of a human cadaver is supplemented with lectures on the structure and function of the major organ systems. Dissection focuses on the muscles of the torso, the contents of the thorax and abdomen, and the upper limb. **Credit 4**

2020-732 Human Gross Anatomy II
The second half of a two-quarter sequence devoted to the study of the human body. Detailed dissection of a human cadaver is supplemented with lectures on the structure and function of the major organ systems; with a detailed dissection of the head and neck and moves on to the pelvis, perineum, and lower limb. (2020 731) **Credit 4**

2020-761 3-D Modeling of Organic Forms
This course introduces students to NURB, Polygon, and Subdivision modeling techniques for creating virtual three-dimensional organic subjects. Accurate portrayal of the subject, including form, texture, and color are emphasized. Developing models from student drawings is required. **Credit 3**

2020-762 3-D Animation of Organic Forms I
Course work focuses on accurate animation of organic and/or biomedical subjects using three-dimensional computer modeling. All animations are intended for display on the World Wide Web. Projects are three dimensional animations that teach or portray an assigned topic.(2020-761 recommended) **Credit 3**

2020-763 3-D Animation of Organic Forms II
Students are introduced to three-dimensional computer animation using character rigging. Assignments focus on creating joint skeletons and binding three-dimensional surfaces to these "joints". Course work introduces manipulating surface deformations in response to movements and surface material. All animations are intended for display on the World Wide Web. Projects are "applied animations" that teach or portray an assigned topic. (2020-762 or permission of instructor) **Credit 3**

2020-767 Molecular Illustration
Accurate representations of molecular structures are essential to illustrate recent advances in biotechnology, medical genetics, and pharmacology. This course provides a basic overview of molecular biology and introduces the principles of molecular illustration. Students will locate three-dimensional molecular model files on the Internet and manipulate these models to create two- and three dimensional, and animated representations of molecules and biochemical processes. **Credit 3**

2020-781 Medical Illustration Topics I
A introductory course; designed to acquaint the illustration student with art techniques commonly used in medical illustration and with the medical library and audio-visual television supporting milieu in which the medical illustrator works. **Credit 3**

2020-782 Medical Illustration Graphics
A course emphasizing the use of computer software and hardware as a resource for generating titles, charts and graphs, schematics, and illustrations as vehicles to meeting instructional and communicative needs. Students will learn the various techniques available and will apply those techniques while designing pamphlets, in-house publications and poster exhibits. **Credit 3**

2020-783 Anatomical Studies
Sketches drawn from human dissection are translated into instructional illustrations using watercolor wash, pen, and ink. Emphasis will be on rapid but accurate sketching and observation in the laboratory, with a representation of form and structure in living tissue for publication. **Credit 3**

2020-784 Medical Illustration Topics II
A introduction to two-dimensional computer animation as it applies to contemporary methods of instruction in medicine and allied health. Students will research current topics in health care and develop an interactive lesson that matches the instructional objectives of their topic. **Credit 3**

2020-785 Surgical Procedures I
The application of creating instructional aids designed to increase learner understanding of surgical procedures and concepts. Sketches are to be drawn while observing the surgery, consulting with the surgeon for accuracy of detail and development. The final preparation of the artwork will match its intended use (publication, slide graphic, computer graphic, etc.) **Credit 3**

2020-786 Surgical Procedures II
A continuation of the concepts begun in Surgical Procedures I (2020-785); specifically, combining anatomical knowledge with surgical observation to construct a concise and accurate surgical series. Students will concentrate on communicating essential surgical concepts to a specific audience, as well as ensuring that their artwork will meet the demands of reproduction. **Credit 3**

2020-890 Research and Thesis-Medical Illustration
The development of a thesis project initiated by the student and approved by a faculty committee. Primarily a creative production, the thesis must also include a written report and participation in a graduate thesis show. (Approval required) **Credit 0–14 (offered every quarter)**

Fine Arts Studio

2021-710 Introduction to Painting: Acrylic Graduate
A course in the basic materials and processes of acrylic painting. Students will explore the expressive and stylistic possibilities of the medium. Subjects will include various interpretations of still life and model as well as individual projects. Discussion of work will focus on form, composition, and color. **Credit 3**

2021-711 Introduction to Painting: Oils Graduate
This course introduces students to oil painting. Along with learning about the properties and techniques of this medium, students will be encouraged to experiment and seek solutions to problems of composition and structure in painting. Preparatory sketches and studies will be encouraged for the production of finished works. Lectures, demonstrations, examples, and slide talks will compliment the growth gained through the students' creation of a variety of paintings from both observation and imagination. **Credit 3**

2021-712 Introduction to Painting: Figure Graduate
The fundamentals of representational figure painting in oils or acrylics using traditional materials and process. Color-mixing and painting application techniques related to depicting the figure and its immediate environment will be explored. Observational study of form, space, and quality of light will be stressed. **Credit 3**

2021-721 Watercolor: Graduate Elective
Use and control of the technique of water color painting. Exploring watercolor as an illustrative and painting media. **Credit 3**

2021-722 Contemporary Drawing Graduate Elective
Emphasis is on drawing and the development of form, space and expression from a variety of sources, including the human figure. Emphasis on basic techniques, materials, and concepts for further study are explored. **Credit 3**

2021-730 Introduction to Printmaking: Etching Graduate
Conceptual and technical assignments introduce the basic techniques in etching focusing on line, value and texture. An investigation of line using the following techniques: line etch, litho crayon, open bite, scraping, and burnishing. Personal expression will be encouraged through variations in the use of line, value, and texture. **Credit 3**

2021-731 Introduction to Printmaking: Lithograph
Conceptual and technical assignments that introduce the basic techniques in lithography focusing on line, value, and texture. An investigation of form relationships using the techniques of etching on litho-plates and stones; using pencils, crayons, inks, and transfer imagery to create and encourage personal expression. **Credit 3**

2021-733 Introduction to Printmaking: Non-toxic Graduate
The student will explore of a wide range of non-toxic printmaking processes and techniques. In the mastery and application of these processes and techniques the student will achieve personal aesthetic goals. **Credit 3**

2021-741 Non-toxic Intaglio Printmaking I
The first of three graduate level non-toxic intaglio courses. The aim of this introductory level is to gain a technical understanding of basic Intaglio-Type and non-toxic alternative techniques for hand etching copper plates. Aspects of health and safety as applied to the intaglio studio along with working methodology will also be explored. (Matriculation into Non-Toxic Printmaking Certificate) **Credit 4**

2021-742 Non-toxic Intaglio Printmaking II
The second of three graduate level non-toxic intaglio courses. The aim of this second level is to gain a technical understanding of Intaglio-Type etch techniques and gain a greater understanding of non toxic alternative techniques for hand etching. Introduction of computer generated methods of making halftones. To learn about the Edinburgh Etch. (2021-741 or portfolio review) **Credit 4**

2021-743 Non-toxic Intaglio Printmaking III
The last course in a series of three graduate level non-toxic intaglio courses. The aim of this third-level is to gain an advanced technical understanding of Intaglio-Type etch techniques and to either; learn how to make high quality photographic halftones, learn more advanced hand etching techniques. (2021-741 and 2021-742) **Credit 4**

2021-761, 762, 763, 764 Fine Arts Studio Graduate Elective
Traditional sculptural concepts will evolve through a variety of processes and materials—predominately clay, plaster, cement, stone, paper, and metal. The human figure is presented as a subject for study and for use as a springboard to invention. **Credit 3** per quarter

2021-769 Art Gallery Management
The complex social and cultural role of a fine arts gallery will be explored through supportive gallery operations: the installation of experimental and traditional exhibits, promotion, and marketing for competitions, student initiatives and special events tailored to the RIT and community art audiences. (Metro site presentations and research plus arranged studio hours in a laboratory: gallery setting). **Credit 3**

2021-775 Sculpture: Assemblage Graduate Elective
One of the most basic approaches to creating Sculpture, this course involves assembling or bringing together parts/pieces to form a whole. Spontaneous and immediate contact with unique materials, creative processes and the degree of sculptural impact may all be characterized as extremely direct. This straightforward confrontation offers no flashy techniques, seductive material or process to hide behind. Instead, at the onset, basic sculptural manipulation must occur. **Credit 3**

2021-776 Sculpture: Figure Graduate Elective
This sculpture course investigates the study of human form through the development of sculpted clay figures working directly from living models. Emphasis is placed on exploring the following sculptural elements: the underlying three-dimensional structure of the human figure; proportions of the human figure; volume, mass and surface anatomy; gesture; support and balance; figurative spatial relationships; expressive qualities of human form; use and control of basic material; and processes related to figure sculpture. **Credit 3**

2021-780 Fine Arts Studio Graduate I
Fine Arts Studio: enter into a critical discourse and examination of ideas and relationships in the fine arts. Critiques, guest artists, lectures, and discussion along with studio production. Painting: develop painting skill in oil, acrylic, watercolor, drawing through individual studio investigation under the direction of fine art faculty. Sculpture: sculpture concepts are explored through a variety of processes and materials, including clay, plaster, cement, stone, wood, and metal. These concepts reveal themselves through separate sections devoted to the human figure, installation, public art, or other contemporary manifestations of sculpture. Printmaking: non toxic printmaking techniques and processes are the means for students to develop along independent lines and directions for contemporary fine art printmaking. **Credit 3 per quarter**

2021-790 Fine Arts Studio Graduate II
Fine Arts Studio: enter into a critical discourse and examination of ideas and relationships in the fine arts. Critiques, guest artists, lectures, and discussion along with studio production. Painting: develop painting skills in oil, acrylic, watercolor, drawing through individual studio investigation under the direction of fine art faculty. Sculpture: sculpture concepts are explored through a variety of processes and materials, including clay, plaster, cement, stone, wood, and metal. These concepts reveal themselves through separate sections devoted to the human figure, installation, public art, or other contemporary manifestations of sculpture. Printmaking: non toxic printmaking techniques and processes are the means for students to develop along independent lines and directions for contemporary fine art printmaking. All areas: **Credit 3 per quarter**

2021-797 Art Gallery Practicum
Operating an art gallery serving a metropolitan community provides small business opportunities in research, marketing and management. Students will learn how to attract sponsorships, manage a gallery web site, supervise office assistants, prepare guidelines for the office staff manual, as well as plan and promote a full calendar year of exhibitions and special events. This course provides each student with actual business responsibilities found in any successful art gallery setting. **Credit 4**

2021-872 Business Practices for Fine Arts
This class is devoted to business issues that artists will face which include portfolio development, pricing, and marketing strategies, and public relations. Students will research exhibition venues and career support services. Professional accomplishment in the arts depends on communication skills. Artists run small creative businesses; students will study opportunities to network with others artists, review grant applications, and look at other financial supports. **Credit 3**

2021-890 Research and Thesis: Fine Arts Studio
The development of a thesis project initiated by the student and approved by a faculty committee. Primarily a creative production, the thesis must also include a written report and participation in a graduate thesis show. Credit 0-**14 (offered every quarter)**

School of Design

Graphic Design

2010-711 Design Theory and Methods Seminar
Graphic design, computer graphics design, and industrial design MFA majors participate in this seminar to explore cross-disciplinary principles, theories, and methods from areas such as science, literature, architecture, urban design, anthropology, etc. that are relevant to problem solving in design. Through selected readings from current periodicals, critical writing, hands-on involvement, presentations and guest lectures, students broaden their awareness of topics such as systems thinking, human factors, semiotic theory and visual rhetoric, and become familiar with brainstorming and evaluation methods in order to sharpen their understanding of the overall design process. Focus will be directed toward meaningful concept development and the selection of appropriate methodologies for design problem-solving. **Credit 3**

2010-712 Graduate Typographic Design
This course investigates typographic hierarchy-the use of typographic variables to differentiate parts of a message with attention to communication and readability. Typographic grid structure, typographic detail, and formal aspects of typographic design are explored. Project focus is on the process of developing harmonious type and image integration within sequential design applications. **Credit 4**

2010-713 Design History Seminar
Graduate students in graphic design, computer graphics design and industrial design will be provided with a basis in the history of design which complements the overall graduate core in the School of Design as well as specific course work in each major field of design study. The course content focuses on subjects relative to the history of design (people, processes, products, places), critical thinking, and contextual historical issues. Students are expected to write critical essays and questions and to participate in weekly discussion groups. **Credit 3**

2010-716 Image Forms
This course investigates formal visual aesthetics related to graphic design problem solving. Emphasis is on the process of image selection or generation, analysis, ideation, and integration. Focus is given to strategic message-making and optimal audience comprehension. Theories and principles from visual rhetoric and semiotics are discussed and employed. Image-generation tools are selected from both traditional and digital media as appropriate for specific projects. **Credit 4**

2010-717 Graduate Systems Design
This course investigates various approaches toward visually and conceptually organizing components of graphic design problems (i.e. concepts, language, typography, imagery, color, space, and temporal or sensory considerations) for the purpose of clear, unified communication. Projects may include the creation of multiple components within an overall shared framework. **Credit 4**

2010-718 Graduate Information Design
This course stresses the importance of reader and user responses to written and visually presented information. Clarity and accessibility are prioritized during the investigation of many formats (charts, diagrams, tables, forms, maps, instructional materials, wayfinding systems, etc.) and their attributes. Projects also include testing mechanisms to substantiate design effectiveness. **Credit 4**

2010-722 Graduate Graphic Design Applications
Printing production processes, relevant terminology and technical constraints from pre-press to post-press are the focus of this course. File and color management for digital and conventional printing are emphasized. **Credit 4**

2010-724 Graduate Graphic Design Topics
Content in this course is tailored each year for the particular student group. Potential modules may include: design planning, human factors, interface design, writing and design, sequencing and narrative structures, and other relevant topics. This course involves research and design applications related to the selected course topic. **Credit 4**

2010-726 Design Issues Seminar
This graduate course exposes first-year graphic design, computer graphics design, and industrial design to the range of contemporary issues that face design professionals. Topics will include, but not be limited to, issues related to sustainable design, ethics and values, audience appropriateness, and the role of the designer in society. Selected readings, essays and in-seminar discussions are integrated throughout the course content. **Credit 3**

2010-861 Graphic Design Thesis Planning
This is the first in the sequence of courses focused on the MFA thesis requirement. Students are exposed to strategies that establish project content, planning, scheduling, and research. The product of the course is a fully articulated thesis plan. **Credit 4**

2010-862 Graphic Design Thesis Development
This is the second in a sequence of courses focused on the thesis project. Students are exposed to strategies appropriate to the continuation of project content, research, concept development, ideation, and in-process evaluation planning. **Credit 4**

2010-863 Graphic Design Thesis Implementation
This is the final course in a sequence of courses focused on the MFA thesis requirement. Students are exposed to strategies appropriate to the implementation and retrospective evaluation of an intensive design problem. Verbal/written articulation of their design process and the required public exhibition are a focus of this course. **Credit 4**

Computer Graphics Design

2014-701 Survey of Computer Graphics
The computer graphics profession is constantly progressing. This course will provide a conceptual framework to designing and implementing multimedia applications, game art and design, instructional multimedia, visualization, interactive animation, and Web page design. Students research ideas, concepts, uses, history, aesthetics, and design principles of computer graphics and interactive media as it relates to the ever-evolving field. The content integrates visual semiotics, information architecture, user interface guidelines, and icon design. Students will complete assigned projects and readings. (Computer graphics design major or permission of instructor) **Credit 2**

2014-711 Digital Video
Use of digital video cameras, lights and microphones for motion recording and the use of storyboarding, titling, editing, and software to create and format digital Quick Time movies of DVDs for multimedia productions or motion graphics. (Computer graphics design major or permission of instructor) **Credit 4**

2014-713 Design Research
This course will focus primarily on developing students' research and graphic design skills and exposing them to a range of writing techniques. Emphasis will be placed on an exposure to a wide range of research resources including the more traditional library vehicles, newer developments on the World Wide Web, and relevant archives and special collections. This course will begin to establish each student's thesis direction in very general terms by including the development of a preliminary thesis proposal and establishing an overview of research directions. (Course is limited to MFA majors in computer graphics design, industrial design or graphic design) **Credit 3**

2014-717 Authoring Multimedia
This course explores the art and design of interactive applications for the web, mobile devices, and tangible media. Exposure to computer graphic algorithms, design heuristics, design methodology, and program structure of two-dimensional imagery for multimedia design. Projects involve programming interactive user experiences for on line and mobile technology. (Computer graphics design major or permission of instructor) **Credit 4**

2014-721 3DDG Modeling
This course covers a contrast and comparison of various methods of creating geometry for use in three-dimensional environments including polygons, NURBS, and subdivision surfaces for various purposes. Skills learned can be applied to creating elements for computer and video games, creating virtual environments or in visualization. Students have the opportunity to work on projects of their own invention or with real world application. **Credit 4**

2014-722 3DDG Interactive Motion
This course covers first the use of animation in interactive environment including games, visualization, and virtual reality. Students will create animation using key frames, paths, deformation, forward, and inverse kinematics. **Credit 4**

2014-723 Graphical User Interface
This course provides an in-depth look at graphical user interface design. Students learn the basic components of a user interface, HCI (Human-Computer Interaction) and how to design alternative navigational solutions. (Computer graphics design major or permission of instructor) **Credit 4**

2014-731 3DDG Lighting
Students apply standard lighting methods to lighting three-dimensional models. The interaction of light and pigment, use of light in painting, photography, film, and computer graphics are used as examples. Students apply problem solving techniques to arrive at a lighting solution for various problems. (2014-721) **Credit 4**

2014-732 3DDG Shading
The course focuses on incorporating two- and three-dimensional groups of textures into realistic materials. Students learn to use texture maps instead of detail in models to increase interaction speeds. Textures are also used in order to incorporate simple models into diverse scenes. Displacement textures are used to create detail in models. Advanced techniques in the use of shading networks are incorporated into the process. (2014-721) **Credit 4**

2014-733 3DDG Character Design
This course covers first the design of characters and then the creation of them using three-dimensional software, inverse kinematics, and deformers. Students create interpretant matrices, model sheets, sketches, and maquettes of characters followed by development of the character in software. (2014-721) **Credit 4**

2014-741 3DDG Poly and SubD Modeling
This course provides extensive coverage of methods for modeling with polygons and subdivision surfaced. In addition students extend their knowledge of methods for laying out UVs for placing materials on polygonal shapes. **Credit 4**

2014-747 3DDG Rendering
This course covers a contrast and comparison of various methods and resolutions of rendering and outputting information from three dimensional software. (2014-721) **Credit 4**

2014-767 3DDG Particles and Dynamics
This course is the introduction to particle systems and dynamic simulations in a three-dimensional software environment. Students will create projects incorporating these dynamic stimulations in practical computer graphic contexts.

2014-782 3D Computer Graphics Design
This course is an introduction to desktop three-dimensional visualization. It also expands on previous visualization skills and design experiences to include fundamentals for more advanced studies in three-dimensional animation, virtual spaces, and multi-dimensional navigation spaces. (Computer graphics design major or permission of instructor) **Credit 4**

2014-784 **Digital Typography in Motion**
A study of digital typography and, in particular, digital type in motion as used in interactive applications and motion graphics. (2014-796 or permission of instructor) **Credit 4**

2014-785 **Instructional Multimedia**
Interactive and other software packages will be used to create instructional programs for different age groups. Course work will include subject matter research, developing objectives, creating graphics, sound and interactivity, and program evaluation. Each student will produce an instructional multimedia application. (Computer graphics design major or permission of instructor) **Credit 4**

2014-786 **2D Computer Animation**
This course will include two-dimensional computer animation techniques, linear and non-linear, and interactive storytelling methods, narrative design, character design and animation, digital sound, and both frame-based and scripting animation methods. These techniques will be used to create interactive, web, and broadcast narratives with animation. (First year computer graphics design major or permission of instructor) **Credit 4**

2014-787 **Advanced Computer Graphics Design I**
This course extends previous multimedia experience and skills to emphasize advanced multimedia applications that use gaming concepts, delivery systems, and software as a design tool for entertaining and informing. Students will work with two-, three-dimensional visual concepts, virtual reality, interactivity, and sound to develop games of their own. (Computer graphics design major or permission of instructor) **Credit 4**

2014-791 **Advanced Computer Graphics Design II**
This course provides the opportunity to expose students to the latest concepts, techniques, and skills in a quickly evolving technological and information oriented society. This course is open ended so that new information, techniques concepts, principles, software, and hardware can be introduced in a timely manner. (Computer graphics design major or permission of instructor) **Credit 3**

2014-796 **Special Effects**
Exposure to the development of visual effects and motion graphics for broadcast and the web. Computer software and storyboarding are used to create visual effects in both animation and live video. Sequencing, storyboarding, digital sounds, titling, animation, video clips, and special effects are integrated. (Computer graphics design major or permission of instructor) **Credit 4**

2014-797 **Advanced Computer Graphics Design III**
This course provides an in-depth look at creating an effective electronic portfolio. Students create, organize and design a portfolio based upon personal strengths and interests, with professional standards, and career expectations in mind. (Computer graphics design major or permission of instructor) **Credit 4**

2014-798 **Production Pipeline**
The course focuses on implementing a project from the planning stage, through implementation, to completion, and presentation. (2014-721, plus at least one other three-dimensional design computer graphics design course) **Credit 4**

2014-803 **3DDG Motion Integration**
This course covers techniques and the application of three-dimensional elements with a two-dimensional motion graphics setting. There will be a review of the entire production process from sketches and storyboards to final rendering. The focus will be on the entire process with an emphasis on creating three-dimensional assets quickly and efficiently. **Credit 4**

2014-831 **Thesis Planning**
This course helps the student to research and develop a thesis related to a design problem. A thesis statement, review of the literature, construction of a time line, and application of organizational skills are integrated into this course. Revision and refinement of the proposal are based on critique and feedback. This course is required before development of a final thesis project. (Required for second year computer graphics design majors) **Credit 2**

2014-890 **Thesis: Computer Graphics Design**
The development of a thesis project initiated by the student and approved by a faculty committee. Primarily a creative production, the thesis must also include a project report and participation in a graduate thesis show. (Computer graphic design majors only) **Credit 0–14**

Industrial Design

2035-708 **Furniture Design Graduate**
Experience in the design of furniture for a defined sector of the contract market is acquired through a project exercise involving industry collaboration. **Credit 3**

2035-711 **Advanced Computer Modeling I**
The first of three required graduate-level electronic media courses. The emphasis in this beginning level modeling course is learning software tools competency through assigned exercises and creative projects. The objective is student understanding of the nature, location, and use of all tools commonly available at the professional level for electronic surface modeling in degree three and higher B spline curves and surfaces. Learning simple effect-of motion techniques (turntable animation, fly-around animation) is included. **Credit 3**

2035-716 **Industrial Design Presentation**
Industrial designers are required to give many visual presentations throughout their academic and professional careers. This course will reinforce presentation principles and skills, both verbal and visual. Students will give numerous design presentations using appropriate supporting materials and media. (Prerequisite: Acceptance into MFA Industrial Design Program) **Credit 3**

2035-721 **Advanced Computer Modeling II**
The second of three required graduate-level electronic media courses. The emphasis in this second-level modeling course is learning higher software competency -techniques- for modeling complex and difficult shapes through assigned exercises and creative projects. The objective is student understanding of the most efficient use of professionally preferred tools for electronic surface modeling in degree three and higher B-spline curves and surfaces. (2035-711 or permission of instructor) **Credit 3**

2035-731 **Advanced Computer Modeling III**
The third of three required graduate-level electronic media courses. The goal for this third-level modeling course is learning higher software competency directed toward team working. The emphasis is in strategizing the process of modeling complex and difficult shapes to achieve results typically expected by professional project team members, through assigned exercises and creative projects. Included are the methods and techniques for flawless transferring of design intent of these electronic surface models to and from other professional-level surface and solids software. (2035-721 or permission of instructor) **Credit 3**

2035-736 **Industrial Design Problems I**
This course investigates various theoretical and philosophical approaches to design and provides a basis for critical analysis of current design problems. Projects will extend these ideas into the practice of industrial design as a mode of discourse. We will design, in two- and three-dimensional form, products and artifacts through a process of iteration and reiteration. Categories of products may include: consumer goods, equipment transportation, furniture, or packaging. (Acceptance into MFA industrial design program) **Credit 6**

2035-737 **Industrial Design Problems II**
This course is the second in a three-part series. The design problems we address will now require a more theoretically rigorous and research-based design approach. Our focus will be on human centered, culturally based design problems with supporting projects including: universal and appropriate product design, and environmentally responsible design practices. (2035-736) **Credit 6**

2035-738 **Industrial Design Problems III**
This course is the third in a three-part series. This course continues product design activities, but broadens the scope to focus on products and their interaction within a context. This broadening will involve project management, product testing and results analysis, with projects including environment design, mass customization, and niche production. (2035-737) **Credit 6**

2035-840 **Thesis Research**
Guidance in selecting and planning a thesis project, conducting a search for background material, and writing a thesis proposal. (Second-year MFA industrial design major or permission of instructor) **Credit 3**

2035-890 **Thesis: Industrial Design**
The development of a thesis project initiated by the student and approved by a faculty committee. Primarily a creative production, the thesis must also include a written report and participation in a graduate thesis show. **Credit 0–14**

School of American Crafts

Ceramics

2040-761, 762, 763, 764 **Ceramic Graduate Elective**
Basic instruction and experience in ceramic design, fabrication, and production of ceramic forms is undertaken. This study provides ceramic technology and terminology and gives experience with clays along with fundamental forming techniques. The development of design awareness is encouraged through lectures and critiques. Materials fee required. **Credit 3 per quarter**

2040-781 **Graduate Ceramics Studio I**
This is the first of a four-quarter sequential courses covering the advanced aesthetics and techniques in ceramics. This program is structured on the basis of the individual student's needs, interests and background preparation as they may be determined through faculty counseling. There will be a strengthening of ceramic techniques, design fundamentals, and encouragement of personal expression. The student will be encouraged to evaluate new techniques, materials, and concepts. This sequence leads to the master's thesis, proposed by the student and approved by the faculty. Materials fee required. **Credit 9**

2040-782 **Graduate Ceramics Studio II**
This is the second of a four-quarter sequential courses covering the advanced aesthetics and techniques in ceramics. This is a continuation of the program developed on the basis of the individual student's needs, interests and background preparation techniques, design fundamentals, and encouragement of personal expression. The student will be encouraged to evaluate new techniques, materials, and concepts. This sequence leads to the master's thesis, proposed by the student and approved by the faculty. Materials fee required. **Credit 9**

2040-783 **Graduate Ceramics Studio III**
This is the third of a four-quarter sequential courses covering the advanced aesthetics and techniques in ceramics. This is a continuation of the program developed on the basis of the individual student's needs, interests and background preparation as they may be determined through faculty counseling. The student will begin to seriously experiment with issues and themes that may prove relevant to their final selection of a thesis topic. The student will be encouraged to evaluate new techniques, materials, and concepts. This sequence leads to the master's thesis, proposed by the student and approved by the faculty. Materials fee required. **Credit 9**

2040-784 **Graduate Ceramics Studio IV**
This is the fourth of a four-quarter sequential course covering the advanced aesthetics and techniques in ceramics. This is the culmination, prior to the thesis studio course, of the program developed on the basis of the individual student's needs, interests, and background preparation as they have been determined through faculty counseling. The student will seriously pursue issues and themes that are relevant to their final thesis topic. The student will be encouraged to utilize new techniques, materials, and concepts. This sequence leads to the master's thesis, proposed by the student and approved by the faculty. Materials fee required. **Credit 9**

2040-890 **Ceramics Graduate Thesis**
The development of an acceptable thesis project initiated by the student and approved by the student's thesis committee and chairperson of the school. Primarily a creative production resulting in a body of work, the thesis will include a written report, which addresses the body of work. The work will be exhibited in the graduate thesis show. **Credit 0–18**

Glass

2041-761, 762, 763, 764 **Glass Graduate Elective**
Collaborative work in the student's major area of study and glass fabrication is encouraged. Various techniques, both hot and cold, will be considered in different quarters: casting, slumping, fusing, blowing, engraving, sand carving, cutting, lamp working, and sculptural construction. Course emphasis on personal, independent development encouraging contemporary thought and concept. Materials fee required. **Credit 3 per quarter**

2041-781 **Graduate Glass Studio I**
This is the first of a four-quarter sequential courses covering the advanced aesthetics and techniques in glass. This program is structured on the basis of the individual student's needs, interests, and background preparation as they may be determined through faculty counseling. There will be a strengthening of ceramic techniques, design fundamentals, and encouragement of personal expression. The student will be encouraged to evaluate new techniques, materials, and concepts. This sequence leads to the master's thesis, proposed by the student and approved by the faculty. Materials fee required. **Credit 9**

2041-782 **Graduate Glass Studio II**
This is the second of a four-quarter sequential courses covering the advanced aesthetics and techniques in glass. This is a continuation of the program developed on the basis of the individual student's needs, interests, and background preparation techniques, design fundamentals, and encouragement of personal expression. The student will be encouraged to evaluate new techniques, materials, and concepts. This sequence leads to the master's thesis, proposed by the student and approved by the faculty. Materials fee required. **Credit 9**

2041-783 **Graduate Glass Studio III**
This is the third of a four-quarter sequential courses covering the advanced aesthetics and techniques in glass. This is a continuation of the program developed on the basis of the individual student's needs, interests, and background preparation as they may be determined through faculty counseling. The student will begin to seriously experiment with issues and themes that may prove relevant to their final selection of a thesis topic. The student will be encouraged to evaluate new techniques, materials, and concepts. This sequence leads to the master's thesis, proposed by the student and approved by the faculty. Materials fee required. **Credit 9**

2041-784 **Graduate Glass Studio IV**
This is the fourth of a four-quarter sequential courses covering the advanced aesthetics and techniques in glass. This is the culmination, prior to the thesis studio course, of the program developed on the basis of the individual student's needs, interests, and background preparation as they have been determined through faculty counseling. The student will seriously pursue issues and themes that are relevant to their final thesis topic. The student will be encouraged to utilize new techniques, materials, and concepts. This sequence leads to the master's thesis, proposed by the student and approved by the faculty. Materials fee required. **Credit 9**

2041-890 **Glass Graduate Thesis**
The development of an acceptable thesis project initiated by the student and approved by the student's thesis committee and chairperson of the school. Primarily a creative production resulting in a body of work, the thesis will include a written report, which addresses the body of work. The work will be exhibited in the graduate thesis show. **Credit 0–18**

Metalcrafts and Jewelry Design

2042-761, 762, 763, 764 **Metals Graduate Elective**
This course offers students fundamental, intermediate and advanced fabrication/forming techniques as they apply to hollow ware and jewelry design. Creative designs and innovative artistic concepts are encouraged. Individual and group instruction covers the properties of various metals, the use of the shop equipment, and safety procedures as they apply to metalsmithing. Materials fee required. **Credit 3 per quarter**

2042-781 **Graduate Metals Studio I**
This is the first of a four-quarter sequential courses covering the advanced aesthetics and techniques in metals. This program is structured on the basis of the individual student's needs, interests and background preparation as they are determined through faculty counseling. There will be a strengthening of material knowledge and explore design fundamentals, and encouragement of personal expression. The student will be encouraged to evaluate and explore new techniques, materials, and concepts. This sequence leads to the master's thesis, proposed by the student and approved by the faculty. Materials fee required. **Credit 9**

2042-782 **Graduate Metals Studio II**
This is the second of a four-quarter sequential courses covering the advanced aesthetics and techniques in metals. This is a continuation of the program developed on the basis of the individual student's needs, interests and background preparation techniques, design fundamentals, and encouragement of personal expression. The student will be encouraged to evaluate new and innovative concepts. This sequence leads to the master's thesis, proposed by the student and approved by the faculty. Materials fee required. (2042-781) **Credit 9**

2042-783 **Graduate Metals Studio III**
This is the third of a four-quarter sequential courses covering the advanced aesthetics and techniques. This is a continuation of the program developed on the basis of the individual student's needs, interests, and background preparation as they may be determined through faculty counseling. The student will seriously explore issues and themes that may prove relevant to their final selection of a thesis topic. This sequence leads to the master's thesis, proposed by the student and approved by the faculty. Materials fee required. (2042-782) **Credit 9**

2042-784 **Graduate Metals Studio IV**
This is the fourth of a four-quarter sequential courses covering the advanced aesthetics and techniques in metals. This is the culmination, prior to the thesis studio course, of the program developed on the basis of the individual student's needs, interests, and background preparation as they have been determined through faculty counseling. The student will seriously pursue issues and themes that are relevant to their thesis topic. The student will be encouraged to utilize new techniques, materials, and concepts. This sequence leads to the master's thesis, proposed by the student and approved by the faculty. Materials fee required. (2042-783) **Credit 9**

2042-890 **Metals Graduate Thesis**
The development of an acceptable thesis project initiated by the student and approved by the student's thesis committee and chairperson of the school. Primarily a creative production resulting in a body of work, the thesis will include a written report, which addresses the body of work. The work will be exhibited in the graduate thesis show. **Credit 0–18**

Textiles

2043-761, 762, 763, 764 **Textile Graduate Elective**
This is the study and appreciation of weaving and textile techniques, soft sculpture, off-loom weaving, and printing. Design approaches are stressed. Materials fee required. **Credit 3 per quarter**

Woodworking and Furniture Design

2044-761, 762, 763, 764 **Wood Graduate Elective**
This is a course in woodworking techniques and procedures. It enables the student to gain design competency through wood and an individual solution to wood projects based on suggested needs. Materials fee required. **Credit 3 per quarter**

2044-781 **Graduate Wood Studio I**
This is the first of a four-quarter sequential courses covering the advanced aesthetics and techniques in wood. This program is structured on the basis of the individual student's needs, interests, and background preparation as they may be determined through faculty counseling. There will be a strengthening of wood techniques, design fundamentals, and encouragement of personal expression. The student will be encouraged to evaluate new techniques, materials, and concepts. This sequence leads to the master's thesis, proposed by the student and approved by the faculty. Materials fee required. **Credit 9**

2044-782 **Graduate Wood Studio II**
This is the second of a four-quarter sequential courses covering the advanced aesthetics and techniques in wood. This is a continuation of the program developed on the basis of the individual student's needs, interests and background preparation techniques, design fundamentals, and encouragement of personal expression. The student will be encouraged to evaluate new techniques, materials, and concepts. This sequence leads to the master's thesis, proposed by the student and approved by the faculty. Materials fee required. (2044-781) **Credit 9**

2044-783 **Graduate Wood Studio III**
This is the third of a four-quarter sequential courses covering the advanced aesthetics and techniques in wood. This is a continuation of the program developed on the basis of the individual student's needs, interests, and background preparation as they may be determined through faculty counseling. The student will begin to seriously experiment with issues and themes that may prove relevant to their final selection of a thesis topic. The student will be encouraged to evaluate new techniques, materials, and concepts. This sequence leads to the master's thesis, proposed by the student and approved by the faculty. Materials fee required. (2044-782) **Credit 9**

2044-784 **Graduate Wood Studio IV**
This is the fourth of a four-quarter sequential courses covering the advanced aesthetics and techniques in wood. This is the culmination, prior to the thesis studio course, of the program developed on the basis of the individual student's needs, interests, and background preparation as they have been determined through faculty counseling. The student will seriously pursue issues and themes that are relevant to their final thesis topic. The student will be encouraged to utilize new techniques, materials, and concepts. This sequence leads to the master's thesis, proposed by the student and approved by the faculty. Materials fee required. (2044-783) **Credit 9**

2044-890 **Wood Graduate Thesis**
The development of an acceptable thesis project initiated by the student and approved by the student's thesis committee and chairperson of the school. Primarily a creative production resulting in a body of work, the thesis will include a written report, which addresses the body of work. The work will be exhibited in the graduate thesis show. **Credit 0–18**

General Craft Studies

2045-721 **Thesis Implementation**
This course, coordinated and overseen by the SAC graduate coordinator and thesis chief advisor, will monitor the progress of a graduate student in the development of the comprehensive and well-integrated body of work that constitutes their thesis. Students will review their work, both thesis and non-thesis, regularly throughout the quarter with both their major faculty and their thesis committee members. A minimum of two comprehensive thesis reviews will take place during the quarter, reviewed by thesis committee members. A final and formal thesis critique will take place at the end of the quarter. Students will receive a written evaluation of the evaluation. **Credit 2**

2045-722 **Thesis Review**
This course, coordinated and overseen by the SAC graduate coordinator and thesis chief advisor, will continue to monitor the progress of a graduate student in the development of the comprehensive and well integrated body of work that constitutes their thesis. It will determine a students' final readiness to exhibit their thesis work in the Spring Thesis Exhibitions. Students will review their work, both thesis and non-thesis regularly throughout the quarter, with both their major faculty and their thesis committee members. A minimum of two comprehensive thesis reviews will take place during the quarter, reviewed by thesis committee members. A final and formal thesis critique will take place at the end of the quarter. Students will receive a written evaluation of the evaluation. **Credit 2**

2045-723 **Graduate Crafts Seminar**
This course will examine the investigative process required for a craft artist to develop a comprehensive and well-integrated body of work. Students will review the work of known artists; and will research the themes and issues in their own work. They will work with the faculty and their thesis committee to develop strong viable themes for their thesis. This course if offered only in spring quarter. **Credit 2**

School of Film and Animation

Film and Animation

2065-701 **History and Aesthetics of Film**
An extended comparative survey of the history and aesthetics of film that will explore the four basic forms of the medium: fiction, documentary, animated, and experimental. Emphasis is on determining the unique characteristics of the medium and how those characteristics are used as a means of interpretation and expression. **Credit 4 per quarter**

2065-706 **Introduction to Drawn Animation**
Three different courses in 2D animation are offered. Each course provides a different focus and assumes considerable drawing skill. This course consists of seven intensive exercises based on timing, characterization and weight. Students will apply foundation principles to hand drawn movement. All projects will be shot under camera, timed and presented professionally. **Credit 3**

2065-711 **Film and Animation Core**
Major emphasis is placed on the individual's learning to generate and intensify his or her personal statement through creative projects. Some of the projects are assigned, while the candidate selects others. Work is critiqued weekly by the instructor. (Restricted to MFA computer animation major) **Credit 4 per quarter**

2065-717 **Production Processes**
An introduction to all aspects of professional film/video narrative production. Students produce short projects while learning basic shooting and crewing procedures, equipment handling, and maintenance. Students will do research on appropriate topics arranged with instructors. (2065-611) **Credit 6**

2065-721 **Animation and Graphic Film 1**
An introduction to the techniques and practice of graphic and animated film production. This course provides training and practical experience in a wide variety of approaches to single-frame motion picture production. Students produce a number of short film exercises utilizing both existing and original artwork. Some techniques covered in the course are: direct modification of the film surface; cell, ink and paint animation; and kinestasis. Screenings of professionally made films will illustrate each technique. Proficiency in drawing is not required. **Credit 4**

2065-724 Live Action Pre-production
Students will learn the basic pre-production techniques for narrative fiction, experimental and documentary filmmaking. Students will also prepare a pre-production binder in a genre of their choice to be used in an actual production workshop. Graduate students will be required to do advanced pre-production for their projects. This includes having locations secured and actors auditions completed. **Credit 3**

2065-726 Graduate Live-action Seminar
This course allows students to conceive and develop their ideas for their winter core film. Students are required to complete all necessary pre-production so they are ready to move into production at the beginning of winter quarter. (2065-711) **Credit 2**

2065-727 Scriptwriting for Animation
This course explores the principles of dramatic structure and storytelling in both fiction and nonfiction animated film and video. Students prepare short scripts suitable for production. **Credit 4**

2065-731 Film and Video Tools and Technology
An intensive tools and technology course that will allow the student to work in the digital video format. Examines the technical concerns of single and double system portable video production and editing. Production skills in camera work, editing, and sound recording will be covered. (Must have completed required bridge work) **Credit 4**

2065-732 Basic Sound Recording
Learn the techniques of production sound recording, how to use professional recording gear and proper recording and mixing techniques to realize a fully mixed soundtrack to professional quality standards. This course includes fundamental information about sound and sound recording equipment and establishes the foundation for future sound work in advanced production classes. **Credit 3**

2065-733 Graduate Screen Writing
This course explores the writing of fiction for theatrical and non-theatrical films and television. Training concentrates on the elements of dramatic construction. A brief exploration of non fictional writing, examining preparation, information gathering techniques, and methods of investigation will also be assessed. Both nonfiction and fiction are treated as expository, storytelling forms. Students are responsible for writing a film or television script on a subject of their own choosing and for completing several brief written exercises in areas such as character, dialogue, suspense, subtext, and plot. Class discussion is based on assigned readings, in-class exercises, and in-class reading of student work. (2065-342 or equivalent) **Credit 3**

2065-734 Graduate Screen Writing II
A workshop in writing a short film script. This course focuses on story proposal, script treatment, writing, and rewriting a short script. (2065-733 or permission of instructor) **Credit 4**

2065-736 Theory via Short Narrative Film
A screenings, classic theory readings, and discussion course designed to introduce MFA production and animation graduate students to themes in classic film theory. A variety of short films and videos will be employed paired with extensive readings from classic theory from the span of the past century of world cinema. **Credit 4**

2065-737 2D Computer Animation I
Students in this course create animated sequences and projects using a commercial animation software package for a popular microcomputer. In addition to mastering specific software, students learn the principles of digital computer operation and how those principles apply to the problems of animation with computers. (2065-721) **Credit 4**

2065-738 2D Computer Animation II
This course focuses on the integration of computer animation into film and video. Students produce a finished animated project on film or videotape with sound, which can be used as a portfolio piece. Emphasis is placed upon various postproduction strategies which involve such techniques as combining computer animation with live action, the addition of film and video special effects and combining computer animation with existing film or video imagery. (2065-721) **Credit 4**

2065-741 Graduate Drawing for Animation: Dynamics
This advanced course focuses on drawing of drawn animation. It is one of three different courses in drawing for animation offered, which do not need to be taken in sequence; each course provides a different focus. Students explore the use of acceleration and deceleration squash, and stretch, maintaining volume, anticipation, secondary action, overlapping action, paths of motion, follow through, and exaggeration. A variety of examples of drawn animation will be screened in class. Gesture drawing from live models may be included. (Figure in Motion) **Credit 3**

2065-742 Graduate Drawing for Animation: Sequence
This advanced course focuses on structuring the shots in a scene. It is one of three different courses in drawing for animation offered, which do not need to be taken in sequence; each course provides a different focus. Flexibility is provided for students at different stages of development. Students learn how to break a scene into shots and storyboard the sequence. They learn to compose the frame for action and juxtapose one shot against the next. Students learn to use exposure sheets to plan out animation, and animate short sequences using acquired skills. A variety of examples drawn animation will be screened in class. Gesture drawing from live models may be included. (Figure in Motion) **Credit 3**

2065-743 Graduate Drawing for Animation: Character
This advanced course focuses on character development for animation. It is one of three different courses in drawing for animation offered, which do not need to be taken in sequence; each course provides a different focus. Students produce character sheets. They explore different perspectives of the character drawing from imagination and use the characters in sequential frames of motion. A variety of drawn animation examples will be screened in class. Gesture drawing from live models may be included. (Figure in Motion) **Credit 3**

2065-744 Business of Animation
This class is intended to give students an understanding of studio production and freelance animation. Students will learn the basics of running a business. Production issues particularly related to animation will be studied. Methods of examining costs and projecting work time lines will be practiced. Students will draw up contracts and negotiate terms. Copyright law as it applies to distribution and contracts will be studied. A business plan will be developed by each student. **Credit 2**

2065-745 Acting for Film and Video
A course in basic acting technique with emphasis on the special problems peculiar to film and video production. The class is taught in conjunction with Directing the Actor (2065-746). Class meetings are organized around the presentation of scenes prepared by student actors and directors. **Credit 4**

2065-746 Directing the Actor
A course in basic directorial techniques with emphasis on the special problems peculiar to film and video production. This class is offered concurrently with 2065-745. Class meetings are organized around the presentation of scenes prepared by student directors. **Credit 4**

2065-747 Introduction to 3D Computer Animation
This course is an introduction to three-dimensional computer animation. Topics will include modeling using NURBSs and polygons, basic texture mapping and lighting, keyframe animation, forward and inverse kinematics, and rendering. Professional animation software such as Alias/Wavefront's Maya package will be used throughout. By the end of the course, students will be able to model basic characters and objects and to create a simple animation and render a sequence of frames. **Credit 4**

2065-748 Intermediate 3D Computer Animation
This course gives students the skills to develop their own digital characters. Topics will include advanced modeling, facial expressions, character rigging, nonlinear animation, and the use of "Paint Effects" to create hair and vegetation in software such as Alias/Wavefront's Maya. By the end of the course, students will be able to create and rig their own characters, with facial expressions and hair. They create a short animation introducing their character and demonstrating a range of emotions. (2065-747) **Credit 4**

2065-750, 751, 752, 753 Special Topics-Graduate
Advanced topics of current or special interest designed to broaden and intensify the student's ability to use animation as a means of communication and expression. **Credit 3–9**

2065-754 Writing the Feature I
A production workshop in developing and writing the outline and first act for a feature length film script or episode TV series; also can be taken by students who want to rewrite an existing feature length screenplay. This course focuses on proposing a script and writing the outline for a feature film of TV series. Students work at their own level within the class, and discussions provide feedback and incentive. The project can be continued in Writing the Feature I (2065-755). (2065-734) **Credit 4**

2065-755 Writing the Feature II
A continuation of Writing the Feature I (2065-745). Students will complete the script they began to develop in the first class. This course can also be taken by students who want to rewrite an existing feature length screenplay. (2065-754) **Credit 4**

2065-756, 757, 758 Film and Animation Workshop
Each faculty member offers a different opportunity for students to explore the multiplicity of ways that photography or filmmaking can be used as a vehicle for expression and communication. Visual research, group critiques, field trips, studio and laboratory practice are used. **Credit 4**

2065-761 Image Movement Music
A seminar-level course co-sponsored by the College of Imaging Arts and Sciences at RIT, the Eastman School of Music (University of Rochester), and the Graduate Department of Dance at SUNY College at Brockport. Lecture/demonstration held during the first six-weeks of the course are designed to provide all students with a basic, practical knowledge of current and experimental performance and production techniques in film, video and animation, and contemporary art, music, dance/choreography and related arts. During the latter four-weeks of this course, students will work jointly and individually, under faculty advisement, on creative or research projects involving combinations of image, movement, and sound/music. Weekly three-hour classes will be held alternately at three schools. Transportation will be provided. (Graduate status) **Credit 3**

2065-762 Stop Motion Animation
Explore techniques for producing stop motion animation. Gain familiarity with the use of a variety of materials, which may include clay, puppet, foam, latex, and more. Develop techniques for making armatures and skeletons and creating joints. Learn how to measure movement from frame to frame. Research and write about a stop motion technique or animator. (2065-331 or 2065-721) **Credit 4**

2065-763 Women's Stories, Women's Films
This course provides an introduction to women's films. Through screening films and class discussion, the course examines the themes and issues of women's narratives and how they function in the medium of film. The hero's journey and traditional narrative structure are contrasted with the heroine's journey and the more personal storytelling style of the feminine. The course also examines differences in films made by women and films made by men about women. During the course, students will have an opportunity to explore their own creativity. **Credit 4**

2065-764 Business of Film and Video
This course examines the business aspects of designing, developing, and producing film or video projects. Emphasis is on development of production projects with interactive problem solving experiences in which the instructor and students work as a production team. Special attention will be given to the role of the producer, estimation and management of production costs, problems of location productions, and the legal issues involved in filmmaking. **Credit 3**

2065-766 Advanced Modeling for Animation
A detailed approach to the construction of complex three-dimensional forms, object deconstruction, problem solving, modeling methodologies, and the advantages and disadvantages of various construction methods. Lighting and texturing techniques will be incorporated into three dimensional objects as they relate to an extension of the modeling process. Each modeling solution is tested in the lab and discussed in lecture with the required notion that animation is the end goal for each model. Students will perform three-dimensional modeling exercises and create three-dimensional projects including a complex object and a humanoid character. (2065-457 or 2065-747 or instructor permission) **Credit 4**

2065-767 Directing for Animation
A seminar in solving directorial problems for animators. Topics will include character and movement development, working with actors and models, identifying and understanding scene construction, directorial responsibility, and the relationship between images in sequence. Both the application of acting techniques for creative development and the aesthetic demands of "visual music" will be emphasized. (2065-347) **Credit 3**

2065-768 Lighting for Film and Video Production
This course will present the fundamental principles of lighting for film and video production. The current methods and practices of lighting used in the motion picture industry will be explored through demonstrations, lectures, and "hands on" lab assignments. (2065-311, 2065-431 or 2065-731) **Credit 3**

2065-769 Digital Video Post-production
Explore techniques for editing video in a non-linear technique. Students will be exposed to non-linear editing, titling, special effects, audio, and video. Students will produce a series of projects exploring different capabilities on a non-linear editing system. In addition students will be exposed to the various aesthetic theories of editing. (2065-731) **Credit 4**

2065-771, 772, 773, 774 Graduate Seminar I
The seminar provides an opportunity for all MFA students to develop a sense of community and to openly discuss matters of concern, to discuss each other's animations or films, to meet with visiting artists on campus and to participate in a thesis sharing from time to time. (Restricted to MFA Computer Animation majors) **Credit 2 per quarter**

2065-774 Post Production Process
This course is designed to teach students the professional workflow of handling digital film and video files through the complex post production process. Areas of study include learning a cinema file database, media management, color correction, HD compositing, visual and time base effects, sound professing and track building, and titling and graphics. (2065-717) **Credit 4**

2065-776 Dramatic Structure in Film and Television
This course explores the theories of dramatic structure from Aristotle to the present and applies these theories to current and classic dramatic works. The course also explores writing for film and television, including feature film genres, one-hour drama, mini series, soap opera, and sitcom. A segment on the business of writing covers reader's reports, adaptation of material from other media, and acquisition of rights. **Credit 3**

2065-777 Film and Video Internship: Graduate
Provides the student with on-the-job experience in the field of film/video/animation. The student seeks and acquires a school approved internship position in a business or industry. The working environment provides the forum for learning more about the student's chosen career. A final interview with the internship coordinator assists the student in evaluating the experience. The coordinator should be the faculty member most familiar with the student's internship field. (Permission of internship coordinator) **Credit 1–6**

2065-781 Alternative Processes
An advanced course in the production and presentation of still or moving images using historical and contemporary visual imaging processes. Emphasis is on extending the students' experience in image making by incorporating alternatives to conventional animation or filmmaking into their work. Processes to be covered include lighting, inverse kinematics, digital cinematography, particles, procedural animation, compositing, montage, and combinations of techniques. **Credit 4 per quarter**

2065-784 DVD Authoring
This course is designed to introduce the design and practices of the DVD development with emphasis on rethinking a completed film project. The student develops a specific DVD based on a film they have completed. Class discussion and presentation is oriented towards new directions for the film story with interactivity and sequencing considerations. The student will acquire development tools to include: menu development, subtitles, audio streams, encoding principals, hybrid DVD creation, web linking (DVD@ccess), and basic scripting. **Credit 4**

2065-786, 787, 788 Contemporary Issues
A study of current issues relevant to fine art photography and filmmaking, how they relate to broader historical/cultural issues and how they might suggest future directions. **Credit 2 per quarter**

2065-791 Particle Effects
This course gives students the skills to insert three-dimensional computer special effects into animation and live action footage. The students explore three-dimensional computer particle animation and dynamic simulation using Maya software. Students will create short animations using particle effects, soft bodies, and rigid bodies to simulate nature effects like fire, rain, water and physics-based dynamic, and collision events. MEL scripting is an integral part of this course. (2065-747) **Credit 4**

2065-792 Gesture Drawing for Animators
This course will consist of intensive anatomy and quick sketch workshops using live models and references from videos, Internet, and print sources. Live models, both human and animal, will be scheduled for a portion of each class. Students will study kinesiology, the effect of movement on muscle and bone, and comparative anatomy. As a final project students will create original imaginary characters based on their class assignments. Most of the course work will be in class drawing sessions. Graduate students will create additional materials such as maquettes and animation cycles or Maya models. (2013-211) **Credit 3**

2065-793 Node-based Digital Compositing
Node-based compositing is the industry standard for film and HD video image compositing. This course, currently offered only in the spring quarter, covers the basics of node based compositing trees, color correction, garbage and hold-out mattes, keying, resolution proxies, motion tracking, macros, and expressions. (2065-731) **Credit 4**

2065-796 **Programming for Artists**
Students will learn scripting languages in three-dimensional applications. General logic concepts and code structures will be discussed fully. How to use these structures within the framework of the three-dimensional application will then be the focus. A final graduate project consisting of creating a useful automating script will be assigned. (2065-747) **Credit 4**

2065-797 **Methods in Motion**
This course will give graduate students an opportunity to explore a visual language of acting, timing, posing, and animation principles that will help strengthen their animation abilities. Every animator needs to build a library and understanding of animated movements and timing that they can draw on for all of their future animated films. The graduate section will have the added elements of sound and its relationship to the visual movement to study and understand. **Credit 3**

2065-799 **Independent Study**
Learning experiences not provided by formal course structure may be obtained through the use of an independent study contract. (Approval required) **Credit 1–9**

2065-812 **Advanced Sound Recording**
This course discusses and demonstrates how to accomplish complex audio post-production procedures like ADR, Foley recording, and mixing for film and video. This course is heavily based on the evaluation of the students' performance on three deadlines for a group project that the entire class participates in. (2065-732) **Credit 3**

2065-813 **Career Planning and Portfolio**
This course offers practical advice and assistance in job-seeking and life after RIT. In addition, the course aids students in preparing projects for festival entry and distribution. Materials produced by the student include a resume, portfolio, and work reel. Students will do research and writing related to their specific career plan. (2065-711) **Credit 2**

2065-818 **Advanced Storyboard and Layout**
This course involves creation of in-depth storyboard, production design, and art direction for various media. Students will work on predesigned characters as well as their own projects. Differing styles of layout, boarding, and workbook will be explained. (2065-743) **Credit 3**

2065-821 **Underwater Cinematography**
This course is designed to prepare students to professionally complete cinematography assignments in the underwater environment. To accomplish this students' will complete basic scuba diving training and achieving scuba diving certification. The student will become familiar with underwater video camera housings and accessories and basic underwater shooting techniques. Graduate students will research video housing types and applications. There is a facility fee to cover equipment, off campus facility use, texts and insurance. (2065-717 and facility fee) **Credit 4**

2065-822 **Advanced Stop Motion Animation**
Explore advanced techniques for producing stop motion animation. Gain familiarity with the use of a variety of materials, which may include clay, rubbers, aluminum, and more. Develop techniques for making armatures using wire and steel joints. Learn character performance in gesture and expression. Practice methods of miniature lighting and photography, uses digital effects. (2065-372) **Credit 3**

2065-824 **Directing a 30-second Commercial**
Graduate students learn how to direct and produce television commercials beginning with developing the creative idea, experiencing all facets of pre-production including talent casting, selecting crew, and location scouting followed by commercial film or video production through editorial. Students will meet with advertising agency personnel and established industry professionals in order to learn more about the process. Graduate students will be required to do additional post production. **Credit 4**

2065-841, 842, 843 **Research Seminar**
This seminar serves as a planning stage for preparing a research thesis proposal and for an ongoing critique and discussion of the research in progress. Issues related to exhibitions, publications, distribution, and gallery also are covered. (JPHC) **Credit 2**

2065-845 **Acting for Film and Video II**
An intermediate level acting class working in depth with techniques and approaches introduced in the basic acting class with the additional focus of using external observation to determine appropriate behavior. Class meetings are organized around the presentation of scenes prepared by student actors and directors. The class is taught in conjunction with Directing the Actor II. (2065-745) **Credit 3**

2065-846 **Directing the Actor II**
The class offers in-depth study of techniques introduced in the basic directing class, with an additional focus on using external observation to determine appropriate behavior. This course emphasizes the special problems peculiar to film and video production. Class meetings are organized around the presentation of scenes prepared by student directors using the acting students in the class. Meets in conjunction with Acting II for Film and Video, 2065-845. (2065-746) **Credit 3**

2065-857 **The New Documentary**
The goal of this course is to introduce the student to trends in documentary film during the last decade. During class discussions, we will examine each film critically; analyzing the film theme, structure, style, intent, and effectiveness. Some of the issues that will be discussed are the rise of personal voice in documentary, the impact of political documentary, the trend towards combing fiction and nonfiction techniques, and the ethical relationships between subject and filmmaker. The graduate student who takes this course is expected to go on to make their own documentary film that expresses some of the contemporary issues that we examine in this class. This will be evident by the in-depth discussion between the teacher and the graduate student, about how the issues inform and influence their own films. **Credit 3**

2065-884 **3D Lighting**
Students will learn to use lighting in digital three-dimensional software. The process for developing projects in class will be critique based. Projects may include modeling and lighting simple objects or spaces, matching a three-dimensional object or space to a scanned photographic or video image in lighting, quality, and perspective. Elements of the rendered software that relate to lighting will be discussed fully. A final graduate project mastering one or more advanced lighting concepts will be completed for completion of the course. (2065-747) **Credit 4**

2065-890 **Research and Thesis: Film and Animation**
This thesis is designed and proposed by the candidate. It is considered his or her culminating experience in the program, involving research, a creative body of work, an exhibition or suitable presentation, and a written illustrated report. (Approval required) **Credit 0–12**

School of Photographic Arts and Sciences

Graduate Photography

2066-701, 702, 703 **History and Aesthetics of Photo**
This required seminar surveys and examines the development of the medium beginning with prehistory. Students will explore the first applications of photographic documentation, portraiture, art, and science and will study photography in the context of visual culture. **Credit 3 per quarter**

2066-711, 712, 713 **Photography Core**
Students engage in a rigorous group critique process to develop a mature body of work, which combines experimental and analytical learning methods. They develop aesthetic and technical strategies for the production and presentation of artwork. They also address theoretical research, contemporary art concepts and methodologies, informing practice. This course is required each quarter in the first year of the MFA photography graduate program. **Credit 4 per quarter**

2066-732 **Professional Development**
To prepare students for their professional life beyond graduate school. Students will gain practical knowledge in portfolio preparation, visual display, grant writing, and contract negotiations for their art making practice. In preparation for employment students will learn about and prepare teaching philosophies, resumes, and a professional portfolio. (2066-711) **Credit 4**

2066-745 **Moving Media 1**
Graduate students taking this tools course will work with still photographs, electronic images, video footage, and camera recorded sound to create new work that merges the disciplines of photography and video. Students will use media software to produce work that weaves photography and video. Students will explore experimental narratives, conceptual constructions, and performance. They will work with traditional photography processes, electronic media, and projection equipment to create and display their projects. Students will research the Media Cafe collection, exploring the history and evolution of the art of the moving image. Each student will produce a final project for public presentation during the final week of class. **Credit 5**

2066-750, 751, 752, 753 **Special Topics Workshop**
Advanced topics of current or special interest designed to broaden and advance the student's knowledge of photography and related media. Recent topics include Women and Visual Imaging, Warhol and Beuys Art and Censorship and Digital Media Cafe. **Credit 4 per quarter**

2066-754 **Museum Studies**
Students study advanced topics related to museum and gallery practice through internships, research and projects, which are formally proposed by the student. Emphasis is placed on the function and administration of museums, galleries and the conceptual nature of curating and planning exhibits. (Graduate Status) **Credit 1–9**

2066-755 **Moving Media 2**
Moving Media 2 builds on the foundational skills and artistic language provided in Moving Media 1. Students work with electronically produced imagery to develop advanced technical skills. Students bring their intellectual studies to practice with a mastery of complex video editing techniques. They will learn sound recording, sound theory, sound manipulation, and sound editing techniques. Students work on assignments as well as self-generated projects. Students study contemporary sound artists and analyze the various strategies artists use to convey their ideas. Each student will produce a final project for public presentation during the final week of class. The work of each student will be stores in the Media Cafe collection at Wallace Library. (2066-745) **Credit 5**

2066-756 **Photographic Workshop**
Each faculty member offers a different opportunity for students to explore the multiplicity of ways that photography and related media can be used as a vehicle for expression and communication. Visual research, group critiques, field trips, studio, and laboratory practice and critical readings are used. Workshops may be taught as a theme class or on an individual basis to provide students with critical feedback on projects. Recent theme classes include: Digital Media Cafe, Web Seminar, Electronic Arts Seminar, and Imaging the Self. **Credit 4 per quarter**

2066-761 **Graduate Digital Imagery I**
This graduate course addresses the vital issue of digital imaging in regards to workflow from a fine art perspective. In combination with this practical approach, this course also places fine art digital image-making within the historical context of art, photography, and culture, in particular its relationship to be photomechanical and new media. Students will learn both the thought and practice of digital imaging from conceptualization to capture, with consideration to its specific aesthetic language. This course does not require a pre requisite or corequisite for registration. Interested students are expected to demonstrate basic computer literacy and competency. **Credit 3**

2066-763 **Beyond the Family Album**
Beyond the family album is a fine art photography course that balances the production of original art work with primary and secondary research, within an intensive critique and seminar format. The narrative of the conventional family album will be a core subject for discussion and study. The concept of 'album' will go beyond the conventional book form to embrace photographic imagery, installation, text, digital forms, and the use of family mementos. Interdisciplinary critical readings and visual art projects concerning issues of identity, and representation of family life in the public and private sphere will form the underpinnings of primary research, against which visual and written projects will be produced. Graduate students will create an original body of artwork on the topic and contribute written and visual material to a class research archive. (MFA or permission of instructor) **Credit 4**

2066-765 **Photography Extensions**
Strip photography, slit/scan photography and stroboscopy are used to probe and artistically manipulate spatial and temporal dimensions in order to create unseen poetic expressions of a space/time continuum. Perceptual principles and technical problems associated with the production and exhibition of such images are studied. **Credit 4**

2066-770 **Photography in the Desert Southwest**
An extended workshop for students to photograph and travel in the Four Corners region of the American southwest with an instructor leading a camping tour through New Mexico, Utah, Colorado and Arizona. Federal and state campgrounds are exclusively used. Students participate in day trips and hikes or make their own daily itinerary. Maps and reading assignments introduce students to the geology, climate, history, and cultures of the Southwest. **Credit 3–9**

2066-771, 782, 783 **Graduate Seminar**
Graduate Seminar is designed to engage students in dialogue with guest speakers and faculty on their professional work. Each class involves a professional presentation by a different speaker to be followed by discussion. Activities that foster the emerging career of the artist are stressed. **Credit 2**

2066-786 **Contemporary Issues**
A study of current issues relevant to fine art photography and related media, how they relate to broader historical/cultural issues and how they might suggest future directions. Emphasis is placed on the integration of critical theoretical discourses and studio practice. **Credit 2 per quarter**

2066-841, 842, 843 **Research Seminar**
The seminar serves as a planning stage and forum for preparing the research thesis proposal and for an ongoing critique and discussion of the research in progress. Additionally, this course will review the thesis process, provide guidelines, and resources for thesis preparation and presentation of the written thesis research paper. Over the course of the quarter a research proposal will be completed and submitted to thesis advisors for critique and approval. **Credit 2 per quarter**

2066-890 **Research and Thesis**
The thesis is designed and proposed by the candidate to a committee of graduate faculty. It is considered his/her culminating experience in the program, involving the development of independent research leading to new work. There are three components to the thesis: the thesis exhibition, the thesis paper, and the public defense. The defense is a public presentation of both the paper and the exhibit. **Credit 0–12**

2066-890-99 **Continuation of Thesis**
This course involves the completion of an established thesis or research project requirements coordinated between the student and the thesis research advisor. Credit 0

School of Print Media

Printing Management

2080-707 **Estimating and Analyzing in Graphic Art**
Course content covers the application of information from other management and technical courses to comprehensive situations in estimating. Its aim is to provide the student with an understanding of the relationships between estimation, pricing, and the supply and demand forces which occur in the marketplace and to expose students to several printing specialties so they may appreciate the various cost advantages and disadvantages involved in the use of particular technologies. Class sessions include lectures, discussions, labs, and project presentations by students. In addition to normal reading assignments, the student will be required to prepare and deliver an oral report or a written term paper on a topic related to an estimating, pricing, time-study, or some other cost-related problem of special interest to the student. **Credit 4**

2080-712 **Operations Management in Graphic Arts**
Designed to give the student a broad perspective of the many topics related to managing a printing facility. Topics include an examination of the systems approach to production management, the use of statistics and other quantitative techniques in methods and decision analysis, the cost-volume-price relationship in printing production, and the effect of organizational structure on decision making, line-staff relationships, and management personnel. **Credit 4**

2080-840 **Project Design**
This course exposes graduate students to the applications of the principles of research in the graphic media industry. This includes a systematic study of the scientific method, research statement generation, and types of research design. The students will study problems in the graphic media industry in preparation to complete a graduate level research project. Additional outside work will concentrate on problem solving, the use of the Internet and the library in developing bibliographies and the form of the technical writing required for the Research Project. **Credit 2**

Printing Technology

2081-701 **Research Methods and Trends in Graphic Media**
The theory and applications of the principles of scientific research in the graphic arts will be covered, including a systematic study of the scientific method, hypothesis generation, the nature of theory, types of research design, and measurement. The study of problems in the graphic arts includes ink and paper, reproduction methods, and quality control. **Credit 4**

2081-709 **Printing Industry: Trends and Issues**
This course presents a detailed analysis of the trends and issues related to the printing industry. It provides an in-depth look at key technologies as well as business and related issues which contributes to the student's fuller understanding of the technology and the issues affecting print communication. This course prepares students for successful careers by providing insights into the nature and scope of the major challenges facing industry managers and leaders. Research and survey projects help to focus the student's understanding of the industry. **Credit 4**

2081-711 **Tone and Color Analysis**
This course addresses principles and practices of color measurement for color matching and color image rendering in graphic arts imaging. Emphases are placed on the analyses and rendering of spot colors and pictorial images with the use of ICC-based color management systems. Topics include densitometry, CIE colorimetry, color management systems, graphic arts technology standards, and process control. There are lab assignments on color measurement and tone, and color analyses. A self-directed project is required. The instruction is a combination of lectures (live and video-taped), demonstrations, discussions of lab assignments, and when appropriate, guest speakers. **Credit 4**

2081-716 **Materials & Processes in Printing**
This course offers a survey of the materials and processes used in print reproduction. Students will learn the basic theory of image reproduction embodied in the available analog and digital printing processes, and learn to identify the process origins of print samples. Additionally, students will learn the chemical and physical properties associated with the consumables in order to obtain an understanding necessary to make informed decisions about use and application. **Credit 4**

2081-721 **Digital Print and Publishing**
This course provides students with an opportunity to learn the principles and applications of digital printing. Technical aspects of the major digital print engines and comparison of digital printing to conventional printing processes will be presented. The strategic use of digital printing will be emphasized from a digital workflow standpoint. Variable data personalization and on-demand printing will be studied from both technical and marketing perspectives. **Credit 4**

2081-723 **Contemporary Publishing**
An examination of how various contemporary publishing entities are responding to changes in technology with an emphasis on editorial, production, circulation/distribution, and marketing issues and concerns. The course will begin with a review of historic book models and practices with respect to their continued influence on today's formats and designs. The advantages and disadvantages of the various kinds of publishing mechanisms are discussed, together with an exploration of the divisions now occurring between print- and web based deliveries of content. The degree to which the intellectual content of books is changing in response to technology will also be covered. **Credit 4**

2081-728 **Database Publishing Applications**
This course presents the various processes, methods, and techniques related to the effective application of databases to the publishing process. Topics include the use of database output as the content for print, electronic media and on-line viewing, as well as the use of databases (such as digital asset management systems, font management systems, etc.) as enablers within the digital publishing process. Course projects range from elementary database construction to sophisticated variable data publishing. The course includes a survey of the spectrum of database applications that enable variable information printing and on-demand publishing. A final project incorporating one or more database publishing methods is required. (Basic Macintosh computer skills and competency in using page-layout applications such as InDesign or QuarkXPress) **Credit 4**

2081-747 **Cross Media Workfow I**
This course is designed to expose students to all the elements needed to master a cross media workfow project. It will introduce students to concepts and laws around copyright and intellectual property and will explore ways companies create and utilize Digital Asset Management Systems. Emerging industry and ISO standards for each of the fields will be presented. Hands-on exercises, conducted outside of class, will complement lectures to deepen the understanding of the various topics. **Credit 4**

2081-763 **Advanced Color Management**
This course will further the scientific methodology in process control for repeatable color and extend the scope of ICC-based color management practices by integrating a number of image capture devices in color-managed digital workflows. Students are expected to work in a team environment, to engage in planning, and conducting press run analyses, and to publish a technical publication using the state-of the-art printing facilities at RIT. (2081-711 or 2081-577) **Credit 4**

2081-766 **News Production Management**
This course brings together all the elements of new media publishing technologies such as various computer platforms, digital photography, scanners, storage devices, and distribution mechanisms. This course focuses on the management of these elements rather than the technology. The lecture portion focuses on the specific supplication of managerial principles to new media production while the lab portion is based on group production exercises. **Credit 4**

2081-767 **Media Industries Analysis**
This course provides students with an understanding of the major industries closely allied with the printing industry; advertising, publishing, and packaging. The intent is to give students in-depth knowledge of; (1) the structure of each of these industries; (2) the channels and methods through which and by which each distributes its products and services; and (3) the major customer/clients of its products and services. Particular attention will be devoted to investigating the business models for the use of print to create value in advertising, publishing, and packaging. **Credit 4**

2081-783 **Media Distribution and Transmission**
In this course students will gain extensive knowledge of the various methods and techniques used to electronically and physically distribute information. Students will study planning, scheduling, inventory management and customer fulfillment. **Credit 4**

2081-786 **Gravure Process**
This course analyzes the infrastructure as well as the print production workflows in the gravure printing industry. Students will comprehend the use of gravure as a business solution for publication, packaging, and special product applications. In addition to classroom lectures and laboratory assignments, students will meet and interact with gravure industry professionals during RIT Gravure Day and take an extensive industry field trip to visit cylinders engravers and gravure printers. (2081-716) **Credit 4**

2081-787 **Substrates for Printing**
This course covers the science and technology of the many kinds of printing substrates used by various printing processes. Students will learn the basic concepts of the substrate composition, structure, manufacture, optical and appearance properties, and testing of printing substrates, with an emphasis on factors which relate to print quality and press runnability. Students will learn to identify the full range of printing substrates and their applications. (2081-716 and 2081-717) **Credit 4**

2081-840 **Research Project**
Individual research projects in which independent data are collected by the student, followed by analysis, and evaluation. A comprehensive written report is required. Consent of advisor is required. **Credit 4**

2081-890 **Thesis**
An experimental survey of a problem area in the communication industry. **Credit 8**

2081-890-99 **Continuation of Thesis/Research Project**
Involves the completion of established thesis or research project requirement as coordinated between the student and thesis/research advisor. **Credit 0**

College of Liberal Arts

James J. Winebrake, Dean
www.rit.edu/cla

The College of Liberal Arts offers master of science degrees in the following areas: applied experimental and engineering psychology; communication and media technologies; criminal justice; science, technology, and public policy; and school psychology.

Elective graduate courses complement the professional emphasis of our degree programs by exploring the broader knowledge and social implications embodied in these areas of study. By providing this humanistic perspective, these courses play an integral role in professional education, making a direct and distinct contribution to the student's preparation for a specialized career.

The college also provides a number of graduate courses that serve as electives for graduate degree programs offered by other RIT colleges.

Admission requirements

The college offering the program makes all decisions on graduate admission. Please refer to each individual program for information regarding specific admission criteria. For general graduate admission information, please refer to the Admission section of this bulletin.

Financial aid and scholarships

Please refer to the Financial Aid and Scholarship section of this bulletin for information regarding financial aid, scholarships, grants, loans, and graduate assistantships.

Faculty

Members of the faculty serve as students' advisers as well as their professors. Their backgrounds in their fields, in the classroom, and in their research are the basis for academic standards and expertise that anticipate graduates' career requirements.

Study options

Most graduate programs offer a variety of study options, including full-time, part-time, and online study. Please refer to each individual program for specific information regarding these options.

Programs of study

Psychology Department

www.rit.edu/cla/psychology

Applied Experimental and Engineering Psychology, MS

http://www.rit.edu/cla/psychology/engg.htm

Andrew Herbert, Department Chair
(585) 475-4554, amhgss@rit.edu

Program overview

The master of science degree program in applied experimental and engineering psychology emphasizes the role of human

behavior and performance in both simple and complex human-machine systems. The departments of psychology, industrial and systems engineering, and information technology all contribute to the program curriculum.

Engineering psychology examines human capabilities to sense, perceive, store, and process information and how these human factors impact interactions with technology. This knowledge is applied to the design, use, and maintenance of human-machine systems. Students are trained in both research methods of experimental psychology and application of the results to contemporary problems in industry.

Engineering psychologists are interested in how and why performance might be changed through the use of technology. For instance, a new interface for controlling the radio in a vehicle may cause errors because a control is too sensitive for human-motor performance or because the driver is confused as to how to use the interface.

The program prepares students to function as effective engineering psychologists in industrial, governmental, or consulting organizations. The program also provides a foundation for further advanced academic study in human factors or experimental psychology.

Curriculum

The MS program in applied experimental and engineering psychology includes 16 credit hours of core courses, 16 credit hours of required engineering pscyhology courses, two elective courses, and 8 thesis credits.

COURSE		QTR. CR. HRS.
Core courses		
0514-784	Graduate Statistics	4
0514-785	Advanced Perception	4
0514-786	Research Methodology	4
0514-787	Advanced Cognition	4
Required engineering psychology courses		
0514-788	Topics in Engineering Psychology	4
4004-745	Foundations of Human-Computer Interaction	4
0303-731	Advanced Topics: Ergonomics/Human Factors	4
0303-734	Systems Safety Engineering	4
Required thesis credits		
0514-889	Thesis Proposal	4
0514-890	Thesis (course may be repeated)	4

Electives

Students select two from the following (course prerequisites are in parentheses):

4004-748	Usability Engineering (4004-745 and 4004-741)
4004-749	Usability Testing (4004-748 and Statistics)
4004-755	Advanced Topics in HCI (4004-745)
0303-760	Product/Process Development and Design
0303-732	Biomechanics (0304-331, 0304-332, 0303-730 or equivalent)
2014-701	Introduction to Computer Graphics (permission of the instructor required)
2014-717	Authoring Multimedia (permission of the instructor required)
2014-723	Graphical User Interface

Thesis

The thesis requires a minimum of eight credit hours. Students select a thesis adviser during the first year. Selection of an adviser, thesis topic, and research proposal must be completed in the third quarter of the first year of the program. Ongoing research activity is expected in the spring and summer quarters of the first year of the program. At the completion of the thesis, students will publically present their findings and defend their research before a thesis committee.

Admission requirements

To be considered for admission to the MS in applied experimental and engineering psychology, candidates must fulfill the following requirements:

- Have 20 quarter credit hours (15 semester hours) of course work in undergraduate psychology or a related field (e.g., engineering, computer science, information technology), including one course in experimental psychology and another in statistics,
- Submit official transcripts (in English) for all previoulsy completed undergraduate and graduate work,
- Have a minimum GPA of 3.0 (for undergraduate work),
- Submit scores from the Graduate Record Examination (GRE),
- Submit at least two letters of reference from professors or supervisors,
- Submit a biographical statement describing the applicant's experience and goals regarding the program, and
- Complete a graduate application.

Additional information

Cooperative education

The program includes an optional cooperative education component. Co-op is generally completed in the summer quarter after the first year of the program. The goal of a co-op experience is to provide experiential learning that integrates with classroom education. It allows students to apply psychological principles to problems in a variety of work environments. Co-op may be completed in any business or industrial setting.

School Psychology, MS

http://www.rit.edu/cla/schoolpsychology/

Suzanne Bamonto, Graduate Program Director
(585) 475-2765, sbggsp@rit.edu

Program overview

The master of science degree in school psychology is approved by the National Association of School Psychologists and prepares students for provisional New York state certification as school psychologists. Designed to provide students with a strong background in psychological foundations, the program develops professional skills and competencies in assessment, counseling, consultation, and program evaluation.

A school psychologist works with young children (birth to age five); elementary, junior high, and high school students; teachers and administrators; parents; and professionals to offer services that lead to the amelioration of existing student difficulties and attempts to prevent school problems. Through diagnostic testing, counseling, consultation, and intervention, school psychologists help students deal with learning and behavioral difficulties and help improve students' adjustment to school and their community.

The master of science degree is awarded after students have completed all course work, an internship, and have passed a portfolio review. The advanced certificate in school psychology is awarded to students who have met all the requirements of the MS degree and have completed and defended a thesis or research project.

Curriculum

COURSE		QTR. CR. HRS.
Required Psychological Foundation and Professional Courses (20 credits)		
0527-701	Advanced Developmental Psychology	4
0527-702	Psychology of Teaching/Learning	4
0527-723	Developmental Psychopathology	4
0527-752	Children and Trauma	4
0527-703	Cultural Diversity in Education	4
Required Statistics and Research Methodology (11 credits)		
0527-728	Inferential Statistics I	2
0527-759	Research Methods I	2
0527-890	Thesis	
	or	
0527-891	Project (1 per quarter for 3 quarters)	3
0527-810	Research Methods II	2
0527-811	Inferential Statistics II	2
Required Specialized Courses (44 credits)		
0527-724	Interpersonal Intervention Skills	4
0527-726	Psychoeducational Assessment I	4
0527-730	Seminar—Professional and Legal Issues	4
0527-731	Psychoeducational Assessment II	4
0527-732	Psychoeducational Assessment III	4
0527-733	Applied Behavioral Analysis	4
0527-734	Linking Assessment to Intervention	4
0527-742	Biological Basis of Behavior	4
0527-744	Advanced Counseling	4
0527-745	Alternative Assessment Techniques	4
0527-749	Advanced Consultation	4
0527-744	Advanced Counseling	4
Required Field Experience (21 credits)		
0527-712–717	Practicum I, II, III, IV, V, and VI	12
0527-777	Internship I, II, and III	9
	Total Quarter Credit Hours	96

Proposed plan of study

First Year

Fall Quarter

0527-726	Psychoeducational Assessment I
0527-724	Interpersonal Intervention Skills
0527-733	Applied Behavioral Analysis
0527-712	Practicum I

Winter Quarter

0527-731	Psychoeducational Assessment II
0527-749	Advanced Consultation
0527-701	Advanced Developmental Psychology
0527-713	Practicum II

Spring Quarter

0527-732	Psychoeducational Assessment III
0527-744	Advanced Counseling
0527-723	Developmental Psychopathology
0527-714	Practicum III
	Project/Thesis

Second Year

Fall Quarter

0527-734	Linking Assessment to Intervention
0527-745	Alternative Assessment Techniques
0527-759	Research Methods I
0527-728	Inferential Statistics I
0527-715	Practicum IV
	Project/Thesis

Winter Quarter

0527-742	Biological Basis of Behavior
0527-702	Psychology of Teaching/Learning
0527-810	Research Methods II
0527-811	Inferential Statistics II
0527-716	Practicum V
	Project/Thesis

Spring Quarter

0527-703	Cultural Diversity in Education
0527-752	Children and Trauma
0527-730	Seminar—Professional and Legal Issues
0527-717	Practicum VI
	Project/Thesis (If needed)

Third Year

Fall Quarter

0527-777	Internship I
	Project/Thesis (If needed)

Winter Quarter

0527-777	Internship II
	Project/Thesis (If needed)

Spring Quarter

0527-777	Internship III

Degree requirements

A minimum of 96 credit hours are required for completion of the program. Before registering for the internship, students must pass a portfolio review. A cumulative GPA of 3.0 or above is required.

Admission requirements

To be considered for admission to the MS program in school pscyhology, candidates must fulfill the following requirements:

- Hold a baccalaureate degree at an accredited college or university,
- Have a minimum undergraduate cumulative GPA of 3.0,
- Have completed at least 18 semester hours (27 quarter hours) in behavioral sciences with a grade of B or above,
- Have completed prerequisite undergraduate courses in general psychology, elementary statistics, child or developmental psychology, and abnormal psychology,
- Submit scores from the Graduate Record Exam (GRE),
- Submit letters of reference,
- Submit transcripts (in English) of all previously completed undergraduate and graduate course work,
- Submit an essay outlining the candidate's goals and related experience that shows evidence of a professional commitment and the potential for developing effective relationships with children, youth, and adults,
- Complete an individual interview, and
- Complete an application for graduate study.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language. A minimum score of 580 (paper-based) is required. This requirement is waived for native speakers of English and those submitting transcripts from American undergraduate schools.

All credentials must be submitted and reviewed before the student completes 12 credit hours of graduate work in the program. Applications are due by February 1. Later applications will be reviewed on a space-available basis.

School Psychology, Adv. Cert.

http://www.rit.edu/cla/schoolpsychology/

Suzanne Bamonto, Graduate Program Director
(585) 475-2765, sbggsp@rit.edu

The advanced certificate in school psychology is awarded to students who have met all the requirements of the MS degree and have completed and defended a thesis or research project. Please refer to the program description for the MS degree in school psychology for information on course work and admission requirements.

Department of Communication

Communication and Media Technologies, MS

http://www.rit.edu/cmt

Rudy Pugliese, Graduate Program Director
(585) 475-5925, rrpgsl@rit.edu

Program overview

Communication and the technologies for message creation and dissemination are at the center of dramatic economic, social, and cultural changes occurring as a result of technological development and global connectedness. The master of science degree in communication and media technologies is an interdisciplinary advanced program of study combining liberal arts courses in communication with course work in an applied or professional program. Graduates will be adept at the analysis of communication problems, the development of solutions, and the creation of messages as a result of their combined training in the social sciences, humanities, and applied technologies.

Communication courses rooted in the humanities and social sciences provide students with the opportunity to gain a broad, historical understanding of issues in communication, including the ethical, legal, and social dimensions. Additional courses give students advanced guidance in the creation of written and visual message content. Courses in applied technologies or professional programs provide opportunities for implementation and application. The required thesis combines knowledge, practice, original research, and application under the guidance of a graduate advisement committee.

Graduates are prepared for careers as communication experts in such venues as commerce, industry, education, entertainment, and government, as well as for graduate work toward a doctoral degree.

Curriculum

The degree requires the completion of a minimum of 45 credit hours of graduate course work. Students will complete 16 credit

hours of required communication courses, 12-16 credit hours of communication electives, 12-16 credit hours of applied professional or technical courses, and a master's thesis or project.

Required communication courses

Students will complete four required communication courses, plus a thesis/project.

COURSE		QTR. CR. HRS.
0535-701	History of Media Technologies	4
0535-702	Communication Theory	4
0535-703	Research Methods in Communication	4
0535-704	Communications Law and Ethics	4
0535-800	Project/Thesis	5–9

Communication electives

Students are required to select three communication electives from the choices below; a fourth elective is optional. History of Media Technologies (0535-701) and Communication Theory (0535-702) are prerequisites for all communication electives.

COURSE		QTR. CR. HRS.
0535-705	Electronic Communication and Society	4
0535-706	Crafting the Message	4
0535-707	International Media	4
0535-708	Communication Education	4
0535-709	Online Advertising	4
0535-710	Visual Communication	4
0535-713	Readings in Mass Media	4
0535-725	Special Topics in Communication	4

Applied professional or technical courses

Students are required to select three applied professional or technical courses from the choices below; a fourth applied or technical course is optional.

COURSE		QTR. CR. HRS.
College of Imaging Arts and Sciences		
2081-709	Printing Industry Trends and Issues	4
2081-721	Digital Print and Publishing	4
2081-723	Contemporary Publishing	4
B. Thomas Golisano College of Computing and Information Sciences		
4002-722	Fundamentals of Instructional Technology	4
4002-741	Fundamentals of Web-Based Multimedia	4
4004-745	Fundamentals of Human-Computer Interaction	4
E. Philip Saunders College of Business		
0105-761	Marketing Concepts	4
0105-766	Marketing in Global Business	4
0105-767	Advertising and Marketing Communications	4
0105-772	Marketing on the Internet	4
0105-778	Commercializing and Marketing of New Products	
0102-740	Organizational Behavior and Leadership	4
0102-741	Managing Organizational Change	4
0102-742	Introduction to Technology Management	4
College of Applied Science and Technology		
0626-707	Applied Data Analysis	4
0635-840	Health Systems Policy and Law	4
0625-844	Breakthrough Thinking, Creativity, and Innovation	4
0635-715	Information Systems in Health Administration	4
0635-754	eHealth	4
0635-830	Health Systems Planning	4
0635-882	Bioethics	4
College of Liberal Arts		
0521-700	Readings in Public Policy	4
0521-708	Technological Innovation and Public Policy	4
0521-709	Public Administration and Management	4
0521-710	Information and Communication Policy	4

A full-time student will create a graduate advisement committee by the end of the first quarter of study. The committee will be comprised of at least one faculty member from the department of communication and one faculty member from outside the department. The outside member should have a terminal degree. The committee advises and guides the student's elective course selection and course sequencing. With the guidance and approval of the graduate advising committee, students design and conduct a thesis or thesis/project appropriate to their course of study and their career goals.

Master's thesis/project

A thesis or thesis/project is required of all students in the program. The thesis/project topic should complement the student's academic graduate interests and scholarly training. Topic selection and method(s) for implementing the thesis/project occur in consultation with the student's graduate advisement committee.

Proposed plan of study

Fall Quarter	
0535-702	Communication Theory
	Communication elective or applied professional/technical course
	Communication elective or applied professional/technical course
Winter Quarter	
0535-703	Research Methods in Communication
0535-701	History of Media Technologies
	Communication elective or applied professional/technical course
Spring Quarter	
0535-704	Communications Law and Ethics
	Communication elective
	Communication elective or applied professional/technical course
Summer Quarter	
	Communication elective or applied professional/technical course
0535-800	Communications Thesis and Project

Admission requirements

To be considered for admission to the MS program in communication and media technologies, candidates must fulfill the following requirements:

- Hold a baccalaureate degree at an accredited college or university,
- Submit official transcripts (in English) of all previously completed undergraduate and graduate course work,
- Have a minimum cumulative undergraduate GPA of 3.0,
- Submit three letters of reference from academic advisers, major professors, and/or supervisors or managers,
- Submit a writing portfolio consisting of at least three writing samples, such as academic papers written for class, work-related brochures and pamphlets, or newspaper or magazine articles, and
- Complete a graduate application.
- International students, whose native language is not English, must submit scores from the Test of English as a Foreign Language (TOEFL). Minimum scores of 600 (paper-based), 250 (computer-based), or 100 (Internet-based) are required. This requirement may be waived for students who submit undergraduate transcripts from American colleges and universities.

Department of Criminal Justice

Criminal Justice, MS

http://www.rit.edu/cla/criminaljustice

Laverne McQuiller-Williams, Department Chair
(585) 475-2935, llmgcj@rit.edu

Program overview

The master of science degree in criminal justice emphasizes a multidisciplinary approach to urban studies with a focus on public safety. The program stresses training in policy analysis and practice, particularly as it is relevant to community and urban issues.

The program builds on the foundation of locally relevant policy research by providing its students with the critical skills to carry out such work and the experience to assure success in employment or in pursuit of further graduate studies. The program's objective is to provide students with a strong foundation in criminological, criminal justice theory, and social scientific research skills, thus enabling graduates to have successful careers in the policy analysis arena or to be prepared to pursue advanced study beyond the master's degree.

Curriculum

A minimum of 48 credit hours is required for completion of the MS in criminal justice.

Students transferring into the MS program from other BS degree programs at RIT or from outside the university should have a strong undergraduate foundation in criminology and research methods. Students that do not possess these skills may be required to complete additional undergraduate course work (e.g., Criminology, Theories of Crime, and Research Methods) or demonstrate that they have equivalent skills for completion of the degree.

The curriculum includes seven required core courses:	
0501-710	Pro-Seminar in Criminal Justice Theory
0501-720	Pro-Seminar in Research Methods
0501-721	Pro-Seminar in Law and Policy
0501-722	Advanced Criminology
0501-715	Advanced Statistics
0501-723	Crime, Justice and Community
0501-724	Interventions and Change in Criminal Justice

In addition, students will choose three elective courses and are required to successfully complete a research practicum and master's thesis.

Admission requirements

To be considered for admission to the MS program in criminal justice, candidates must fulfill the following requirements:

- Hold a baccalaureate degree from an accredited college or university,
- Have a minimum cumulative GPA of 3.0 (on a 4.0 scale),
- Submit two writing samples, one of which is a personal statement,
- Participate in a personal interview,
- Have completed a statistics course (students may be required to take a data analysis or a statistics course if not taken previously),
- Submit two letters of recommendation (when possible l etters should be from faculty familiar with the applicant's academic work)
- Submit scores from the Graduate Record Examination (GRE), and
- Complete an application for graduate study.
- International applicants, whose native language is not English, should submit scores from the Test of English as a Foreign Language (TOEFL). Minimum scores of 570 (paper-based), 230 (computer-based), or 88 (Internet-based) are required.

Department of Science, Technology and Society/Public Policy

Science, Technology and Public Policy, MS

http://www.rit.edu/cla/publicpolicy

Franz A. Foltz, Graduate Program Director
(585) 475-5368, fafgsh@rit.edu

Program overview

This innovative master of science degree in science, technology and public policy, emphasizes the creation and understanding of engineering, science, and technology policy. The program builds on RIT's strengths as a technological university, enabling students to interact with faculty members and researchers who are working on scientific developments and technological innovations that drive new public policy considerations.

The program is interdisciplinary and draws significantly from disciplines and courses of study in RIT's colleges of Liberal Arts,

Business, Science, Engineering, and Applied Science and Technology. The program is geared toward graduates who will make significant contributions in the private, public, and not-for-profit sectors.

All students take a set of policy core courses that emphasize analysis, problem solving, and interdisciplinary approaches. Students work with an adviser to choose electives that focus their policy studies in a particular area, such as environmental policy, telecommunications policy, or energy policy. Typical students include those with science or engineering backgrounds looking to broaden their career opportunities in government or business settings, as well as those with liberal arts undergraduate degrees (e.g., economics) interested in science, technology, and policy issues. Full-time students can typically finish the program in one to two years. The program prides itself on working one-on-one with students to ensure that their educational needs and academic goals are attained.

Curriculum

A minimum of 48 credit hours is required for completion of the program.

Students transferring into the MS program from other BS degree programs at RIT or from outside the university may be required to complete an additional three-course policy analysis sequence (Graduate Policy Analysis I, II and III) or demonstrate equivalent skills for completion of the degree.

The graduate curriculum has a required five-course core. In addition, students will choose five courses within their area of specialization. Students also are required to successfully complete a master's thesis. The thesis allows students to work with a faculty adviser on an independent research project in their area of interest.

Required core courses:

0521-700	Readings in Public Policy
0521-701	Advanced Theory and Methods in Public Policy
0521-702	Evaluation Research
0508-740	Science, Technology and Policy Seminar
0521-709	Public Administration and Management

Elective courses

Students choose five elective courses based on their interests and career goals. Courses may be offered in various colleges throughout the university, including the colleges of Business, Engineering, Science, and Applied Science and Technology. Course selection is done jointly with a faculty adviser and typically is aimed at developing a specialized area of interest for the student (e.g., biotechnology policy, environmental policy, energy policy, communications policy). Example elective courses include:

0521-708	Technological Innovation and Public Policy
0521-751	Energy Policy
0521-710	Information and Communications Policy
0521-706	Qualitative Policy Analysis
0521-749	Special Topics in Public Policy
0521-810	Technology, Policy, and Sustainability
0102-749	Introduction to Technology Management
0614-780	Telecommunication Policy and Issues
0508-484	Environmental Policy
0508-770	Environmental Studies Seminar
0508-790	Biodiversity and Society
4002-873	Information Technology and Strategic Opportunity
0630-770	Environmental Risk Assessment, Management and Communications
0307-772	Applied Survey Design and Analysis
0102-745	Social and Political Environment of Business
0511-711	Microeconomics for Graduate Students
0511-750	Benefit-Cost Analysis
0511-757	Applied Econometrics
0511-766	Health Care Policy
0511-781	Environmental Economics
0511-784	Natural Resource Economics

Admission requirements

To be considered for admission to the MS program in science, technology and public policy, candidates must fulfill the following requirements:

- Hold a baccalaureate degree at an accredited college or university,
- Have a minimum 3.0 overall GPA,
- Submit two writing samples, one of which should be a statement of interest,
- Submit scores from the Graduate Record Examination (GRE),
- Submit official transcripts (in English) of all previously completed undergraduate and graduate course work,
- Have completed course work in calculus and statistics (students may be required to take a data analysis or statistics course and an introductory calculus course, if not taken previously),
- Submit two formal letters of reference, and
- Complete a graduate application.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language TOEFL). Minimum scores of 570 (paper-based), 230 (computer-based), or 88 (Internet-based) are required.

Additional information

Accelerated dual degree option

Current RIT undergraduate students may enter the program from the public policy or mechanical engineering BS programs and earn a combined BS/MS in five years. To be admitted into the graduate portion of the BS/MS track, a student must receive permission of the department, complete all requirements of the BS curriculum, and have a minimum GPA of 3.0. The BS/MS student may obtain 12 credit hours of graduate work in the fourth year of the BS curriculum. Thus, a BS/MS student would need to take only 36 credit hours in the fifth year.

Graduate Faculty

James J. Winebrake, BS, Lafayette College; MS, Massachusetts Institute of Technology; Ph.D., University of Pennsylvania—Dean; Professor

M. Ann Howard, BS, Cornell University; JD, Rutgers University—Sr. Associate Dean; Professor

Babak Elahi, BA, San Diego State University; MA, University of California at San Diego; Ph.D., University of Rochester—Associate Dean; Associate Professor

Communication

Bruce A. Austin, BA, Rider College; MS, Illinois State University; Ph.D., Temple University—Professor

Keri Barone, BA, MA, State University College at Brockport—Lecturer

Grant C. Cos, BA, University of Massachusetts; MA, Emerson College; Ph.D., Kent State University—Associate Professor

Andrea Hickerson, BA, Syracuse University; MA, University of Texas at Austin; Ph.D., University of Washington—Assistant Professor

Keith B. Jenkins, BA, University of Arkansas; MA, Ph.D., Florida State University—Associate Professor

Mike Johansson, MA, Syracuse University—Lecturer

Ki-Young Lee, BA, Hanyang University (South Korea); MA, Northwestern University; Ph.D., Michigan State University—Assistant Professor

Hinda Mandell, BA, Brandeis University; MA, Harvard University; Ph.D., Syracuse University—Assistant Professor

Kelly Norris Martin, BA, John Carroll University; MS, Ph.D., North Carolina State University—Assistant Professor

David R. Neumann, BA, Ithaca College; MA, Ph.D., Bowling Green State University—Professor

Elizabeth Reeves O'Connor, BS, MS, Rochester Institute of Technology—Senior Lecturer

Rudy Pugliese, BA, State University College at Oneonta; MA, State University College at Brockport; Ph.D., Temple University—Graduate Program Director; Professor

Patrick M. Scanlon, BA, State University of New York at Albany; MA, Ph.D., University of Rochester—Department Chair; Professor

Jonathan E. Schroeder, BA, University of Michigan; MA, Ph.D., University of California at Berkeley—William A. Kern Professor in Communications

Wang, Xiao, BA, Beijing University of Aeronautics and Astronautics (China); MA, Marquette University; Ph.D., Florida State University—Assistant Professor

Tracy R. Worrell, BA, Otterbein College; MA, University of Cincinnati; Ph.D., Michigan State University—Assistant Professor

Criminal Justice

John Klofas, BA, College of the Holy Cross; MA, Ph.D., State University of New York at Albany—Professor

Cynthia Perez McCluskey, BA, University of California at Irvine; MA, Ph.D., State University of New York at Albany—Associate Professor

John McCluskey, BA, MA, Ph.D., State University of New York at Albany—Associate Professor

LaVerne McQuiller Williams, BS, Rochester Institute of Technology; MS, Buffalo State College; JD, Albany Law School; Ph.D., University at Buffalo—Department Chair; Associate Professor

Judy Porter, BA, University of Northern Colorado; MA, New Mexico State University; Ph.D., University of Nebraska at Omaha—Assistant Professor

Christopher Schrek, BA, University of Florida; MA, University of Arizona; Ph.D., Pennsylvania State University—Professor

Jason Scott, BS, Roberts Wesleyan College; MA, Ph.D., State University of New York at Albany—Associate Professor

Tony Smith, BA, MA, Ph.D., State University of New York at Albany—Assistant Professor

Economics

Amit Batabyal, BS, Cornell University; MS, University of Minnesota; Ph.D., University of California at Berkeley—Arthur J. Gosnell Professor of Economics

Javier Espinosa, BS, Miami University; MA, Ph.D., University of Maryland at College Park—Assistant Professor

M. Jeffrey Wagner, BA, University of Missouri; MA, Ph.D., University of Illinois—Associate Professor

Humanities

Charles D. Collins, AB, Rutgers University; MA, Ph.D., University of Iowa—Professor, Fine Arts

Rebecca O. Edwards, BA, College of the Holy Cross; Ph.D., University of Rochester—Associate Professor, History

Timothy H. Engström, BA, MA, Ph.D., University of Edinburgh—Professor, Philosophy

David B. Suits, BA, Purdue University; MA, Ph.D., University of Waterloo—Professor, Philosophy

Psychology

Suzanne Bamonto, AA, Finger Lakes Community College; BA, State University College at Geneseo; Ph.D., University of Oregon—Graduate Program Director; Associate Professor

Joseph Baschnagel, BA, MA, Ph.D., State University of New York at Buffalo—Assistant Professor

Kirsten Condry, BA, Swarthmore College; Ph.D., University of Minnesota—Assistant Professor

Caroline DeLong, BA, New College of Florida; MA, Ph.D., University of Hawaii—Assistant Professor

Nicholas DiFonzo, AB, Lafayette College; MA, Rider College; MA, Ph.D., Temple University—Professor

John E. Edlund, BS, MA, Ph.D., Northern Illinois University—Assistant Professor

Roger Harnish, BA, University of Rochester; Ph.D., Oklahoma State University—Professor

Rhiannon Hart, BA, University of Washington; MS, Ph.D., University of Pittsburgh—Assistant Professor

Andrew M. Herbert, B.Sc., McGill University; MA, Ph.D., University of Western Ontario—Department Chair; Associate Professor

Jennifer Lukomski, BA, Williams College; MA, Gallaudet University; Ph.D., University of Arizona—Associate Professor

Scott P. Merydith, BA, M.Ed., Ph.D., Kent State University—Professor

Vincent Pandolfi, BA, Lafayette College; MA, Ph.D., Hofstra University—Associate Professor

Esa Rantenen, BS, MS, Embry-Riddle Aeronautical University; MS, Ph.D., Pennsylvania State University—Associate Professor

Lindsay Schenkel, BA, St. John Fisher College; MA, Ph.D., University of Nebraska at Lincoln—Assistant Professor

Tywanquila Walker, BS, Vanderbilt University; Ph.D., Cornell University—Assistant Professor

Science, Technology, and Public Policy

Robert Alexander, BS, Duke University; MS, MPA, Indiana University at Bloomington; Ph.D., Syracuse University—Visiting Assistant Professor

Deborah Blizzard, BA, Smith College; MS, Ph.D., Rensselaer Polytechnic Institute—Acting Department Chair; Associate Professor

Thomas Cornell, BA, Rhodes College; MS, Georgia Institute of Technology; Ph.D., Johns Hopkins University—Professor

Franz A. Foltz, BS, MS, Pennsylvania State University; Ph.D., Rensselaer Polytechnic Institute—Graduate Program Director; Associate Professor

Ron Hira, BS, Carnegie Mellon University; MS, Ph.D., George Mason University—Associate Professor

M. Ann Howard, BS, Cornell University; JD, Rutgers University—Professor

William A. Johnson Jr., BA, MA, Howard University—Distinguished Professor

Christine Keiner, BA, Western Maryland College; Ph.D., Johns Hopkins University—Associate Professor

Robert J. Paradowski, BS, Spring Hill College; MA, Brandeis University; Ph.D., University of Wisconsin—Professor

Richard Shearman, BA, Western State College of Colorado; MS, Eastern New Mexico University; Ph.D., State University of New York College of Environmental Science and Forestry—Associate Professor

James J. Winebrake, BS, Lafayette College; MS, Massachusetts Institute of Technology; Ph.D., University of Pennsylvania—Dean; Professor

Criminal Justice

0501-710 Pro-seminar in Criminal Justice Theory
In this pro-seminar students examine the theoretical foundation of criminal justice. This course integrates studies of criminal justice systems, enforcement organizations, judicial decision-making, courtroom communities and correctional systems by focusing on the study of governmental social control premised on punishment or blame worthiness. It examines the underlying causes and patterns of official responses to behavior that may be labeled criminal, and the structures, policies and practices of criminal justice. Required course for criminal justice master's degree program. May be taken as a graduate elective. (0501-400 or equivalent) **Class 4, Credit 4 (offered annually)**

0501-715 Advanced Statistics
The purpose of this course is to provide students with training in quantitative analysis of social science data. Students will develop a conceptual understanding of techniques, the ability to recognize the appropriate selection of techniques, and the ability to use those statistical measures and interpret their results. Students will gain experience with inferential statistics through the level of commonly used multivariate analyses. The prerequisite for this course will be a strong undergraduate foundation in statistical analysis. With the consent of their advisor and the graduate coordinator, qualified students may substitute more specialized statistics courses(s) in such areas as geographical information systems (GIS). Other students may select those courses as electives. Required course in criminal justice master's degree program. May be taken as a graduate elective. **Class 4, Credit 4 (offered annually)**

0501-720 Pro-seminar in Research Methods
This seminar will focus on the principles and techniques of research with a special focus on evaluation research. The course will cover research conceptualization and design, development of appropriate measures, collection and analysis of data using a wide range of methods. Students will gain a thorough understanding of the research process as well as the policy implications and consequences of research and evaluation. Students will also begin to develop a thesis research proposal. Required course for criminal justice master's degree program. (0501-401 and 0501-541 or equivalent) **Class 4, Credit 4 (offered annually)**

0501-721 Pro-seminar in Law and Policy
The course will consider the processes of policy development and analysis in criminal justice with a particular emphasis on the intersection of policy and law. The legal and political environments of criminal justice policy will be examined in study of the development of federal crime policy. Additionally, the roots, development, legal context and impact of major policies such as contemporary policing strategies, problem solving courts and restorative justice will be explored. Required course in the criminal justice master's degree program. **Class 4, Credit 4 (offered annually)**

0501-722 Advanced Criminology
This course will provide students with a detailed understanding of the theories that have guided criminological research and policy. Subject matter will cover the major influences in criminology: the classical school, the Chicago School, strain theories, socialization and learning theories, and conflict theories, among others. Required course for the criminal justice master's degree program. (0501-528 or equivalent) **Class 4, Credit 4 (offered annually)**

0501-723 Crime, Justice and Community
This course provides an overview of the role of communities in crime and criminal justice. The course begins by preparing a foundation in community theory. Students will gain an understanding of the critical dimensions and attributes which define "community." The course will involve an examination of community-based theory and research with a special emphasis on the criminology of place and how crime and justice patterns are embedded in particular social structures and cultures. We will discuss the extent to which structural characteristics and social processes are related to crime and disorder. The course will also examine the potential that exists within criminal justice to intervene in communities to reduce crime and disorder and "build community" in the process. Required course for the criminal justice master's degree program. **Class 4, Credit 4 (offered annually)**

0501-724 Interventions and Change in Criminal Justice
This course will focus on theory and research regarding the effectiveness of broad anti-crime strategies and specific intervention efforts at the local, state, national and international level. Theoretical explanations of crime and ideological orientations towards crime will be linked with the crime control and prevention strategies associated with those perspectives. Each strategy of crime control/prevention (including deterrence, incapacitation, rehabilitation, and community crime prevention) will be assessed in terms of research findings focused on the effectiveness of such strategies. Detailed attention will be given to prevention/control strategies aimed at both juvenile and adult offenders. Required course in the criminal justice master's degree program. **Class 4, Credit 4 (offered annually)**

0501-725 Criminal Justice Research Practicum
This research practicum will involve students designing and undertaking an evaluation of a program or intervention conducted in the field. Under the supervision of faculty, students will complete background research, review of literature, discussions with program leader's design of a program evaluation, and a preliminary evaluation. This may be conducted as a group project. Students will gain a thorough understanding of the research process as well as the policy implications and consequences of research and evaluation. It is understood that this course will provide a significant step toward completion of thesis research. Required course in the criminal justice master's degree program. (0501-701, 0501-720, 0501-721, and 0501-722) **Class 4, Credit 4 (offered annually)**

0501-726 Current Issues in Criminal Justice
This course focuses on contemporary issues and topics not otherwise distinctly incorporated in established criminal justice courses. It concentrates on student discussion and interaction surrounding required readings on topics such as crime prevention, qualitative design, crime mapping, and crime analysis. Elective course for criminal justice master's degree program. Restricted to matriculated students. **Class 4, Credit 4 (offered annually)**

0501-728 Directed Readings in Criminal Justice
This course will involve students designing and undertaking research related to crime or criminal justice policy conducted in the field. Under the supervision of faculty, students will complete background research and in-depth inquiry into the literature influencing key contemporary debates in crime and criminal justice. It is understood that this course will provide a significant step toward completion of thesis research. (Graduate standing in the criminal justice master's program or permission of the instructor is required.) **Class 4, Credit 4, (W)**

0501-800 Thesis in Criminal Justice
The master's thesis in criminal justice involves independent research on an approved topic judged by a faculty committee and under the supervision of one faculty member. The thesis requires students to develop, design and complete an original research project; orally defend the thesis before the thesis committee and the public; and submit a bound copy to the library. Students will meet weekly with their thesis chair. Required course for the criminal justice master's degree program. (0501-710, 0501-720, 0501-721, and 0501-722) **Class 4, Credit 4 (offered annually)**

Fine Arts

0505-704 The Art of Dying
The course explores the experience of dying as it is represented by artists who are themselves facing imminent death. The unique and deeply personal process of each dying artist is crucially informed by social, cultural and historical as well as artistic contexts. The course will focus primarily on visual artists, film makers and writers living with and dying of disease or simply of mortality and old age. The graduate level of the art of dying: visual art and narrative of dying artists is enhanced with a more intensive investigation of the theoretical discussion amongst scholars of visual culture, philosophy, art, photography and film. Graduate students will read the list of recommended reading in addition to the daily readings and will use this scholarship in the development of a substantive final project. **Class 4, Credit 4 (offered annually)**

History

0507-701 History of Deaf Educational Thought
This is an historical analysis of change and continuity in educational history from colonial through contemporary America. Special emphasis will be given to the development of the field of deaf education in the United States. Lectures, seminar discussions, and readings offer comprehensive coverage of the salient intellectual themes of American deaf educational history. **Class 4, Credit 4 (offered annually)**

Science, Technology and Society

0508-740 Graduate Science and Technology Policy Seminar
Students in this course will apply basic policy skills, concepts, and methods to a contemporary science and technology policy topic. Topics may vary from year to year or term to term. (Graduate standing in science, technology and public policy, or permission of the instructor) **Class 4, Credit 4 (offered annually)**

0508-770 Graduate Environmental Studies Seminar
This course explores a specific, in-depth environmental issue, problem, or topic from multidisciplinary perspectives. Students will read pivotal texts appropriate to the topic with the goal of formulating reasonable and appropriate responses; experiential learning activities such as field trips may also be included. (Graduate standing in science, technology and public policy or environmental science or permission of instructor) **Class 4, Credit 4 (offered occasionally)**

0508-790 **Graduate Biodiversity and Society**
This course explores the problems, issues, and values stemming from the current massive loss of biodiversity. This course also explores why preserving or conserving biodiversity is considered to be important, and what mechanisms have been identified for its maintenance. (Graduate standing in science, technology and public policy or environmental science, or permission of instructor) **Class 4, Credit 4 (offered occasionally)**

0508-791 **Sustainable Communities**
This course uses the concept of sustainability to explore the connections between natural and human communities, between nature and culture, and among environmental, economic, and social systems. The course also encourages learning outside the classroom. In the context of neighborhoods in the city of Rochester, students will observe firsthand the contemporary issues associated with urban communities that are seeking to achieve sustainability. Graduate students will be responsible for leading class discussions and will be required to prepare an in-depth, community based research paper on a topic selected in consultation with the instructor. (Graduate standing in science, technology, and public policy or environmental science or permission of instructor) **Class 4, Credit 4 (offered at least every other year)**

Philosophy

0509-705 **Philosophy of Art and Aesthetics**
The four-hour meetings of this seminar are based largely on discussions, and participation of all students is required. Since the theories and examples discussed are mostly from the Western canon, familiarity with the history of Western art is recommended. The questions discussed are philosophical questions about art and aesthetic experience: What is the relationship between art and beauty, art and truth, art and knowledge, art and judgment, art and politics, art and interpretation, art and contemporary philosophical theory? What makes an interpretation of an artwork valid or invalid? How is aesthetic value related to other values? **Class 4, Credit 4 (offered annually)**

0509-706 **Philosophy of Mind**
Philosophy of mind is the philosophical discipline that explores what a mind is and how it fits in the natural world. In doing this, philosophy of mind raises further questions such as: What do we mean by the mind? How do we attribute mentality? How are mental and physical properties related? What is consciousness? Can computers think? How is rationality connected to mental states like beliefs and desires? In this course we discuss and critically assess answers to these and related philosophical questions. **Class 4, Credit 4 (offered annually)**

0509-707 **Philosophy of Vision and Imaging**
This course appeals to sight, to the rhetoric of seeing, and to various media and technologies of imaging that have had an enormous impact on philosophy and on human culture generally. This course will introduce students to the philosophy of vision and imaging by critically investigating four interrelated sets of concerns: 1) the relation between appeals to vision and the imaging technologies that mediate what and how we see; 2) the relation between imaging technologies and the acquisition and representation of knowledge; 3) the relations between imaging technologies and human identity and agency; 4) the relations between imaging theories/practices and ethical, political, ideological, and social contexts. **Class 4, Credit 4 (offered occasionally)**

0509-708 **Philosophy of Film**
The course will consider such thinkers/writers as: Sergei Eisenstein, Andre Bazin, Christian Metz, Sigfried Kracauer, Rudolf Arnheim, Noel Carroll, Jonathan Crary, Gilles Deleuze, Stanley Cavell, Leo Braudy, David Bordwell, Laura Mulvey, Roland Barthes, Lev Manovich, Anne Friedberg, and others. We will also consider such writers in the context of specific classical and contemporary films; and one of the responsibilities of the students in the class will be to determine some of the films to be considered for inclusion in the course. The course may also involve the occasional participation of faculty from other departments and disciplines who are interested in film theory. **Class 4, Credit 4 (offered occasionally)**

Economics

0511-711 **Microeconomics for Graduate Students**
This course develops the tools that are commonly used to study the allocation of resources in a mixed economy of private and public enterprises. This course provides an intensive overview of the microeconomic models underlying the actions of consumers and households, firms, regulators, and other public institutions. These models will be applied to current issues in policy (as it arises in all fields of inquiry). This course is an elective for science, technology, and public policy master's degree students; environmental science master's degree students; and students in other graduate programs seeking an economics elective course. **Class 4, Credit 4 (offered annually)**

0511-750 **Benefit-cost Analysis**
Most programs of governmental agencies are now normally evaluated using the techniques of benefit-cost analysis and debates about the usefulness of alternate projects often draw on benefit-cost findings. Yet, the application of benefit-cost analysis is controversial, in part because of disagreements about the goals of such analysis and about the way in which such analysis ought to be conducted. Thus, this graduate level course will explore the use and the abuse of benefit-cost and related analytical techniques commonly encountered in economic policy analysis. This course is an elective for science, technology and public policy graduate students; environmental science graduate students, and students in other graduate programs seeking an elective course in economics. (0511-211 or 0511-711 or equivalent) **Class 4, Credit 4 (offered annually)**

0511-757 **Applied Econometrics**
This course provides students with an opportunity to develop their skills in applied regression analysis. It covers the various regression models, estimation techniques, data preparation and transformation, and the interpretation of regression results. There is particular emphasis on the dangers of misuse of regression techniques. This course is an elective for the science, technology and public policy graduate students and students in other graduate programs with an interest in economics who have fulfilled the prerequisites. (0511-211, or 711, 1016-319, 1016-226) **Class 4, Credit 4 (offered annually)**

0511-766 **Health Care Policy**
This course examines the economics of health care including, the organization of its delivery and financing, analyzing access to care issues, the role of insurance, the regulation of hospitals, physicians, and the drug industry, the role of technology, and limits on health care spending. Calculus, intermediate or accelerated microeconomics, statistics and regression analysis are necessary tools for reading health care policy research and conducting economic modeling. This course is an elective for the science, technology and public policy graduate students and students in other graduate programs seeking an economics elective course. (0511-211 or equivalent) **Class 4, Credit 4 (offered annually)**

0511-781 **Environmental Economics**
This course examines the relationship and apparent conflict between economic growth and environmental quality, the economics of environmental issues and policy, the environment as a resource and a public good, and the ability and lack of ability of free markets and the government to deal adequately with pollution and other environmental problems. This course is an elective for science, technology and public policy graduate students; environmental science graduate students and students in other graduate programs seeking an economics elective course. (0511-211 or 0511-711 or equivalent) **Class 4, Credit 4 (offered annually)**

0511-784 **Natural Resource Economics**
This course develops an economic perspective on one of the most important and challenging issues facing global society - the allocation, use, and preservation of natural resources. The course presents and discusses the methodology economists use to inform natural resource managers and policy makers. Economic thought and analysis are used to evaluate a variety of issues in this area. The course concludes with a brief discussion of the interdisciplinary aspects of natural resource management. This course is an elective for the science, technology and public policy graduate students; environmental science graduate students; and students in other graduate programs seeking an economics elective course. (0511-211 or 0511-711 or equivalent) **Class 4, Credit 4 (offered annually)**

0511-810 **Economics of Sustainability**
The economics of sustainability entails conceptualizing appropriate dynamic consumption and production paths and strategies for attaining such paths. This course begins by exploring how problems of sustainability can be analyzed using the neoclassical economics paradigm. We then consider how sustainability concerns arise within consumer theory and within the theory of the firm (e.g., issues of green design). Standard modeling tools used in economics are introduced. Environmental and resource economic policy instruments are critically evaluated for use in various contexts in which sustainability is of concern. Consideration is given to how the economic theory of sustainability complements perspectives from other disciplines. The course concludes with a discussion of current issues in sustainability such as climate change. (0511-711 or equivalent or permission of instructor) **Class 4, Credit 4 (offered annually)**

Applied Experimental and Engineering Psychology

0514-784 Graduate Statistics
This course introduces students to advanced inferential parametric and non-parametric data-analysis techniques commonly used in psychological research. These include single, independent and dependent samples, t-tests, factorial, repeated and mixed ANOVA, ANCOVA, contrast analysis, linear and multiple regressions, chi-square goodness of fit and tests of independence, and Mann-Whitney U. The focus is on the conceptual understanding of these statistics, how different statistical procedures are applied in different research methods, how to perform analyses, how to interpret the results in the context of the research question, and how to communicate these results. Required course for VKSI degree program. No prerequisite. **Class 3, Lab 1, Credit 4 (offered at least every other year)**

0514-785 Advanced Perception
This course will examine topics related to human factors and engineering psychology such as temporal and spatial frequency perception; after effects, visual illusions and their relationship to cortical function and pattern perception; color perception; depth and motion perception; higher order perception such as face and object recognition; and/or music and speech perception. The goal is to cover current research and theories in perception, looking at current developments and their antecedents. This course will be organized so students will work in groups on various projects as well as covering topics through readings and classroom instruction designed to provide students with a deeper understanding of topics in perception. There will be lab time for students where they will examine empirical findings in perception and develop their research skills. **Class 3, Lab 1, Credit 4 (offered at least every other year)**

0514-786 Research Methodology
This course offers an in-depth examination of acquiring knowledge of human behavior and performance through the observation, identification, description, experimental investigation, and theoretical explanation of phenomena, that is, methods of science. Particular emphasis is placed on design of experiments, measurement of appropriate dependent variables, manipulation and transformations of data, exploratory data analysis and data visualization, and drawing conclusions from statistical tests. **Class 3, Lab 1, Credit 4 (offered at least every other year)**

0514-787 Advanced Cognition
This course will survey theoretical and empirical approaches toward understanding the nature of the mental processes involved in attention, object recognition, learning and memory, reasoning, problem solving, decision-making, and language. The course attempts to present a balance between historically significant findings and current state-of-the-art research. Readings that have structured the nature and direction of scientific debate in these fields will be discussed. The course also includes discussions of methodology and practical applications. Students will have opportunities to develop their research skills and critical thinking by designing research studies in cognitive psychology. **Class 3, Lab 1, Credit 4 (offered at least every other year)**

0514-788 Topics in Engineering Psychology
The purpose of the course is to provide the students a solid foundation in the fundamental principles and methods of the very broad discipline of engineering psychology, but in the context of contemporary issues and problems reflecting current interests of both the instructor and the students. The topics covered in this course may vary each time it is offered. Students may thus repeat the course as many times as they want as long as it is on a different topic each time. **Class 3, Lab 1, Credit 4 (offered at least every other year)**

0514-799 Independent Study
A student may register for a graduate independent study project subject to the approval of the director of the student's graduate program, the faculty sponsor, and the dean of the College of Liberal Arts. . Because of the length of the approval process, students who desire to take independent study should make arrangements several weeks before the quarter begins. An independent study project enables the interested student and his or her faculty sponsor to coordinate their efforts on subjects and topics that range beyond the normal sequence of the graduate course selection. Credit variable

Public Policy

0521-700 Seminar: Readings in Public Policy
This course provides an in-depth inquiry into the seminal literature influencing key contemporary public policy debates. Students engage in critical reflection and original thought on theoretical and applied public policy problems. Emphasis is placed on policy issues in selected science and technology fields. (Graduate standing in the science, technology and public policy master's program or permission of the instructor is required) **Class 4, Credit 4 (F)**

0521-701 Seminar: Advanced Theory and Methods
This course will cover the major theoretical and applied analytical methods and techniques in both quantitative and qualitative analysis. An emphasis will be placed on integrating empirical and normative concerns. Methods covered vary by quarter, but may include optimization, cost benefit analysis, systems modeling, and multi criteria decision analysis. (Graduate standing in the science, technology and public policy master's program or permission of the instructor is required) **Class 4, Credit 4 (W)**

0521-702 Seminar: Evaluation Research
The focus of this course is on evaluation of program outcomes. Students will explore the questions and methodologies associated with meeting programmatic outcomes, secondary or unanticipated effects, and an analysis of alternative means for achieving program outcomes. Critique of evaluation research methodologies will also be considered. (Graduate standing in the science, technology and public policy master's program or permission of the instructor is required) **Class 4, Credit 4 (S)**

0521-703 Thesis Research
The master's thesis in science, technology, and public policy requires the student to select a thesis topic, advisor and committee; prepare a written thesis proposal for approval by the faculty; present and defend the thesis before a thesis committee; and submit a bound copy of the thesis to the library and to the program chair. (Graduate standing in the science, technology and public policy master's program, acceptance of a thesis proposal and satisfactory completion of a minimum of 16 graduate credits are required.) **Class 4, Credit 8 (offered quarterly**)

0521-706 Qualitative Policy Analysis
This course examines multiple methodologies and techniques used for the qualitative analysis of public policy. The course examines methods known for their descriptive richness, interpretive insights, heightened concern for research subjects' views, and socio-cultural relativism. Specific techniques include: interviewing, field methods, participant observation, ethnography, focus groups, Delphi panels, and case studies. (Graduate standing) **Class 4, Credit 4 (offered annually)**

0521-708 Technological Innovation and Public Policy
Technological innovation, the incremental and revolutionary improvements in technology, has been a major causal factor for economic growth and social and political change. This course will introduce generic models of innovation that span multiple sectors including: energy, environment, biotechnology and information technologies. The course will then analyze how governments choose policies to spur innovation. (Graduate standing) **Class 4, Credit 4 (offered annually)**

0521-709 Public Administration and Management
This course provides an introduction to the fields of public administration and public management. This survey course covers topics such as bureaucratic behavior, program implementation, and recent innovations in management of public organizations. (Graduate standing) **Class 4, Credit 4 (offered annually)**

0521-710 Information and Communications Policy
This course examines how federal and international policies are developed to influence innovation of information and communication technology. In particular the course will examine such topics as privacy, freedom of speech, intellectual property rights, access to information technology, and regulation of the Internet. (Graduate standing) **Class 4, Credit 4 (offered occasionally)**

0521-712 Graduate Policy Analysis I
This course is the first in a three-course sequence (Graduate Policy Analysis I–III) that will provide students with tools to become effective policy analysts. This course will emphasize tools stemming from the decision sciences, statistics, and the rational choice method for policy analysis. Graduate standing in the science, technology and public policy master's program or permission of the instructor. Students who have taken 0521-402 may not take this course. **Class 4, Credit 4 (F)**

0521-713 Graduate Policy Analysis II
This course is the second in a three-course sequence (Graduate Policy Analysis I-III) that will provide students with tools to become effective policy analysts. This course will emphasize tools stemming from the decision sciences, statistics, and the rational choice method for policy analysis. Graduate standing in the science, technology and public policy master's program or permission of the instructor. Students who have taken 0521-403 may not take this course for credit. **Class 4, Credit 4 (W)**

0521-714 **Graduate Policy Analysis III**
This course is the third in a three-course sequence (Graduate Policy Analysis I–III) that will provide students with tools to become effective policy analysts. This course will emphasize tools stemming from the decision sciences, statistics, and the rational choice method for policy analysis. Students who have taken 0521-404 may not take this course for credit. **Class 4, Credit 4 (S)**

0521-749 **Special Topics: Public Policy**
This course will examine current topics in public policy and may be used with consent of advisor as a policy elective for the science, technology, and public policy master's degree. The course will examine a special problem or area relevant to the other courses in the degree. **Class 4, Credit 4 (offered occasionally)**

0521-751 **Energy Policy**
This course provides an overview of energy resources, technologies, and policies designed to ensure clean, stable supplies of energy for the future. The course evaluates the impacts of fossil fuel, renewable energy, and hydrogen technologies and how public policies can be used to influence their development. The development of U.S. energy policy is of particular concern, although a global perspective will be integrated throughout the course. This course is a professional elective for the science, technology, and public policy master's degree program and students in other graduate programs looking for policy electives (e.g., environmental science). **Class 4, Credit 4 (offered annually)**

0521-810 **Technology, Policy and Sustainability**
This course introduces students to public policy and its role in building a sustainable society. The course places particular emphasis on the policy process; the relationship among technology, policy, and the environment; and policy mechanisms for addressing market and government failures that threaten sustainability. Enrollment is restricted to students in the PhD in Sustainability program or permission of instructor. May be taken as an elective by MS and BS/MS students in the science, technology, and public policy program; MBA students, MS students in sustainable engineering; other graduate students interested in the relationships among public policy, technology, and sustainability. **Class 4, Credit 4 (offered annually)**

School Psychology

0527-701 **Advanced Developmental Psychology`**
This course is designed to examine a variety of topics that pertain to the social and emotional development of children/adolescents. During the first part of the course we will focus on attachment issues and resiliency. We will then examine children's play and children's cognitive, social and emotional development. Lastly, we will reflect on the adolescents' cognitive, social and emotional development. Students will learn how to wear developmentally appropriate glasses when working with children and adolescents. Students must be matriculated in school psychology program or have permission of instructor. **Class 4, Credit 4 (W)**

0527-702 **Psychology of Teaching and Learning**
Most of the referrals to school psychologists are the result of some sort of learning problem. Yet, most of us know little about the causes of school learning. We will examine theories and the basic psychological principles that apply to teaching and learning. This will be accomplished through the examination of the role of teachers, which includes their responsibility for teaching curriculum, classroom management, and the social and emotional growth of students. Emphasis will be placed on obtaining an understanding of learning disorders including diagnosis and intervention strategies. Student must be matriculated in school psychology program or have permission of instructor. **Class 4, Credit 4 (W)**

0527-703 **Cultural Diversity in Education**
The aim of this course is to understand the historical and structural origins of the present schooling system in the US. The function of schools, from an ideological as well as technical viewpoint will be analyzed. Different forms of school organizations will be compared, as in the public vs. private dimensions. The functionalist theoretical approach will be presented as well as the conflict perspective to frame the discussion and analysis of opposing sociological systems of thought. The role of education in promoting or inhibiting socioeconomic mobility will also be analyzed. This course attempts to understand how role expectations are actually carried within the school system and how its different actors react to technical as well as value constraints. Student must be matriculated in school psychology program or have permission of instructor. **Class 4, Credit 4 (S)**

0527-712 **Practicum I**
For the first year practicum the activities that you participate in will enable you to obtain first-hand knowledge and familiarity with: a) schools as systems, b) the role and function of the school psychologist, c) collaborative problem solving, d) counseling, e) teaching processes, and f) other relevant professional legal issues. More specifically, in the first quarter you will be doing functional assessments, classroom observations, possibly some achievement testing. In the second quarter you will do more teacher consultation, and by the third quarter you will be doing more counseling. The learning goals will fall within the eleven NASP domains of training and will provide you with the fundamental building blocks. Student must be matriculated in the school psychology program. **Class 2, Credit 2 (F)**

0527-713 **Practicum II**
For the first year practicum the activities will enable you to obtain first-hand knowledge and familiarity with: a) schools as systems, b) the role and function of the school psychologist, c) collaborative problem solving, d) counseling, e) teaching processes, and f) other relevant professional and legal issues. You will be doing functional assessments, classroom observations, possibly some achievement testing. In the second quarter you will do more teacher consultation, and by the third quarter you will be doing more counseling. The learning goals will fall within the eleven NASP domains of training and will provide you with the fundamental building blocks. Student must be matriculated in school psychology program and have a grade of B or better in preceding practicum course. **Class 2, Credit 2 (W)**

0527-714 **Practicum III**
For the first year practicum the activities will enable you to obtain first-hand knowledge and familiarity with: a) schools as systems, b) the role and function of the school psychologist, c) collaborative problem solving, d) counseling, e) teaching processes, and f) other relevant professional and legal issues. You will be doing functional assessments, classroom observations, possibly some achievement testing. In the second quarter you will do more teacher consultation, and by the third quarter you will be doing more counseling. The learning goals will fall within the eleven NASP domains of training and will provide you with the fundamental building blocks. Student must be matriculated in school psychology program and a grade of B or better in preceding practicum courses. **Class 2, Credit 2 (S)**

0527-715 **Practicum IV**
In the second year of practicum experience students will continue to participate in supervised field experiences in school settings along with integrative on-campus seminars. Trainees will advance from observational experiences to hands-on-experiences. These active learning activities will enable you to obtain first-hand knowledge and familiarity with schools as systems, the role and functioning of the school psychologist, collaborative problem solving, counseling, teaching process, consultation, and other relevant, professional and legal issues. You will be expected to gain a better understanding and sensitivity to the diverse cultural student populations in the Greater Rochester area. Many of you will be working with inner city youth of Rochester as well as with the special programs administered by BOCES personnel. Student must be matriculated in school psychology program. **Class 2, Credit 2 (F)**

0527-717 **Practicum VI**
In the second year of practicum experience students will continue to participate in supervised field experiences in school settings along with integrative on-campus seminars. Trainees will advance from observational experiences to hands-on-experiences. These active learning activities will enable you to obtain first-hand knowledge and familiarity with schools as systems, the role and functioning of the school psychologist, collaborative problem solving, counseling, teaching process, consultation, and other relevant, professional and legal issues. You will be expected to gain a better understanding and sensitivity to the diverse cultural student populations that we have in the Greater Rochester Area. Many of you will be working with inner city youth of Rochester as well as with the special programs administered by BOCES personnel. Student must be matriculated in the school psychology program. **Class 2, Credit 2 (S)**

0527-723 **Developmental Psychopathology**
This course focuses on maladaptive behavior of children and youth. Models of deviant behavior are presented with attention to physiological, learned, and environmental bases of behavior. Assessment and treatment approaches are discussed. Student must be matriculated in school psychology program or have permission of instructor. **Class 4, Credit 4 (S)**

0527-724 Interpersonal Intervention Skills
This course will concentrate on the development of individual counseling and consultation skills for the school psychologist. Students will acquire an understanding of the basic models and states of the counseling and consultation processes. Emphasis will be on building fundamental skills (e.g. attending, empathy, and probing) and on helping clients/consultees identify and clarify problem situations. There will be an emphasis on collaborative problem solving. Extensive laboratory work will involve role-play. Readings will focus on pertinent skills and approaches. They have been designed to insure that students will not view counseling and consultation as haphazard processes, but as systematic ones that involve effective listening, problem identification, decision making, and problem solving skills. Student must be matriculated in the school psychology program. **Class 4, Credit 4 (F)**

0527-726 Psychoeducational Assessment I
This introductory course in a series of assessment courses will study assessment generally, types of tests and their uses, strengths and weaknesses of specific instruments, principles of reliability and validity, scales, and norms. Students will acquire an understanding of the quantitative and qualitative aspects of measurements. There will be extensive laboratory experience with a variety of instruments that measure academic and sensory-motor perception. Emphasis will be placed on the clinical use of tests in schools and other settings. Student must be matriculated in the school psychology program. This course serves as the foundation for subsequent courses in the assessment sequence. **Class 4, Credit 4 (F)**

0527-728 Inferential Statistics I
This course reviews descriptive and inferential statistics. Basic and advanced conceptual material will be presented to assist students in their understanding of diverse data analytic methods, their appropriate application, and how to interpret statistical analyses. Topics will include descriptive analyses, measures of central tendency and variability, sampling distributions, statistical tests appropriate for one-and two-sample hypothesis testing, interval estimation, effect size, correlation, chi-square, and methods to assess for the assumptions of statistical tests. Course content will be taught through lectures, discussion, and applied data analysis exercises that requires the use of statistical software. **Class 2, Credit 2 (F)**

0527-730 Seminar: Professional and Legal Issues
Historic foundations and current critical professional issues, roles and functions of the school psychologist are emphasized in the course. Legal and ethical issues that bear on the role of the psychologist in the school are considered. Student must be matriculated in school psychology program plus have 32 quarter credit hours successfully completed in the program or permission of instructor. **Class 4, Credit 4 (S)**

0527-731 Psychoeducational Assessment II
This course concentrates on the development of theory and applied skills in intellectual assessment. Students learn to select and administer individual intelligence tests, to interpret results, to form test-based recommendations for intervention, and to provide written and oral reports. Assessment of persons who are culturally different or disabled is emphasized. Student must be matriculated in school psychology program and have a grade of B or better in psychoeducational assessment I. **Class 4, Credit 4 (W)**

0527-732 Psychoeducational Assessment III
The primary focus of this course is on the use of various social emotional assessment techniques employed by school psychologists for an evaluation of a child or adolescent suspected of having an emotional disturbance. Further, this course will also emphasize the use of adolescent personality tests used in conjunction with career interests as part of facilitating their transition from school to work or to post-secondary education. Students will gain experience in the administration, interpretation, and communication of assessment results. Special emphasis is placed on proficient report writing. Student must be matriculated in school psychology program. **Class 4, Credit 4 (S)**

0527-733 Applied Behavior Analysis
This course offers training in the behavioral assessment of students in educational settings. Students apply various techniques for recording and analyzing behavior and programs for behavior management. Student must be matriculated in the school psychology program or have permission of the instructor. **Class 4, Credit 4 (F)**

0527-734 Linking Assessment to Intervention
This is an applied course in linking the diagnostic assessment of exceptional children and adolescents to recommendations for appropriate interventions. Students learn to select and develop a plan of assessment for a variety of referral questions. Students continue to learn and expand their skills in administering tests. Students primarily learn to interpret and integrate test data and report the results and recommendations for parents, teachers and multi-disciplinary evaluation teams. The understanding goal threads are: 1) What makes a good report, 2) How to differentiate essential from non-essential information, and 3) How does this information inform us. Student must be matriculated in school psychology program. **Class 4, Credit 4 (F)**

0527-742 Biological Bases of Behavior
This course is designed to review the neurophysiological and neuropsychological bases of behavior and learning as it pertains to developmental disorders. Students will identify functional neuroanatomy, neuroimaging techniques, and various neuropsychological concerns. Students will apply findings and research to contemporary problems and issues facing school psychologists. Student must be matriculated in school psychology program or have permission of instructor. **Class 4, Credit 4 (W)**

0527-744 Advanced Counseling
This course focuses on the development of counseling skills used with children and adolescents in individual and group counseling. Students will be given the opportunity to integrate theory, research, and processes relative to individual and group work. We will examine how to create treatment plans. Cognitive Behavior Therapy and Solution Focused orientations will be examined. Techniques for facilitating group counseling will be emphasized—especially group behavior management. Crisis intervention will be reviewed. Student must be matriculated in school psychology program. (0527-701, 724) **Class 4, Credit 4 (S)**

0527-745 Alternative Assessment Techniques
The prime focus is on the assessment of academic problems in the classroom with special emphasis on the collection of data that allow the planning of interventions. Students will learn alternative direct methods of academic or behavioral assessment for both performance and skill deficits. Emphasis will be on the integration of these assessment techniques, collaborative problem solving, systematic observation, the principles of applied behavior analysis and the psychology of learning for the purpose of intervention development. Student must be matriculated in school psychology program. (0527-733, 749, 726, 731, 732) **Class 4, Credit 4 (F)**

0527-749 Advanced Consultation
This course will concentrate on the development of consultation skills for the school psychologist. Students will acquire an understanding of the basic models of consultation and the stages of the consultation process. Emphasis will be on the collaborative problem solving process where the skills of relationship building, problem identification, intervention implementation, and outcome evaluation will be well-honed. Extensive laboratory work will involve role play activities and first-hand experience through real case consultation. Readings will focus on the pertinent research in school-based consultation. Student must be matriculated in school psychology program or have permission of instructor. (0527-724) **Class 4, Credit 4 (F)**

0527-752 Children and Trauma
This course examines the nature, incidence, demographic distribution, sequel and appropriate treatment of trauma in children's lives. After defining trauma, it explores how experiences such as parental or sibling death, serious illness or injury, familial alcoholism, emotional, physical and sexual abuse, divorce or parental abandonment, community violence and natural disasters affect children. Student must be matriculated in school psychology program or have permission of instructor. **Class 4, Credit 4 (S)**

0527-759 Research Methods I
This course explores various types of research methods as well as important methodological issues and concepts. Methodologies studied include experimentation, quasi-experimentation, participant observation, archival methods, content analysis, surveys, interviews, and simulations. Methodological issues covered include philosophical paradigms, research ethics, reliability, threats to internal validity, external validity, demand characteristics, the volunteer subject problem, issues in sampling, and realism. Students will read original and contemporary works on research methodologies, as well as examples of such methodologies, and will write weekly summaries, applications, and criticisms. Course activities rely heavily on seminar-style discussions and presentations. Student must be matriculated in school psychology program or have permission of the instructor. **Class 2, Credit 2 (F)**

0527-777 Internship I, II, and III
The 1200 hour internship is the culminating experience. It provides an intensive, supervised training experience in which interns put the knowledge, skills and attitudes learned during their training program into practice while continuing to develop and expand upon those abilities. The internship year is a broad-based, individualized experience that provides an opportunity to work with a variety of children, parents, teachers, support staff and administrators. Interns are exposed to a variety of educational meetings, programs, workshops, resources, and conferences through their internship sites. Monthly class seminars supplement the supervised training experience. Student must be matriculated in the school psychology program; satisfactory completion of 84 hours in graduate program; a passing portfolio; a grade of B or better in Internship I and II to proceed to Internship III. **Class 4, Credit 4 (offered quarterly)**

0527-810 **Research Methods II**
This course assists students in the school psychology program in beginning their masters' theses or projects. Students will write a thesis/project proposal and give a presentation of this proposal. The proposal will consist of an abstract, a preliminary introduction that includes a literature review, a proposed methods (thesis students) or description of activities (project students) section, a proposed data analysis (thesis students) or product summary/outline (project students) section, a preliminary discussion section, a reference section, and appendices (if applicable). The proposal will be presented at the end of the term. Course activities will consist of library research, thesis/project planning, and writing under the supervision of the instructor. Student must be matriculated in the school psychology program or have permission of instructor and/or a passing grade in 0527-759. **Class 2, Credit 2 (W)**

0527-811 **Inferential Statistics II**
This course will assist students in understanding advanced concepts and methods of multivariate inferential statistics. Topics include correlation; simultaneous, hierarchical, and automated multiple regression; one-way and two-way analysis of variance and post-hoc comparisons, effect size, and methods to assess for assumptions of statistical tests. Students will learn to integrate concepts with computer applications. Course content will be taught through lectures, discussion, and applied data analysis exercises that requires the use of statistical software. **Class 2, Credit 2 (W)**

Communication and Media Technology

0535-700 **Film and Society**
This course provides an inquiry concerning the relationship between motion pictures and society that will use historical, humanistic, and social science research to achieve an understanding of movies as a social force, industry and art form. **Class 4, Credit 4 (offered occasionally)**

0535-701 **History of Media Technology**
This course is an introduction to the history of media technologies including print, telephone, broadcasting, and digital media. The course will also cover the inventors, landmark events, regulations and ethics of communication media along with their effects on and relationships with people and culture. **Class 4, Credit 4 (offered occasionally)**

0535-702 **Communication Theory**
This course focuses on theories of communication as they relate to technology. Theories based in both the humanities and in the social sciences that explain or predict the effects of communication technology on audiences will be presented. **Class 4, Credit 4 (offered annually)**

0535-703 **Research Methods in Communication**
This course provides an introduction to and overview of the methods and ethics of scholarly communication research including quantitative and qualitative approaches. The course focuses on methods of locating, critically analyzing and conducting communication research, and leads to the development of a research proposal suitable for a thesis or project. (0535-701, 702) **Class 4, Credit 4 (offered annually)**

0535-704 **Communication Law and Ethics**
This course focuses on issues presented by communication technologies to the practice of law and study of standards of ethics. Legal challenges presented by communication technologies will be examined in the following contexts: intellectual property, technology rights, patents, privacy and information networks, access to information, defamation, indecency, obscenity, and pornography. Special attention will be paid to the difficulty of applying national laws to international media. (0535-701,702) **Class 4, Credit 4 (offered occasionally)**

0535-705 **Electronic Communication in Society**
Electronic communication is an inquiry into interactive media and how they exert a powerful influence on communicative practices and society. Positioned at the intersection of technology, identity, and culture, interactive media are altering the ways in which people communicate in a wide range of contexts, including education, marketing, civic discourse, politics and popular culture. Utilizing theories about the relationship between communication technology and culture, this course will explore the current and potential future impact of interactive electronic communication and the social changes that are occurring. (0535-701, 702) **Class 4, Credit 4 (offered occasionally)**

0535-706 **Crafting the Message**
This course will focus on the creation of written and visual messages appropriate to a targeted audience and a specific medium including print, broadcast, interactive, digital and on-line technologies. Case studies of effective and unsuccessful messages from advertising, politics, public service, education, entertainment and development will be examined. Students will have the opportunity to create and execute a variety of messages using various writing styles and images, and with varying purpose. (0535-701, 702) **Class 4, Credit 4 (offered occasionally)**

0535-707 **International Media**
This course will evaluate media technology use in the international setting and in various countries and regions of the world. Major theories about the media, international communication developments, and governmental challenges and restrictions are considered. Special attention is paid to the uses and effects of media technologies within various countries and on global implications of the Internet and digital technologies on international cooperation, trade, and culture. (0535-701, 702) **Class 4, Credit 4 (offered occasionally)**

0535-708 **Communication Education**
This course examines various aspects of teaching communication in higher education. Students will explore teaching and learning styles, the role of technology in higher education, and assessment methods. Students will create teaching resources and gain experience teaching in a college classroom. **Class 4, Credit 4 (offered occasionally)**

0535-709 **Online Advertising**
This course reviews the theory and practice of interactive advertising. Topics include digital interactive media used for advertising purposes, interactive advertising theories and models, and the strategies and tactics for developing effective ad campaigns using interactive media, including the Internet, virtual communities, video games and mobile phones. (0535-701, 702) **Class 4, Credit 4 (offered occasionally)**

0535-710 **Visual Communication**
This course focuses on the use of still or moving images in mediated communication. Examples from print, television,Internet, photography and film will be examined in light of traditional and emerging media. The rhetoric of image based technologies is examined. **Class 4, Credit 4 (offered occasionally)**

0535-712 **Computer-mediated Communication**
This course is a graduate seminar examining the evolving forms and functions of computer-mediated communication, including e-mail, discussion groups, newsgroups, chat, instant messenger, and web pages. Grounded in rhetorical, mass media, and interpersonal theory the seminar explores electronically-mediated communication in its many contexts and manifestations in an effort to understand the evolving forms and functions of CMC and its impact on communicative behaviors and public discourse. Course objectives are met through readings, written papers, online observations, lectures, and class discussions. **Class 4, Credit 4 (offered occasionally)**

0535-713 **Readings in Mass Media**
This course is an introduction to the sub-discipline of mass communication via a series of essential texts of twentieth century thought on the subject. Complementing the readings will be a series of films with theses relating to media and their influence on society. It may be taken as an elective. (Matriculation in a graduate program or permission of the instructor.) **Credit 4, Class 4 (F)**

0535-725 **Special Topics: Master's Level**
This course is a focused, in-depth study and analysis of a selected advanced topic in communication and associated issues. Specific topics vary according to faculty assigned and are published when the course is offered. This course is an elective for communication and media technology majors. **Class 4, Credit 4 (offered occasionally)**

0535-800 **Communication Thesis and Project**
The graduate thesis/project will be guided and approved by the student's graduate advisement committee. Students may elect to conduct original research reported in a graduate thesis or to apply theory and research in an applied project. A minimum of 5 credits and no more than 9 credits can be earned as thesis/project credits. **Class 4, Credit 5–9 (offered annually)**

Center for Multidisciplinary Studies

James Myers, Director
www.rit.edu/cms

Programs of study

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Project Management	173
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The Center for Multidisciplinary Studies offers an MS degree in professional studies that is customized by each student and their graduate adviser to achieve particular career objectives. Often times, students are interested in more than one area of study, making the selection of a traditional master's degree difficult. Through the center, students can combine their interests with concentrations from any number of RIT departments to create a singular degree program that relates directly to a student's interests and career aspirations.

Admission requirements

The college makes all decisions regarding graduate admission. Please refer to each individual program for information regarding specific admission criteria. For general graduate admission information, please refer to the Admission section of this bulletin.

Financial aid and scholarship

Please refer to the Financial Aid and Scholarship section of this bulletin for information regarding financial aid, scholarships, grants, loans, and graduate assistantships.

Faculty

The center's faculty is comprised of faculty members from a wide range of disciplines. A core faculty oversees the center and guides students in creating a personalized degree program.

Study options

Most graduate programs offer a variety of study options, including full-time, part-time, and online study. Please refer to each individual program for specific information regarding these options.

Professional Studies, MS

http://www.rit.edu/cms/grad/masters.html

James Myers, Director
(585) 475-4772, jamisr@rit.edu
Samuel McQuade III, Graduate Program Director
(585) 475-5230, scmcms@rit.edu

Program overview

The professional studies program is specifically designed to enable the mature learner to create a customized plan of graduate study tailored to their personal and professional goals. This degree offers students the opportunity to draw on more than 50 graduate programs in order to gain the advanced knowledge and skills necessary to respond successfully to new and emerging career opportunities. The degree also includes a capstone project. The capstone is a practical, hands-on project directly related to the student's individualized plan of study. With certain concentrations, the MS degree in professional studies may be pursued through online learning.

The program requires the completion of 48 credit hours. Students begin their program of study with Contexts and Trends (3099-705), the program's foundation course. Throughout this course students explore their own career objectives and research RIT's many graduate programs to identify courses that best match their professional and personal goals. Students create concentrations that make up their course work for the degree program. Each concentration is a selection of courses drawn from existing RIT graduate programs and can range between 12 to 24 credit hours. Graduate credits earned in other programs may be used in completing a concentration, upon approval. A number of concentrations may be completed online. These include:

Applied Statistics
Computer Graphics
Environmental Health and Safety Management
General Management
Health Systems Administration
Human Resources
Imaging Science
Information Technology
Materials Science
Microelectronics Manufacturing Engineering
Project Management
Security Technology Management
Software Development and Management
Strategic Training
Technical Information Design
Telecommunications Engineering Technology

Credit hours not required in a student's concentration areas may be used for electives. All elective and transferred graduate courses need to be integrated into the proposed plan of study.

Curriculum

The MS program in professional studies includes two required courses, the choice of two or three concentrations chosen by the student and based on their career objectives, and the completion of a capstone project.

Required courses

3099-705 Context and Trends (4 credits)
This course introduces students to interdisciplinary thinking, personal self-assessment, problem solving, goal setting, and research techniques using electronic information resources. Students work toward selecting concentrations and finalizing a plan of study for their graduate program.

3099-775 The Capstone Project (4 credits)
This course is a supervised, hands-on experience in which students apply the skills and knowledge developed through their individualized plans of study, concluding with oral and written presentations.

Sample plans of study

The following examples illustrate typical course sequences when a candidate selects to pursue two concentrations or three. Many combinations of concentrations are possible.

Professional studies with two professional concentrations

COURSE		QTR. CR. HRS.
Required courses:		
3099-705	Context and Trends	4
3099-775	Capstone Project	4
Concentration A: Marketing		
0105-761	Marketing Concepts	4
0105-762	Advanced Marketing Management	4
0105-772	Marketing on the Internet	4
	Marketing Elective	4
Concentration B: Communication and Media Technologies		
0535-725	Social Media	4
0535-710	Visual Communication	4
0535-706	Crafting the Message	4
0535-709	Public Relations and Advertising	4
	Electives	
0626-703	Facilitation Skills	4
0626-730	Strategic Employee Development	4
Total		**48**

Professional studies with three professional concentrations

COURSE		QTR. CR. HRS.
Required courses:		
3099-725	Context and Trends	4
3099-775	The Capstone Project	4
Concentration A: Project Management		
3081-710	Introduction to Project Management	4
3081-711	Advanced Project Management	4
3081-712	International Project Management	4
3088-732	Managing Scientific and Technical Communication	4
Concentration B: Manufacturing and Mechanical Engineering Technology		
0304-618	Computer-Aided Engineering	4
0304-801	Design for Manufacture	4
0304-964	Production Tool Design	4
0610-710	Product Development and Integration	4
Concentration C: General Management		
0102-740	Organizational Behavior and Leadership	4
0102-741	Managing Organizational Change	4
0102-763	Behavioral Skills for Managers	4
Total		**48**

Admission requirements

To be considered for the MS program in professional studies, candidates must fulfill the following requirements:

- Hold a baccalaureate degree at a regionally accredited college or university,
- Have a minimum undergraduate cumulative grade point average of 3.0, or superior endorsements,
- Submit letters of reference from two individuals who have served recently as either the applicant's supervisor or instructor,
- Submit a statement of career objectives and description of the skills and knowledge sought through graduate study,
- Submit transcipts (in English) of all previously completed undergraduate and graduate course work,
- Submit a current resume, and
- Complete a graduate appliction.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language. Minimum scores of 550 (paper-based), 213 (computer-based), or 79 (Internet-based) are required. Scores from the International English Language Testing System (IELTS) exam are accepted in place of the TOEFL exam. Minimum acceptable scores will vary; however, the absolute minimum score for an unconditional acceptance is 6.5. The TOEFL requirement is waived for native speakers of English or those submitting educational transcripts and diplomas from American colleges and universities.

All applicants are urged to discuss their plans with the professional studies program adviser before submitting a formal application.

Project Management, Adv. Cert.

Program overview

In today's business-oriented society, project-based organizations and project management have become much more than just a way of conducting business. New growth within these organizations has changed the shape of project management to reveal what is becoming an exciting new career path for many individuals. Project managers have quickly become a necessary asset for many businesses.

The goal of a project manager is to successfully plan, organize, and accomplish a specific project or one-time effort. Encountering the challenges of cultural and social differences, along with an assortment of industrial focuses, the project manager must be aware of a project's goals on a daily and, sometimes, hourly basis. Completion of any project is achieved via a well thought-out project plan. The advanced certificate in project management teaches students how to plan, develop, and implement successful projects from initiation to completion.

Curriculum

The program consists of three core courses and two electives, which may be chosen with the approval of the student's adviser.

COURSE		QTR. CR. HRS.
3081-710	Introduction to Project Management	4
3081-711	Advanced Project Management	4
3081-712	International Project Management	4
	Two electives	8
Total		**20**

Electives

Many of these electives are available through online learning. Other electives may be used with an adviser's approval.

3088-732	Managing Technical and Scientific Communications
3088-721	Creating Technical Proposals
0626-703	Facilitation Skills
0626-782	Human Performance Management Practices
0625-844	Breakthrough Thinking: Creativity and Innovation
0102-740	Organizational Behavior and Leadership
0625-849	Service Performance Metrics

Admission requirements

To be considered for admission to the advanced certificate in project management, candidates must fulfill the following requirements:

- Hold a baccalaureate degree from an accredited institution,
- Have a minimum undergraduate GPA of 3.0,
- Submit official transcripts (in English) of all previously completed undergraduate and graduate course work,
- Submit a current resume,
- Submit a personal statement,
- Submit two letters of recommendation, and
- Complete a graduate application.

Additional information

Study options

The three required core courses may be completed either on campus and through online learning.

Strategic Training, Adv. Cert.

Program overview

Senior leaders in the most successful businesses agree that leveraging the human capital of an organization is vital to survival in today's competitive business climate. This requires businesses to align employee development plans with strategy and provide targeted learning experiences to ensure they equip their workforce to perform at the peak of their capability, attract the best and brightest candidates, and retain the most qualified employees.

The advanced certificate in strategic training provides professionals in fields such as human resources and business management with the competencies required to develop highly effective learning materials that drive strategic employee development, boost performance, and manage the employee development efforts of an organization.

Curriculum

The advanced certificate includes two core courses plus two electives chosen by the student.

COURSE		QRT. CR. HRS.
3088-750	Performance-based Training	4
0626-730	Strategic Employee Development	4
	Two Electives	8
Total		**16**

Electives

Students may choose two electives from the following. Additional electives may be used with permission of the student's adviser.

3088-732	Managing Technical and Scientific Communication
3088-721	Creating Technical Proposals
3088-716	Design Non-Traditional Learning Programs
3088-717	Design of Interactive Training
3088-718	Design On-the-Job Training

Admission requirements

To be considered for admission to the advanced certificate in strategic training, candidates must fulfill the following requirements:

- Hold a baccalaureate degree from an accredited institution,
- Have a minimum undergraduate GPA of 3.0,
- Submit official transcripts (in English) of all previously completed undergraduate and graduate course work,
- Submit a current resume,
- Submit a personal statement,
- Submit two letters of recommendation, and
- Complete a graduate application.

Additional information

Study options

The certificate's two core courses are available through online learning. Many of the electives are also available through online learning. Depending on the choice of electives, the entire certificate may be completed online.

Technical Information Design, Adv.Cert.

Program overview

Technical information design is a growing multidisciplinary communication field that requires understanding and skills in the development and use of text, graphic design, multimedia, and other techniques to enhance contemporary technical communication. Success in this field demands that the practitioner have superior writing skills, adeptness at selecting and using available and emerging media, and the ability to recognize excellence in the visual aspects of communication design. This program focuses on the information designer's use of technology to create documentation and deliver information to the intended audience.

Curriculum

The advanced certificate includes three required core courses plus a minimum of 12 credit hours of electives, chosen with the approval of the program adviser.

COURSE		QTR. CR. HRS.
Required courses		
3088-711	Technical Information Design	4
3088-731	Technical Procedures	4
3088-741	Usability Design and Testing	4
	Electives	12
Total		**24**

Electives

Many of the following elective courses are available through online learning. Other electives from relevant fields of study, such as human-computer interface, computer graphics, or project management may be used with an adviser's approval.

COURSE		QTR. CR. HRS.
4004-730	Interactive Media Implementation	4
4004-741	Fundamentals of Web-based Multimedia	4
4004-745	Theories in Interactive Computing	4
3088-721	Creating Technical Proposals	4
3088-732	Managing Technical and Scientific Communication	4
2081-723	Contemporary Publishing	4
3088-714	Science Writing	4
3088-7xx	Web Design courses (with approval from adviser)	

Admission requirements

To be considered for admission to the advanced certificate in technical information design, candidates must fulfill the following requirements:

- Hold a baccalaureate (or equivalent degree) from an accredited institution,
- Have a minimum cumulative GPA of 3.0 (B)
- Submit two professional recommendations, and
- Complete a graduate application.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language (TOEFL). A minimum score of 550 (paper-based) is required. Scores from the International English Language Testing System (IELTS) are accepted in place of the TOEFL. Minimum acceptable scores will vary; however, the absolute minimum score for an unconditional acceptance is 6.5. Students with a lower score may be admitted conditionally and may be required to take a prescribed program in English, along with a reduced program course load. Students entering this program also are expected to have basic skills in technical writing and editing, and technical document design.

Students with a lower GPA than required may take courses on a nonmatriculated basis and be admitted after successful completion of two or more courses and permission of the program chair.

Center for Multidisciplinary Studies

James Myers, BS, MS, Rochester Institute of Technology; Ph.D., University of Michigan—Director; Professor

Mary Boyd, BA, Earlham College; MS, University of Iowa—Associate Professor

Thomas Hanney, Certificate, Rochester Institute of Technology; BA, St. John Fisher College; MPA, State University College at Brockport—Lecturer

Guy Johnson, BS, Pennsylvania State University; MS, Syracuse University—Professor

Samuel McQuade III, BA, Western Washington University; MPA, University of Washington; Ph.D., George Mason University—Graduate Program Director; Associate Professor

Richard Morales, BA, Michigan State University; MA, State University College at Brockport; MSW, Ph.D., Syracuse University—Faculty Emeritus

Thomas F. Moran, BSME, California Polytechnic State College; MSME, California State College at Long Beach—Professor

Carol Romanowski, BA, State University College at Plattsburgh; BS, MS, Ph.D., University at Buffalo—Associate Professor

Project Management

3081-710 **Project Management**
Course addresses the qualitative and quantitative facets of project management, as well as techniques required to manage projects. Major topics include project selection, planning, work breakdown structure, conflict resolution and negotiation, budgeting, network scheduling, resource allocation, critical path method, pert, earned value analysis, and risk management. Several software applications are used in the course. Students will complete weekly assignments, a term project, and graduate activities. 0681-410 may not be substituted for 0681-710 in a CMS graduate concentration or advanced certificate. (Introductory course(s) in management; Microsoft Office applications; fundamentals of accounting, finance, statistics, and probability; or permission of instructor) **Credit 4**

3081-711 **Advanced Project Management**
Course covers the advanced project management topics necessary for implementation of and excellence in project management. Deals with turning the principles and theory of project management into practice. Ad-dresses the best practices for project management in the world; project portfolio management; the project office; project risk management; multinational cultures and cultural failures; integrated project teams; and virtual project teams. Incorporates aspects of the Project Management Body of Knowledge (PMBOK). (Project Management 0681-710; or equivalent experience; or by permission of the instructor) **Credit 4**

3081-712 **International Project Management**
With the increasing frequency of globalization, mergers, and acquisitions, international projects are becoming more prevalent and approaching the norm for many organizations. This course addresses a wide range of international projects-based in different industries and multiple countries. Deals with cultural and social differences within firms; cultural and social differences among countries and within countries; languages and dialect variations; different management practices and structures; religious practices; legal, regulatory, and reporting requirements; technology differences in different areas; and time zone differences. Incorporates aspects of the Project Management Body of Knowledge (PMBOK). (Project Management 0681-710 and Advanced Project Management 0681-711;or equivalent experience; or permission of the instructor) **Credit 4**

Quality Management

3084-701 **Warehouse and Inventory Management**
In the world of ever-evolving supply chain technologies, inventory control is now a term of the past. Distribution managers and buyers now need skilled individuals who possess a thorough knowledge of the product supply chain; with an in depth understanding of inventory practices, storage techniques, emerging technology and inventory management strategies. A term project is required; students prepare a long-term plan for a real-life situation using concepts taught in class. Co-listed with 0684-501. Note that students may not receive credit for both 0684-501 and 0684-701. Online course. **Credit 4**

3084-740 **Introduction to Asset Reliability**
Unscheduled downtime costs businesses millions of dollars each year, but reliability and maintenance is often the last area to attract the attention of managers trying to lower costs. Usually thought of as non-value-added, maintenance and reliability policies can have significant impact on a company's profit. This course introduces the student to methods in preventive maintenance and reliability, including repairable systems, non-repairable systems, and ways to optimize maintenance schedules for each type. Students are provided with software packages that allow them to apply concepts and understand results. Graduate students are required to complete a term project integrating these concepts for a real-life system. Co-listed with 0684-440. Note that students may not receive credit for both 0684-440 and 0684-740. Online course. **Credit 4**

3084-780 **Introduction to Asset Management**
Unscheduled downtime costs businesses millions of dollars each year, but asset management and maintenance is often the last area to attract the attention of managers trying to lower costs. Usually thought of as non-value-added, maintenance and asset management policies can have significant impact on a company's profit. This course introduces the student to the wide range of policies and practices, including capital budget issues related to asset acquisition, cost of ownership, and depreciation; inventory/procurement; maintenance policies such as run-to-failure, preventive maintenance, and reliability centered maintenance; training issues; and developing performance indicators for management programs. Co-listed with 0684-480 Note: Students may not receive credit for both 0684-480 and 0684-780. Online course. **Credit 4**

Technical Communication

3088-711 **Technical Information Design**
Intensive practice in the creation of content for online and multimedia documents with emphasis on the presentation of technical and scientific concepts, products, and processes. A survey of graphic methods for the display of complex technical relationships and ideas. Students will also explore contemporary topics (international technical communication, the future of on-line documentation, ethical considerations in technical information design, etc.) and applications (legal, medical, electronics, environmental, etc.) in Technical Information Design. (0688-333 or equivalent, or permission of instructor). **Credit 4**

3088-712 **Advanced Photoshop Techniques**
This course offers a strategic view of the Photoshop/digital imaging work environment, with an emphasis on preparing high-quality images for print. Instead of specific tools, it will focus on broader techniques and strategies with an emphasis on preparing high-quality images for publication. Topics such as image correction, color models, file formats and additional image types such as duotones will be discussed in detail. **Credit 3**

3088-713 **Introduction to XML**
This course provides an introduction to XML (Extensible Markup Language) and its applications in information management and a variety of fields. Students will learn how to use this flexible text format that is playing an increasingly important role in the exchange of a wide variety of data on the Web and elsewhere. Programming experience is not required for this course. **Credit 3**

3088-714 **Science Writing**
Students learn the special requirements for gathering information and writing articles about changes and new developments in the world of science. Students look at contemporary outlets for science writing, read and study examples of science journalism from a variety of fields and prepare a feature length science article. Class articles are published in an on-line journal. **Credit 4**

3088-716 **Design Non-Traditional Learning Programs**
High performance workplace is more than a buzzword in today's organizations; it is the key to viability in the global marketplace. Instructional design professionals must be able to help organizations improve performance without taking employees away from revenue generation activities. The four-credit course examines the development of non-traditional learning programs and tools that drive performance, such as special project assignments, job shadowing, and hiring criteria. Students in the course learn to identify effective non-training interventions and design useful tools and materials to support performance improvements. (0626-730 Strategic Employee Development or equivalent experience or courseware) and 0688-7xx Performance-Based Training Design. This course is offered only online. **Credit 4**

3088-717 **Designing Interactive Training**
As employers become more focused on the need to engage employees to order to improve retention and increase productivity, learning strategies for employee development must model engagement. Employers and employees are seeking well designed, engaging learning programs that link to corporate strategies. This four-credit course examines how to use games, simulations, cases, and other learning experiences to create an interactive, job-relevant training program. Students in the course practice developing learning activities that engage adults, drive learning objectives, and that can be effectively replicated by any number of trainers and across a variety of delivery mechanisms. (0626-730 Strategic Employee Development or equivalent experience or courseware) and 0688-7xx Performance Based Training Design. This course is offered in both traditional and blended modes. **Credit 4**

3088-718 **Designing On-the-Job Training**
Research has shown that adults learn best and retain the most when actively engaged in the task they must master. Traditional approaches to training set up an environment where adults are shown and told what to do. An on-the-job approach to training shortens overall training time and helps new employees get productive sooner. This four-credit course focuses on creating training materials to support on-the-job training of technical tasks. Students in the course learn to write job aids and create training modules that any job expert can use to effectively train peers. They practice writing clear instructions and documenting critical job knowledge. (0626-730 Strategic Employee Development or equivalent experience or courseware and 0688-750 Performance-Based Training Design). This course is offered in both traditional and on-line modes. **Credit 4**

3088-721 Creating Technical Proposals
The elements of proposal writing, including responsiveness, establishing credibility, and technical clarity. The proposal process as practiced in government and industry, including an understanding of RFPs, RFIs, and the decision process. Specialized proposals including NDAs, on-line and multi-media proposals and technical marketing presentations. (0688-333 or equivalent or permission of instructor) **Credit 4**

3088-731 Technical Procedures
Development of task-oriented and process documentation. Procedures complex physical and mental tasks including time-constrained activities, emergencies, diagnostics and troubleshooting, and multiple-path processes. Formats for print, electronic, and multi media instructions. An introduction to the creation of online help including Web-delivered and HTML help. (0688-333 or equivalent or permission of instructor) **Credit 4**

3088-732 Managing Technical and Scientific Communication
Course covers the management of technical and scientific projects and organizations, including managerial roles, practices, and responsibilities as well as management strategies for content and audience evolution. Covers management of parallel (print and online) projects, single-sourcing, and documentation localization; technological factors in the production and distribution of technical documentation; and consideration of career options and independent contracting. (Technical Writing and Editing 0688-333 or equivalent or permission of the instructor) **Credit 4**

3088-741 Usability Design and Test
The elements of successful electronic and print document design. The use of design concepts and tools to increase usability. Introduction to information mapping. Design and usability test considerations for multi-media and user-centered media. (0688-333 or equivalent or permission of instructor) **Credit 4**

3088-750 Performance Based Training
This course provides individuals with the tools needed to develop performance-based, instructor-led learning programs. Students learn techniques to assess performance needs, identify learning gaps, analyze job tasks, write performance-based learning objectives, design learning modules, benchmark content, and test learner comprehension. The course provides the opportunity to complete an actual work-related learning module as an alternative to a case-based module. Students will determine the need to build or buy training, complete the plan phase for project management, how to source effective training to meet given objectives, and tools to communicate with and assess effectiveness of suppliers. Offered only in on-line format. This course is co-listed with 0688-476 Instructional Design Principles; students taking 0688-476 may not receive credit for 0688-750. (0626-730 Strategic Employee Development) **Credit 4**

Math and Science

3092-700 Applied Data Mining
This course is intended to provide students with the knowledge and expertise to leverage data mining's strengths in various domains. The course will cover the data mining methodology, data cleaning and preparation, unsupervised learning algorithms, supervised learning algorithms, new research in the field, and ethical/privacy issues. The focus is on applying data mining methods to a variety of fields; no computer programming experience is necessary. Students should have a computer capable of running Java-based programs and will make extensive use of an open-source data mining application. (Basic statistics and computer literacy, or permission of instructor) **Credit 4**

Geospatial Science and Technology

3093-701 Introduction to Geographic Info Systems
This course will introduce students to the world of Geographic Information Systems (GIS). Course readings lectures and labs cover a mix of practical and technical GIS topics including: fundamental GIS concepts, ArcGIS software competency, spatial data and spatial analysis fundamentals, and cartography. This course is co-listed with 0693-401 and my not be taken for graduate level credit if the student has earned credit for 0693-401. **Credit 4**

3093-702 Geospatial Science
This course will present a survey of the relatively new and rapidly advancing field of Geospatial Science and Technology (GST) and will provide students with the theoretical basis necessary for geospatial research. The lecture portion of the class will present a survey of Geospatial Science theories and will examine a variety of geospatial algorithms. The recitation portion of the class will explore current scientific research topics in Geospatial Science and will present advanced geoprocessing concepts. Computer-based assignments utilizing Geographic Information Science (GIS) software will be required on a weekly basis in order to familiarize students with advanced geoprocessing techniques. This course is co-listed with 0693-402. Students who have taken 0693-402 may not register for 0693-702 for graduate level credit. (Introduction to GIS, 0693-701) **Credit 4**

3093-703 Geospatial Data Analysis
This course is a survey of the theory and techniques used for spatial analysis of complex, geographically-referenced data. This course will incorporate advanced statistical and GIS data analysis techniques for a variety of problem types that span a broad spectrum of disciplines. In-class and out-of-class computer assignments will develop advanced spatial data analysis skills. Students will read a series of assigned technical journal articles, prepare literature reviews, and lead classroom discussions related to their technical assessments of current scientific research topics. An in-depth, independent research project will be prepared and project results will be presented to the class. This course is co-listed with 0693-403. Students who have taken 0693-403 may not register for 0693-703 for graduate level credit. (Geospatial Science, 0693-702) **Credit 4**

3093-704 Geodatabase Development and Implementation
A "Geodatabase" is a geographically-referenced database that geographic data and represents real-world features. This four-credit course will cover the following topics:(1) fundamental concepts of databases and geodatabases;(2) design, development, management, and analysis of geospatial data sets;(5) spatial queries; (6) intro to SQL and ArcObjects; (7) enterprise GIS and enterprise workflows; and (8) internet mapping. Students will read a series of assigned technical journal articles, prepare literature reviews, and lead classroom discussions related to their technical assessments of current scientific research topics. An in-depth, independent research project will be prepared and project results will be presented to the class. This course is co-listed with 0693-404. Students who have taken 0693-404 may not register for 0693-704 for graduate level credit. (Intro to GIS, 0693-701) **Credit 4**

3093-705 Mobile GIS
This credit course will introduce students to concepts in Mobile GIS technology, GPS theory, and the integration of GPS and GIS data. Students will learn how to use handheld GPS units, hand held personal computers, and ArcPad, GPS Analyst, and Trimble GPS software. Additionally, this source will provide students with the opportunity to plan and implement field surveys in a team environment, as well as perform laboratory-based geospatial data analysis on information collected in the field. The course will emphasize the integration of geospatial technologies for field surveys. Students will read a series of assigned technical journal articles, prepare literature reviews, and lead classroom discussions related to their technical assessments of current scientific research topics. **Credit 4**

3093-706 Spatial Modeling and Visualization
This course explores the spatial modeling of geographic data for the characterization of natural phenomena, land use scenarios, and economic variables. Course topics will include three and four dimensional spatial analysis, network analysis, and predictive modeling. Students will use GIS software to analyze and visualize time-series data and spatial patterns. Students will read a series of assigned technical journal articles, prepare literature reviews, and lead classroom discussions related to their technical assessments of current scientific research topics. An in-depth, independent research project will be prepared and project results will be presented to the class. This course is co-listed with 0693-406. Students who have taken 0693-406 may not register for 0693-706 for graduate level credit. (Geospatial Data Analysis, 0693-703) **Credit 4**

Security Technology Management

3096-700 Security Technology Management
This four-credit course examines security threats and technologies, associated R&D processes and relationships among technology developers, and numerous management concerns pertaining to the adoption, implementation and utilization of security enhancing technologies throughout society. **Credit 4**

3096-701 Security Technology Policy, Law and Ethic
This course will introduce the ethical component of security policies and practices especially those involving security systems, tools and related technologies. Within this general framework several specialized topics are addressed including: scientific misconduct in security technology R&D, regulation construction and ethical enforcement practices, reasonable expectations of privacy established in case law rulings, abusive/illegal use of security technologies, causes of personal and vicarious civil liability, and links between personal integrity and professional ethics. **Credit 4**

3096-702 Managing Critical Information Infrastructure Threats
The course explores economic, political, cultural, organizational and technological factors underlying information security threats, conflicts, competitions, and response capabilities, and how these may compromise national, organizational and personal security. (Security Technology Management or with permission of instructor) **Credit 4**

3096-703 Security Enhancement—Environmental Design
This course will provide students with an understanding of the integration of technology into security designs. Physical barriers, locks, lighting, alarm, and CCTV systems are just of few of the many relatively low-to-high technologies that will be addressed with regard to public and private facilities, landscaping and architecture planning. (Security Technology Management or with permission of instructor) **Credit 4**

3096-704 Internal Organizational Security Management
This course provides an essential overview of internal security theory, fundamentals, laws, regulations and best investigative practices with an emphasis on innovative tools and methods now available to enhance internal security functions in all types of organizations. (Security Technology Management or with permission of instructor. **Credit 4**

Professional Studies

3097-701 Psychology of Terrorism
This course provides a brief background of terrorist groups and leads into the psychological aspects of terrorism and terrorists themselves. By examining who becomes a terrorist and why, a better understanding of terrorism as a whole can be formed. In addition, this course will examine the psychological effects of terrorism and their reproductions through the media and the public. (Permission of instructor) **Credit 4**

3097-702 Examining Terrorist Groups
To give students a broad understanding of terrorist groups from a variety of cultures and backgrounds, their motivations, and operating procedures so that the bio threat posed may be accurately assessed. Students will study the history of known organized terrorist activity, including study of common cultural historical correlations, and groups' modus operandi. The latest developments in terrorist profiling will also be discussed. (Permission of the instructor) **Credit 4**

0697-703 Economics of Political Violence
Terrorist groups have successfully financed their terrorist through illegal means such as criminal activities, the heroin market, or the black market. While not ignoring their religious, political, and ideological motives, the course will focus on the economics of modern terrorist groups. An overview of the financial and economic aspects of political violence and terrorism, this course provides students with a closer look into terrorist financing, vulnerabilities and openness of the global financial networks, and economies of violence. Economics of Political Violence offers global and strategic approaches to fighting political violence through information economies, media, and soft power. Students will undertake short research projects as well as engage in small group activities and in-class presentations. (Permission of instructor). **Credit 4**

3097-710 Toxin Chemical Weapons Threat and Defense
This course will introduce students to the toxins secreted by and fungi, as well as marine, venom and plant toxins. Chemical weapons and regulatory peptides will also be discussed. Lectures will include the structure of each toxin type and the mechanism of action of each, as well as various aspects of protection against toxin and chemical weapons. **Lecture 4, Credit 4**

3097-711 Intelligence Analysis
This overview will encompass analytical methodologies, direct and indirect challenges, the various types, categories, and modalities, tactical vs. strategic issues, information sources, customers, clients, and policymakers, and current issues in the intelligence field. Students will undertake short research projects as well as engage in small group activities and in-class presentations. During the quarter guest speakers will be invited to present their particular expertise on key issues. **Class 4, Credit 4**

3097-712 Bacterial and Viral Weapons Threat Defense
This overview will introduce student to those bacteria that are potential agents of bioterrorism. Lecture topics will include the metabolism, virulence factors, physiology, immunology, and genetics of these agents, as well as the pathology and prevention of disease. **Class 4, Credit 4**

3097-713 Radiological Threats and Defense
We are all well aware of the threat that terrorist groups will use radiological weapons against us or our allies, yet the effects of these weapons is not well known. Mitigation and defense measures are equally poorly understood. In this class, students will learn the basics of radiation science, the characteristics and risks posed by radiological terrorism, and how to respond in the event such a device is used. **Credit 4**

3097-798 Special Topics
Special Topics are experimental graduate courses announced quarterly. Watch for titles in the course listing each quarter. **Credit variable**

3099-705 Context and Trends
This course introduces students to interdisciplinary thinking, solving and research techniques and also print and electronic information resources appropriate to the student's individualized plan-of-study. **Credit 4**

3099-775 Capstone Project
This course is a supervised, hands-on experience in which students apply the skills and knowledge developed through their individualized plans-of-study and concludes with a specific product and an oral and written presentation. **Credit 4**

3099-798 Independent Study
This course number should be used by students who plan to study a topic on an independent study basis. The student must obtain the permission of the appropriate faculty member before registering for the course. **Credit 1–12**

National Technical Institute for the Deaf

www.ntid.rit.edu

The National Technical Institute for the Deaf (NTID) is the world's largest technological college for deaf students. Among RIT's more than 17,200 full- and part-time students are more than 1,300 undergraduate and graduate deaf students from the United States and 17 foreign countries.

NTID offers a master of science degree in secondary education of students who are deaf or hard of hearing. All full-time students in the MS program are eligible for scholarships and graduate assistantships.

Students also can pursue master's degrees through RIT's other seven colleges.

Programs

Secondary Education of Students Who Are Deaf or Hard of Hearing, MS

www.rit.edu/NTID/msse

Gerald C. Bateman, Director
(585) 475-6480 (voice/TTY), gcbnmp@rit.edu

Program overview

The master of science degree in secondary education of students who are deaf or hard of hearing is a unique program that prepares students to meet the national need for teachers of secondary students who are deaf or hard of hearing. The program prepares teachers not only as effective and ethical practitioners but also as scholars and leaders in the profession.

Faculty members in this program are international leaders in research and are highly skilled in the education of deaf people. A carefully designed system of faculty advisement is a prominent feature of the program. On-campus facilities, state-of-the-art technology, and a well-established system of educational access services combine to make this a vital program for both deaf and hearing students who desire careers as professional educators of deaf students. Graduates have a 96 percent pass rate on the New York State Teacher Certification examinations.

Curriculum

COURSE		QTR. CR. HRS.
0835-700	History of Deaf Educational Thought	4
0835-701	Psychology and Sociology of Deaf Students	4
0835-702	Deaf Students: Educational and Cultural Diversity	4
0835-703	Special Education in the Social Context	4
0835-704	Teaching Deaf Learners with Secondary Disabilities	4
0835-705	Political/Legal Environment	4
0835-706	Educational Technology and Teaching	2
0835-712	Curriculum Content and Methods of Instruction	4
0835-713	Assessment	4
0835-721	Structure of American Sign Language	4

COURSE		QTR. CR. HRS.
0835-722	Audition and Spoken Language: Application in Education	4
0835-723	Language Acquisition and Variation	4
0835-724	English Language Development	4
0835-790	Foundations of Educational Research	4
0835-820	Perspectives in Teaching Deaf and Hard-of-Hearing Students	2
0835-860	Student Teaching I	10
0835-861	Student Teaching II	10
0835-880	Master's Project Seminar	2
0835-890	Master's Project	8
0835-898	Special Topics	variable
0835-999	Field Experience	0
	Professional Development Seminars	0
	American Sign Language*	8
Total		**94**

*Course placements and credit by exam for American Sign Language courses are determined by the department of American Sign Language and interpreting education.

Proposed plan of study

First Year

Fall Quarter

0835-703	Special Education in the Social Context
0835-701	Psychology and Sociology of Deaf Students
0835-706	Educational Technology and Teaching
0835-721	Structure of American Sign Language
0886-xxx	ASL course

Winter Quarter

0835-700	History of Deaf Educational Thought
0835-722	Audition and Spoken Language: Application in Education
0835-712	Curriculum Content and Methods of Instruction
0835-723	Language Acquisition and Variation
0835-999	Field Experience*
0886-xxx	ASL course

Spring Quarter

0835-860	Student Teaching I*
0835-820	Perspectives in Teaching Deaf and Hard-of-Hearing Students

Second Year

Fall Quarter

0835-713	Assessment
0835-790	Foundations of Educational Research
0835-724	English Language Development
0835-702	Deaf Students: Educational and Cultural Diversity

Winter Quarter

0835-880	Master's Project Seminar
0835-861	Student Teaching II*

Spring Quarter

0835-890	Master's Project
0835-704	Teaching Deaf Learners with Secondary Disabilities
0835-705	Political/Legal Environment

* Students are required to complete a minimum of 250 hours of supervised student teaching, working with deaf and hard-of-hearing students at the secondary (7–12 grade) level. In addition 100 hours of field experience are required before the first student teaching placement.

Degree requirements

Course work will require a minimum of six quarters. A cumulative GPA of at least 3.0 must be maintained. Before graduation, students are expected to have at least intermediate-level signing skills as determined by a Sign Language Proficiency Interview.

Admission requirements

To be considered for admission to the MS program in secondary education of students who are deaf or hard of hearing, candidates must fulfill the following requirements:

- Hold a baccalaureate degree at an accredited college or university,
- Have a cumulative grade point average of 3.0 or higher,
- Have a basic knowledge of sign language as measured by a departmental skill assessment, or willingness to take American Sign Language I, or its equivalent, at NTID or another college prior to beginning the program,
- Have a level of writing proficiency appropriate to graduate study as indicated by a review of undergraduate writing-intensive courses and an expository essay (see below). In addition, applicants may be required to take the COMPASS e-Write, a standardized writing assessment.
- Submit letters of reference and an expository essay that indicate evidence of professional commitment and potential for success in the program,
- Participate in an individual interview, and
- Complete a graduate application.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language (TOEFL). Minimum scores of 550 (paper-based) or 213 (Internet-based) are required.

Additionally, 30 semester credit hours in a content area are required by the New York State Education Department for initial certification to teach a secondary (grades 7–12) content area. Students who do not have the required number of hours must complete the additional credits before applying for New York State certification. Secondary academic subjects include American Sign Language, English, mathematics, social studies, or science. **Note:** The social studies content area includes economics and government, and at least 21 semester hours in the history and geography of the United States and the world.

Additional information

4+2 education program

A 4+2 program designed specifically for RIT students who hope to become teachers of deaf and hard-of-hearing students was created as a bridge between the university's four-year bachelor's degree programs and the two-year MS program in secondary education. Upon successful completion of a bachelor's degree in an approved program with the required credits and GPA, students are guaranteed admission to the MS program.

Financial Aid

NTID tuition is about one-third of RIT's tuition. Approximately 60 percent of NTID's full-time graduate students receive financial aid awards. A student's need is determined by the analysis of the Free Application for Federal Students Aid (FAFSA). RIT has four general categories of financial aid: scholarships, grants, loans, and employment. RIT has grant funding available to address the financial need of all graduate students. Though funds are limited, RIT strives to meet as much of a student's financial need as possible.

Students who pursue the MS program and plan to teach in the content areas of math or science upon graduation, may be eligible for a scholarship of up to $5,000 per year for two years. Up to 10 such scholarships are offered on an annual basis.

All full-time students in the MS program are offered opportunities to work as graduate assistants with members of NTID faculty and staff. These paid positions range from teaching and research assistants to program assistants and tutors. Graduate assistants are required to work five hours per week and receive a stipend of $1,000 per quarter ($3,000 per academic year). There also are numerous on-campus student employment opportunities available.

Graduate Faculty

Gerald P. Berent, BA, University of Virginia; Ph.D., University of North Carolina at Chapel Hill—Interim Chairperson; Professor, Linguistics

John A. Albertini, BA, Drew University; MS, Ph.D., Georgetown University—Professor, Linguistics

Gerald C. Bateman, BS, MS, State University College at Geneseo; Ed.D., University of Rochester—Professor; Director, Curriculum and Teaching

Gerard J. Buckley, BS, Rochester Institute of Technology; MSW, University of Missouri; Ed.D., University of Kansas—President, NTID and Vice President and Dean, RIT; Associate Professor, Educational Policy, Politics, and Legal Issues

Karen Christie, BS, M.Ed., Lewis and Clark College; Ph.D., University of Pittsburgh—Associate Professor, Education

Jessica A. Cuculick, BS, Rochester Institute of Technology; MSW, East Carolina University—Assistant Professor, Curriculum and Teaching

Carol Lee De Filippo, BA, Newark State College; MS, Purdue University; MS, Ph.D., Washington University—Professor, Communication Sciences: Audiology

Susan Foster, BA, Northwestern University; BS, University of Maine; M.Ed., Bridgewater State College; Ph.D., Syracuse University—Professor, Special Education and Rehabilitation

Peter Hauser, BA, Central Connecticut State University; MA, Ph.D., Gallaudet University—Associate Professor, Clinical Psychology

Ronald Kelly, BS, M.Ed., Ph.D., University of Nebraska at Lincoln—Professor, Educational Psychology and Measurements

Baldev Kaur Khalsa, BA, M.Ed., Western Maryland College—Associate Professor, Education of Deaf Students

Christopher Kurz, BA, Rochester Institute of Technology; MS, Ph.D., University of Kansas—Associate Professor, Special Education: Education of Deaf Students

Susan L. Lane-Outlaw, BA, MA, University of North Florida; Ph.D., Gallaudet University—Assistant Professor, Language and Literacy Development

Harry G. Lang, BS, Bethany College; MS, Rochester Institute of Technology; Ed.D., University of Rochester—Professor, Science Curriculum and Teaching

Gary Long, BA, University of Akron; MA, Ph.D., Texas Christian University—Associate Professor, Cognitive Psychology/Mathematical Psychology

Ila Parasnis, BA, MS, Nagpur University; MA, Ph.D., University of Rochester—Professor, Psychology

Amanda Picioli, BS, State University College at Geneseo; MES, Smith College; MS, Syracuse University; AuD., University of Florida—Audiologist, Audiology

Vincent Samar, BA, MA, Ph.D., University of Rochester—Associate Professor, Psychology/Cognitive Neuroscience

Cynthia Sanders, BS, MA, Syracuse University; DA, State University of New York at Albany—Associate Professor, Communication

Sara Schley, BA, Reed College; MA, Northeastern University; Ed.D., Harvard University—Associate Professor, Human Development and Language Acquisition

J. Matt Searls, BA, MA, Gallaudet University; Ph.D., American University—Associate Professor, Counseling and Development

Michael S. Stinson, BA, University of California at Berkeley; MA, Ph.D., University of Michigan—Professor, Educational Psychology

Secondary Education of Students Who Are Deaf or Hard of Hearing

0835-700 History of Deaf Educational Thought
A historical analysis of change and continuity in educational history from colonial through contemporary America. Special emphasis will be given to the development of the field of deaf education in the United States. Lectures, seminar discussions, and readings offer comprehensive coverage of the salient intellectual themes of American deaf educational history. **Class 4, Credit 4 (F)**

0835-701 Psychology and Sociology of Deaf Students
The purpose of this course is to examine the psychological and social development of deaf and hard-of-hearing students in childhood and adolescence. The ways that family, school, and community affect the student's development, including effects on cognitive processes, identity formation, and peer relationships, are considered. Psychological and sociological perspectives on the students' experience in general are used to provide a framework for understanding the development of deaf and hard-of-hearing students. Educational implications of the theories and research presented are discussed. **Class 4, Credit 4 (F)**

0835-702 Deaf Students: Educational and Cultural Diversity
This course introduces the concepts underlying cultural anthropology and uses a cross-cultural approach to examine issues that include transmission and preservation of culture, cultural change and transformation, concepts of marginality, and majority and minority cultures. Deaf culture is examined and compared with other cultures, using comparative studies and cultural constructs such as norms, values, and beliefs. The relationship between education and culture is discussed, and the nature of this relationship with respect to Deaf culture is studied. **Class 4, Credit 4, (F, S)**

0835-703 Special Education in the Social Context
This course takes a sociological approach to disability and special education. Three models of disability are introduced: clinical, social interactionist, and political. The models provide a foundation for the course and guide study of three major aspects of disability and special education. First, students explore how each of the models has guided and continues to guide service and social institutions for persons with disabilities including educational and rehabilitation services. Second, students examine the process through which people with disabilities are so labeled and the interaction between these individuals and others (family, school, community). Third, students analyze the role of the human service professional (including teachers) and the ways in which training programs reflect the various models of disability. The course draws heavily on a variety of philosophical, theoretical, conceptual and methodological perspectives, including phenomenology, symbolic interactions, and human ecology. **Class 4, Credit 4 (F)**

0835-704 Teaching Deaf Learners with Secondary Disabilities
This course focuses on providing students with basic information regarding the needs of deaf learners with disabilities, including (1) developmental disability, (2) emotional or behavioral disorder, (3) learning disability, attention deficit disorder or attentional deficit hyperactivity disorder, or (4) visual impairment. Topics include incidence, identification, assessment, and teaching strategies. The goal is to enable students to see students in a holistic fashion, and incorporates the perspectives of parents, teachers, and students themselves through site visits, interviews, and panel discussion. The course regularly incorporates guest lecturers who have specialized expertise in teaching or research in one or more topic areas. (0835-703) **Class 4, Credit 4 (S)**

0835-705 Political/Legal Environment
The relationship of the goals and processes of deaf education to those of special education and education in general is explored. The course provides a detailed examination of historical and current demographic, economic, political, legal, and social trends that affect the education of deaf and hard-of-hearing students. Current federal and state legislation affecting students with disabilities is analyzed and critiqued. **Class 4, Credit 4 (S)**

0835-706 Educational Technology and Teaching
This introductory course provides an overview of the use of educational technologies to enhance the learning experiences of deaf students. The use of productivity software and educational software including Web-based instruction and resources are explored. The selection, development, implementation, and evaluation of technology-based solutions are addressed. Instructional materials are created following a simplified model of instructional development. **Class 2, Credit 2 (F)**

0835-712 Curriculum Content and Methods of Instruction
Note: There are five discipline-specific courses here, designated by section: 01 (English), 02 (Mathematics), 03 (Science), 04 (Social Studies) and 05 (American Sign Language). Students will take only the section focusing on the content area in which they will be certified.

0835-712 Section 01 English
This course examines issues and methods related to teaching English in the secondary level to students who are deaf or hard-of-hearing. Students investigate and analyze current approaches to curriculum, instruction and materials in the area of English instruction through readings, observations, and seminars. Students design content area projects to demonstrate a variety of methodological philosophies. **Class 4, Credit 4 (W)**

0835-712 Section 02 Mathematics
This course examines issues and methods related to teaching mathematics at the secondary level to students who are deaf or hard-of-hearing. Current instructional methods, curriculum and professional resources in mathematics are studied through seminars, readings, special projects, observations and work with content-area specialists and teachers in secondary-level mathematics courses. **Class 4, Credit 4 (W)**

0835-712 Section 03 Science
This course examines issues and methods in teaching secondary-level science to deaf or hard-of-hearing students, including the selection, modifications, and use of curriculum materials in science. Discussions will be concerned with instructional strategies, classroom managements, cognitive development, testing and evaluation, lab report writing and theories of science teaching. Students will be required to observe teachers in secondary level science courses. **Class 4, Credit 4 (W)**

0835-712 Section 04 Social Studies
This course examines issues and methods related to teaching social studies at the secondary level to students who are deaf or hard-of-hearing. Through seminars, readings, special projects, and work with content area specialists/teachers, current instructional methods, curriculum and professional resources in social studies are examined. Students will be required to observe teachers of secondary level social studies courses at public schools, residential schools for deaf students or in mainstream programs. **Class 4, Credit 4 (W)**

0835-712 Section 05 American Sign Language
This course examines issues and methods related to teaching American Sign Language at the secondary level. Students investigate and analyze current approaches to ASL curriculum, instruction, and materials through readings, observations, and seminars. Students design content area projects to demonstrate their understanding of teaching theories and methods, curriculum design and evaluation techniques. **Class 4, Credit 4 (W)**

0835-713 Assessment
This course addresses assessment as a process involving the choice and interpretation of assessment measures to diagnose the need for and aid in planning for services, referrals, and placement of secondary students who are deaf and hard of hearing, including students with other secondary disabilities. The respective roles of the classroom teacher, school psychologist, parents, and support service providers are addressed. Assessment and educational planning for a student are viewed from an ecological perspective, including the family, the school, the community, the support services, and the legal systems. This course also addresses the development and interpretation of assessment measures of learning through teacher-made, criterion referenced, curriculum-based, and norm-referenced methods. (0835-802, 0835-860) **Class 4, Credit 4, (F)**

0835-721 Structure of American Sign Language
This course concentrates on the linguistic structures of American Sign Language (ASL). Students examine all levels of structure from phonology (sublexical) through morphology and syntax to semantics and discourse. ASL structures will be elucidated through comparison and contrast with English and other spoken languages or dialects, as well as with other sign languages. ASL literacy, language variation, and code switching in the deaf population are also examined. **Class 4, Credit 4 (F)**

0835-722 Audition and Spoken Language: Applications in Education
This course focuses on the ways individuals comprehend and produce spoken English. It provides a functional understanding of auditory physiology, speech perception and deafness, hearing aids and other assistive listening devices. Procedures for audiological and speech/language assessment are examined with their implications for auditory training, speechreading, and speech/language instruction. Models of collaboration among teachers, speech/language pathologists, and audiologists to enhance students' communication using spoken English are discussed and observed. **Class 4, Credit 4 (W)**

0835-723 Language Acquisition and Variation
This course is designed to familiarize students with the processes involved in learning English with a focus on reading and writing. The course concentrates on those aspects of English language development that pertain to teaching deaf and hard-of-hearing students in grades 7 to 12. Students investigate deaf learners' attainments in reading and writing, patterns of English language performance observed in deaf learners, relationships between spoken and written English performance, bilingual/bicultural issues related to English learning and use, second language teaching strategies, and reading and literacy questions. (0835-721 or permission of instructor) **Class 4, Credit 4 (W)**

0835-724 English Language Development
This course is designed to familiarize students with the processes involved in learning English with a focus on reading and writing. The course concentrates on those aspects of English language development that pertain to teaching deaf and hard-of-hearing students in grades 7 to 12. Students investigate deaf learners' attainments in reading and writing, patterns of English language performance observed in deaf learners, relationships between spoken and written English performance, bilingual/bicultural issues related to English learning and use, second language teaching strategies, and reading and literacy questions. **Class 4, Credit 4 (F)**

0835-790 Foundations of Educational Research
This course is an introduction to research and inquiry in education. Perspectives on and issues related to research in the education of people who are deaf and hard of hearing are examined. Students are introduced to the research process, including design, theoretical perspectives, methods of data collection, validity/reliability, data analysis, and interpretation. Students leave this course with a preliminary proposal for the master's thesis or project. **Class 4, Credit 4 (F)**

0835-820 Perspectives on Teaching Deaf and Hard-of-Hearing Students
This course reviews fundamental principles of teaching and learning in light of the recently completed student teaching assignment. Students analyze examples of theoretical applications in teaching this class and from viewing videotapes of their actual lessons used during the student teaching experience. Students propose a plan for change and skill development. (Student Teaching I, 0835-860) **Class 2, Credit 2 (S)**

0835-860 Student Teaching I
This first practicum consists of 10 weeks (250 hours) of teaching and observation. Student teachers are placed with cooperating teachers in residential schools for the deaf. Students develop lesson and unit plans and teach in the content area in which they plan to receive New York State certification. (0835-712, 999) **Credit 10 (S)**

0835-861 Student Teaching II
This is an eight-week practicum done in conjunction with an itinerant or resource room cooperating teacher at the middle or secondary level in a mainstream setting with students who are deaf or hard of hearing. Students develop and deliver support for instruction, participate in student assessment, and, where appropriate, prepare lesson plans and teach to specific IEP objectives. (Student Teaching I, 0835-860; Perspectives on Teaching Deaf and Hard-of-Hearing Students, 0835-820) **Credit 10 (W)**

0835-880 Master's Project Seminar
Students finalize their project proposal and begin research and development. Students also finalize the selection of their project adviser. Format for the seminar is full group meetings in the early part of December followed by individual or small group consultation with project advisers. (Foundations of Educational Research, 0835-790) **Class 2, Credit 2 (W)**

0835-890 Master's Project
This is the capstone experience of the master's degree program. Students must have already submitted an acceptable proposal in order to enroll. Project development, presentation, and/or reporting or research and the preparation of the written thesis are completed in this course. The course work and project must be completed within a seven-year period; register for one credit of continuation of master's project each school term (except summer quarter) after all required course work/student teaching assignments have been met and until the final project is completed. **Variable credit 0-8 (S)**

0835-898 Special Topics
Special topics courses will be developed based on student interest and demand as well as faculty interest and availability. They may include electives in speech, audiology, and comparative linguistics, among others. **Variable credit**

0835-999 Field Experience
As required by the New York State Education Department, each MSSE student is required to complete 100 hours of field experience before their first student teaching assignment during the spring quarter. At the beginning of their first year in the program, the students attend a required meeting where they are given the field experience guidelines that specify the number of hours that have to be met in various settings (classroom observations at both schools for the deaf and mainstreamed programs, attending Deaf culture events, course-specific observations, etc). After completion of all of the required observations, the students are required to submit a field experience portfolio following the specifications stated in the guidelines. This course must be completed with a satisfactory grade before taking Student Teaching I (0835-860). **Credit 0 (W)**

0886-199 American Sign Language I
Designed for students who have no previous knowledge of American Sign Language. ASL I includes the linguistic features, cultural protocols and core vocabulary for students to function in basic ASL conversations that include ASL grammar for asking and answering questions while introducing oneself; exchanging personal information; talking about family, friends and surroundings; and discussing activities. Classroom and lab activities include practicing conversations and videotaping. (SIPI/LCBQ:1) **Class 4, Credit 4 (F, W)**

0886-200 American Sign Language II
Expands the basic principles presented in ASL I. The course teaches students to use linguistic features, cultural protocols, and core vocabulary to function in additional basic ASL conversations including ASL grammar for giving directions; describing others; making requests; talking about family, occupations and routines; and attributing qualities to others. Classroom and lab activities include practicing conversations and videotaping. (0886-199 or equivalent) **Class 4, Credit 4 (F, W, S)**

0886-201 American Sign Language III
This course is a continuation of ASL II expanding the emphasis on ASL grammar, syntax, spatial referencing and vocabulary development. ASL III teaches further communicative competencies in ASL conversations beyond the basic level that include telling life events, describing events in time, asking for clarification, correcting, conforming, elaborating on information, agreeing and disagreeing, resolving conflicts, and giving directions. Classroom and lab activities include practicing dialogues, short stories, narratives and short conversations. (0886-200 or equivalent) **Class 4, Credit 4 (F, W, S)**

Professional Development Seminars
Variety of topics: second-year students present research topics and ideas to all program faculty and students; child abuse and substance abuse; the code of ethics for interpreters; using educational support personnel effectively; identifying and using community resources. **Credit 0**

College of Science

Sophia Maggelakis, Dean
www.rit.edu/cos

Programs of study

Online learning option available

The College of Science offers a unique complement of graduate programs featuring curricula designed with sufficient flexibility to prepare students for direct entry into a variety of careers or further study toward a more advanced graduate degree in a chosen discipline. The college also houses three doctorate programs featuring internationally-recognized, cutting-edge research activities. Whether the focus is on the foundations of matter, the origins of the universe, applications of mathematics, the role of chemists in our daily lives, the encoding of life within DNA, the specialized properties of advanced materials, our impact on the environment, or the science and technology of advanced imaging systems, the college's graduate faculty provide a valuable and integrated understanding of today's most important fundamental problems, applied research issues, and industrial applications.

Admission requirements
The college offering the program makes all decisions on graduate admission. Please refer to each individual program for information regarding specific admission criteria. For general graduate admission information, please refer to the Admission section of this bulletin.

Financial aid and scholarship
Please refer to the Financial Aid and Scholarship section of this bulletin for information regarding financial aid, scholarships, grants, loans, and graduate assistantships.

School of Biological and Medical Sciences

Bioinformatics, MS

http://bioinformatics.rit.edu/

Michael V. Osier, Interim Director
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Program overview

The master of science degree in bioinformatics is offered on a full- or part-time basis to fulfill the needs of traditional students and those currently employed in the field. Students develop a strong foundation in biotechnology, computer programming, computational mathematics, statistics, and database management, and are well-prepared for careers in the biotechnology, bioinformatics, pharmaceutical, and vaccine industries.

Based on consultation with individuals within the industry nationwide, the job market is rich with opportunities for those who obtain a master of science degree in bioinformatics, particularly when coupled with industry-sponsored research as thesis work. This research will provide exposure to real-world problems—and their solutions—not otherwise attainable in an academic setting.

The program provides students with the capability to enter the bioinformatics workforce and become leaders in the field.

The curriculum is designed to fulfill the needs of students with diverse educational and professional backgrounds. Individuals entering an MS program in bioinformatics typically have degrees in biology, biotechnology, chemistry, statistics, computer science, information technology, or a related field. The MS program accommodates this diversity in two ways. First, a comprehensive bridge program exists for students who need to supplement their education before entering the MS program. Second, the program itself consists of two tracks, one for students with backgrounds in the life sciences and one for those with backgrounds in the computational sciences. Regardless of the track pursued, students are prepared to become professional bioinformaticists upon graduation.

Curriculum

A minimum of 45 credit hours, including seven or eight core courses, is required for completion of the program. Two tracks—computational science and life science—are outlined below.
A number of professional graduate electives are available for students to pursue areas of personal or professional interest. In addition, every student is required to complete a research project that addresses a relevant and timely topic in bioinformatics, culminating in a thesis. Graduate electives may be chosen from any relevant RIT graduate courses.

COURSE		QTR. CR. HRS.
Computational science track		
1001-700	Cell and Molecular Genetics I	3
1001-701	Cell and Molecular Genetics II	3
4002-762	Introduction to Bioinformatics Computing	4
4002-763	Advanced Bioinformatics Computing	4
1001-705	Bioinformatics Resources	3
1001-722	Bioinformatics Seminar	2
1001-725	Ethics in Bioinformatics	3
1001-794	Molecular Modeling and Proteomics	4
1016-715	Statistical Models for Bioinformatics	4
	Graduate electives/Thesis	15
	Total	**45**
Life science track		
4002-720	Data Object Development	4
4002-762	Introduction to Bioinformatics Computing	4
4002-763	Advanced Bioinformatics Computing	4
1001-705	Bioinformatics Resources	3
1001-722	Bioinformatics Seminar	2
1001-725	Ethics in Bioinformatics	3
1001-794	Molecular Modeling and Proteomics	4
1016-715	Statistical Models for Bioinformatics	4
	Graduate electives/Thesis	13
	Total	**45**

Admission requirements

To be considered for the MS program in bioinformatics, candidates must fulfill the following requirements:

- Hold a baccalaureate degree in biology, biotechnology, biochemistry, chemistry, computer science, information technology, statistics, or related disciplines,
- Have an undergraduate GPA of 3.2 or higher (on a 4.0 scale),
- Submit transcripts (in English) of all previously completed undergraduate and graduate course work,
- Submit scores from the Graduate Record Examination (GRE), and
- Complete a graduate application.
- International applicants, whose primary language is not English, are required to submit scores from the Test of English as a Foreign Language (TOEFL). Minimum scores of 213 (computer-based), 570 (paper-based), or 79-80 (Internet-based) are required. International English Language Testing System (IELTS) scores are accepted in place of the TOEFL exam. Minimum scores will vary; however, the absolute minimum score required for unconditional acceptance is 6.0-6.5. For additional information about the IELTS, please visit www.ielts.org.

Environmental Science, MS

http://www.rit.edu/cos/environmental/

Karl Korfmacher, Director
(585) 475-5554, kfkscl@rit.edu

Program overview

Habitat loss, global climate change, water and air pollution, ozone depletion, loss of biodiversity, and the accumulation of toxic wastes are outcomes of human behaviors that stem from a general belief that the environment is infinitely renewable. It is not.

Environmental scientists must understand the complexity of problems that pit environmental limits against economic development, diverse cultures, ethics, values, and social stability. They must use integrated and holistic approaches to find solutions to these problems.

Curriculum

Built on the concept that environmental issues are inherently interdisciplinary, the program is offered jointly by the department of biological sciences in the College of Science and by the department of science, technology, and society in the College of Liberal Arts. The curriculum is designed to provide students with a deep understanding of the complex set of circumstances that impact environmental issues, and how environmental decisions and policies attempt to find a balance between environmental conservation and economic development. Students combine their hands-on classroom work with experiential learning (research, internships). These experiences give students the chance to work on real-world environmental problems under the guidance of talented and skilled environmental scientists.

The program includes a core curriculum and electives chosen to reflect the student's background and career goals. A minimum of 51 credit hours beyond the bachelor's degree is required.

COURSE		QTR. CR. HRS.
1001-760	Advanced Conservation Biology	4
1006-450	Raster Applications of GIS	4
1006-711, 712, 713	Environmental Science Graduate Study I, II, III	5
1006-710	Environmental Science Graduate Readings Seminar	3
1015-720	Environmental Chemistry	3
0307-712	Fundamentals of Statistics II (or equivalent)	4
1006-879	Environmental Science Graduate Research	3
	Environmental science core graduate elective	4
	Environmental policy core graduate elective	4
	Environment and society core graduate elective	4
	Graduate professional electives	4-8
1006-890/891	Thesis/Project	5-9

External research credit

The program recognizes that the employment experience of a number of environmental scientists includes independent, creative research. This experience may be applied toward the completion of the MS degree on either a full- or part-time basis.

Thesis or project

All students must propose, conduct, and report on an original research project.

Admission requirements

To be considered for admission to the MS program in environmental science, candidates must fulfill the following requirements:

- Hold a baccalaureate degree in environmental science, biological sciences, or a related field of study,
- Submit transcripts (in English) from all previously completed undergraduate and graduate course work,
- Have a minimum GPA of 3.0 (overall and in science/math),
- Submit a statement outlining the candidate's research/project interests, career goals, and suitability to the program,
- Submit three letters of recommendation, and
- Complete a graduate application.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language (TOEFL). A minimum score of 550 (paper-based) or 213 (computer-based) is required. International English Language Testing System (IELTS) scores are accepted in place of the TOEFL exam. Minimum scores will vary; however, the absolute minimum score required for unconditional acceptance is 6.5. For additional information about the IELTS, please visit www.ielts.org.

Students are strongly encouraged to contact program faculty before applying to discuss thesis topics and research projects.

Additional information

Facilities and equipment

The program provides a wide range of research opportunities. Many environmental science faculty members are engaged in field-based projects. The college also boasts excellent laboratory facilities that support field research. These include wet laboratories and computer facilities (traditional and geographic information systems). For a list of past and present projects, and faculty research interests, please visit the program website.

Monitoring, mapping, and field equipment: ArcGIS 9.3 and IDRISI Andes GIS software, Garmin and Trimble GPS receivers, pocket PCs with ArcPad software, soil sampling equipment, soil analysis equipment, digital clinometer, water sampling devices, multisonde water quality probes, infrared carbon dioxide analyzer, microelectrodes, dissolved oxygen meter, SCT meter, ponar dredges, plankton samplers, macroinvertebrate nets/samplers, and a library of field reference texts.

Other equipment: Fluorimeter, Raman Spectrometer, UV-Vis, GC-MS, ICP, atomic absorption, polarimeter, TGA's Micro-extruder, centrifuge, electrochem equipment, gas chromatography, HPLC detectors, viscometer, ESR (built in-house), incubators, infrared spectrophotometers, capillary electrophoresis, DSCs, DMA, Asher, 300 MHz NMR, drying oven, and a Wiley mill.

School of Mathematical Sciences

Applied and Computational Mathematics, MS

http://www.math.rit.edu/Academics/smag.html

Tamas Wiant, Graduate Program Director
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Program overview

The ideas of applied mathematics pervade several applications in a variety of businesses and industries as well as government. Sophisticated mathematical tools are increasingly used to develop new models, modify existing ones, and analyze system performance. This includes applications of mathematics to problems in management science, biology, portfolio planning, facilities planning, control of dynamic systems, and design of composite materials. The goal is to find computable solutions to real-world problems arising from these types of situations.

The School of Mathematical Sciences offers an interdisciplinary master of science degree in applied and computational mathematics. The objective of the program is to provide students with the capability to apply mathematical models and methods to study various problems that arise in industry and business, with an emphasis on developing computable solutions that can be implemented. Since this is an interdisciplinary program, students have the opportunity to choose from a wide variety of courses.

Curriculum

The program consists of 48 credit hours of study. There are four core courses that total 16 credit hours. These courses, usually taken by the student in the first two quarters, provide a focus on some of the ideas of applied mathematics. Core courses are determined by the department to provide a foundation for further study. The four core courses, which are offered every year, include:

1016-713	Mathematical Methods in Scientific Computing
1016-725	Stochastic Processes
1016-802	Methods of Applied Mathematics
1016-767	Combinatorics

A concentration and a corresponding course of study are formulated by the student in consultation with an advisory committee. The student completes a total of 24 credit hours by taking a set of six specialized courses offered in the School of Mathematical Sciences, as well as other departments. Some of the possible concentrations are dynamical systems, discrete mathematics, computational biomathematics, and scientific computing.

The program includes a thesis, which requires the student to present original ideas and solutions to a specific mathematical problem. The proposal for the thesis work and the results must be presented and defended before the advisory committee.

Admission requirements

To be considered to admission to the MS program in applied and computational mathematics, candidates must fulfill the following requirements:

- Hold a baccalaureate degree from an accredited institution in mathematics or any related field. The prerequisite courses are multivariable calculus, differential equations, matrix theory, probability, and statistics. Knowledge of a programming language is required.
- Submit transcripts (in English) of all previously completed undergraduate and graduate course work,
- Submit a personal statement of educational objectives,
- Have an undergraduate cumulative GPA of 3.0 or higher,
- Submit two letters of recommendation, and
- Complete a graduate application.
- International applicants, whose primary language is not English, are required to take the Test of English as a Foreign Language (TOEFL). A minimum score of 550 (paper-based), 213 (computer-based), or 79-80 (Internet-based) is required. International English Language Testing System (IELTS) scores will be accepted in place of the TOEFL exam. Minimum scores will vary; however, the absolute minimum score required for unconditional acceptance is 6.5. For additional information about the IELTS, please visit www.ielts.org. Those who cannot take the TOEFL will be required to take the Michigan Test of English Proficiency at RIT and obtain a score of 80 or higher.

Although Graduate Record Examination (GRE) scores are not required, submitting them may enhance a candidate's acceptance into the program.

A student may also be granted conditional admission and be required to complete bridge courses selected from among RIT's existing undergraduate courses, as prescribed by the student's adviser. Until these requirements are met, the candidate is considered a nonmatriculated student. The graduate program director evaluates the student's qualifications to determine eligibility for conditional and provisional admission.

Additional information

Student's advisory committee

Upon admission to the program, the student chooses an adviser and forms an advisory committee. This committee will oversee the academic aspects of the student's program, including the selection of a concentration and appropriate courses to fulfill the program's requirements.

Cooperative education

The optional cooperative education program enables the student to alternate periods of study on campus with periods of full-time, paid professional employment. Students may pursue a co-op position after their first quarter.

Part-time study

The program is ideal for practicing professionals who are interested in applying mathematical methods in their work and enhancing their career options. Most courses are scheduled in the late afternoon or early evening. The graduate program may normally be completed in two years of part-time study.

Nonmatriculated students

A student with a bachelor's degree from an approved undergraduate institution, and with the background necessary for specific courses, may take graduate program director as a nonmatriculated student with the permission of the graduate program director and the instructor. Courses taken for credit may be applied toward the master's degree if the student is formally admitted to the graduate program at a later date. However, a maximum of 12 credit hours may be transferred to the degree program from courses taken at RIT as a nonmatriculated student.

Department of Chemistry

Chemistry, MS

http://chemistry.rit.edu/

Joseph P. Hornak, Graduate Program Director
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Program overview

The master of science degree in chemistry is offered on a full- or part-time basis. The program is designed to fill the needs of the traditional student or the practicing chemist who is employed full time and wishes to pursue a graduate degree on a part-time basis.

The department of chemistry has research- and teaching-oriented faculty, as well as excellent equipment and facilities that enable full-time graduate students to carry on a program of independent study and develop the ability to attack scientific problems at the fundamental level. The research can result in either a thesis or a project report.

Through course work and research activities, the program strives to increase the breadth and depth of the student's background in chemistry. Students in the program will develop the ability to attack scientific problems with minimal supervision.

Curriculum

The program offers concentrations in organic, analytical, inorganic, and physical chemistry. In addition, concentrations in polymer chemistry, materials science, and biochemistry are available. Customized program options are available to accommodate specific student interests and needs relating to graduate study in chemistry.

Each student, together with an adviser, will arrange a program best suited to their interests and needs. This program will be subject to the approval of the department head and the chair of the graduate committee.

A deliberate effort will be made to strengthen any areas of weakness indicated by the student's undergraduate records and the placement examinations. The MS degree consists of the following requirements:

1. A minimum of 45 credit hours beyond the bachelor's degree

Courses in chemistry will generally be chosen from 700- and 800-level courses and should include one or more courses in analytical, organic, and physical chemistry. The core requirement is one course each in organic, physical, and analytical chemistry, plus one course in inorganic chemistry, if an appropriate undergraduate course was not taken. Specifically, each student must select core courses (subject to approval by the student's adviser and the graduate committee) that include the following: Analytical Chemistry (1008-621 and 1008-711); Organic Chemistry (1013-737 or 1013-739); and Physical Chemistry (1014-741, 1014-742, 1014-743, or 1014-744). The inorganic core course is 1012-764. As part of the required credits, each student must have one or two quarter credit hours in seminar (1010-870), and three to four quarter credit hours from outside of the department of chemistry. A maximum of nine quarter credits may be taken in undergraduate-level courses.

2. Nine credit hours in research (minimum) for the MS thesis option

A minimum of four and a maximum of eight credit hours are required with the project option. The program also offers a course-work-only MS option. With this option, the student must complete a four credit hour capstone course.

3. Passage of an oral defense of the MS thesis

Students enrolled in the program full time are expected to complete 45 credit hours of course work, including up to 21 quarter credit hours of research leading to the submission of an independent research thesis, and pass an oral defense of the thesis.

A full-time student normally takes six to nine graduate credits per quarter, including thesis work. Typically, all requirements are met within two years. No more than eight credit hours of research are allowed in the non-thesis MS option.

Admission requirements

To be considered for admission to the MS program in chemistry, a candidate must fulfill the following requirements:

- Hold a baccalaureate degree in chemistry from an accredited college or university. Applicants with an undergraduate degree in another scientific discipline and the equivalent of a full year's course work in analytical chemistry, organic chemistry, physical chemistry, physics, and calculus also will be considered for admission.
- Submit official transcripts (in English) for all previously completed undergraduate or graduate course work,
- Submit scores from the Graduate Record Exam (GRE, the chemistry exam is recommended),
- Submit two letters of reference, and
- Complete a graduate application.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language (TOEFL). International English Language Testing System (IELTS) scores will be accepted in place of the TOEFL exam. Minimum scores will vary; however, the absolute minimum score required for unconditional acceptance is 6.5. For additional information about the IELTS, please visit www.ielts.org. This requirement may be waived for students who submit transcripts from universities at which the language of instruction is English. Foreign students with English language deficiencies may be required to take the Michigan Test of English Language Proficiency, given by the RIT English Language Center. If a student's score is below standard, additional course work may be recommended. Successful completion of this work is a requirement of the program. This may mean that the student will need additional time and financial resources to complete the degree program.

As a supplement to the normal application process, it is strongly recommended that students visit RIT.

Additional information

Assistantships

All candidates for teaching assistantships must have a personal interview with the department head and/or the chair of the Chemistry Graduate Committee. International students can complete the interview by phone.

Nonmatriculated students

An applicant with a bachelor's degree from an approved undergraduate institution and the background necessary for specific courses is permitted to take graduate courses as a nonmatriculated student. If the student is subsequently admitted to the graduate program, courses taken for credit usually can be applied toward the master's degree. A maximum of nine credit hours

(from courses taken at RIT as a nonmatriculated student) may be transferred to the degree program.

Any applicant who wishes to register for a graduate course as a nonmatriculated student must obtain permission from the chair of the graduate program and the course instructor.

Part-time study

The department of chemistry offers courses in the late afternoon and evenings to encourage practicing chemists to pursue the MS degree without interrupting their employment. Part-time students may take the course-work-only option with the capstone project, 1010-800. Students employed full time normally take one course each quarter. At this pace, course work can be completed within four to five years.

Accelerated dual degree programs

The accelerated BS/MS program combines the BS programs in chemistry, biochemistry, or polymer chemistry with the MS chemistry program, and enables RIT undergraduates to acquire an MS degree with only one extra year of study. Undergraduate chemistry majors may be considered for entrance into the combined BS/MS chemistry program after completion of their sophomore year. Students in the combined program take graduate-level electives and typically complete an MS thesis or project. Students in the combined BS/MS chemistry program receive both the BS and MS degrees after five years of full-time study.

Equipment

The department of chemistry has modern instrumentation in the areas of spectroscopy (NMR, IR, UV-vis, fluorescence, atomic absorption, fluorimetry), chromatography (gas chromatography, high-performance liquid chromatography, capillary electrophoresis, etc.), mass spectrometry (high-performance lc- and gc-mass spectrometry and electrospray mass spectrometry), and materials characterization (rheometry, thermal gravimetric analysis, differential scanning calorimetry, hot-stage microscopy and contact angle goniometry). Visit the chemistry department's website for a complete list of equipment and instrumentation.

External research credit

The department of chemistry recognizes that the experience of a number of chemists employed in industry includes independent, creative research. A maximum of 16 hours of research credit, conducted during employment, may be applied toward the completion of the master of science degree in chemistry on either a full- or part-time basis.

Cooperative education option

The cooperative education option accommodates students at the master's level who have, or are able to obtain, industrial employment. Quarters of co-op can be interspersed with quarters of full-time academic work. If industrial employment permits research, up to 16 of the 45 required credits may be obtained through the external research credit option. If industrial employment does not permit research, then research credits may be obtained within the department of chemistry.

Center for Materials Science and Engineering

Materials Science and Engineering, MS

http://www.rit.edu/cos/cmse/

K. S. V. Santhanam, Director
Center for Materials Science and Engineering
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Program overview

The master of science degree in materials science and engineering, offered jointly by the College of Science and the Kate Gleason College of Engineering, is designed with a variety of options to satisfy individual and industry needs in the rapidly growing field of materials.

The objectives of the program are threefold:

- With the advent of new classes of materials and instruments, the traditional practice of empiricism in the search for and selection of materials is rapidly becoming obsolete. Therefore, the program offers a serious interdisciplinary learning experience in materials studies, crossing over the traditional boundaries of such classical disciplines as chemistry; physics; and electrical, mechanical, and microelectronic engineering.
- The program provides extensive experimental courses in diverse areas of materials-related studies.
- The program explores avenues for introducing greater harmony between industrial expansion and academic training.

Curriculum

The program consists of five required core courses. These courses are specially designed to establish a common base of materials-oriented knowledge for students with baccalaureate degrees in chemistry, chemical engineering, electrical engineering, mechanical engineering, physics, and related disciplines, providing a new intellectual identity to those involved in the study of materials. The core courses* are:

1028-701	Introduction to Materials Science
1028-702	Introduction to Polymer Science
1028-703	Solid State Science
1028-704	Introduction to Theoretical Methods
1028-717	Material Degradation

*The core courses are offered every year.

The program has an emphasis on experimental techniques, with one required experimental course as part of the core. Additional experimental courses are available for students who wish to pursue course work in this area. These courses are organized into appropriate units covering many aspects of the analysis of materials. This aspect of the program will enhance a student's confidence when dealing with materials-related problems.

A minimum of 45 credit hours, which includes the five core courses and the seminar course (1028-890), is required for completion of the program.

The remaining 24 credit hours may be completed in one of three ways: (1) as a combination of the research thesis and elective courses, (2) as a combination of external research and elective courses, or (3) as elective courses. The elective courses may be selected from advanced courses offered by the Center for Materials Science and Engineering or, upon approval, from courses offered by other RIT graduate programs. Elective courses are scheduled on a periodic basis. Transfer credit may be awarded based on academic background beyond the bachelor's degree or by examination, based on experience.

Admission requirements

To be considered for admission to the MS program in the materials science and engineering program, candidates must fulfill the following requirements:

- Hold a baccalaureate degree in chemistry, physics, chemical engineering, electrical engineering, mechanical engineering, or a related field from an accredited college or university,
- Submit transcripts (in English) from all previously completed undergraduate and graduate course work,
- Submit two letters of recommendation, and
- Complete a graduate application.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language (TOEFL) and the Test of Written English (TWE). A minimum score of 575 (paper-based), 230 (computer-based), 88-89 (Internet-based) is required on the TOEFL, and a 4.0 is required on the TWE. International English Language Testing System (IELTS) scores are accepted in place of the TOEFL exam. Minimum scores will vary; however, the absolute minimum score required for unconditional acceptance is 6.5. For additional information about the IELTS, please visit www.ielts.org. In addition, upon arrival at RIT, international students are required to take the English language exams, administered by the English Language Center. Individuals scoring below an established minimum will be referred to the center for further evaluation and assistance. These students are required to follow the center's recommendations regarding language course work. It is important to note that this additional course work may require additional time and financial resources to complete the degree requirements. Successful completion of this course work is a requirement for the program.

Candidates not meeting the general requirements may petition for admission to the program. In such cases, it may be suggested that the necessary background courses be taken at the undergraduate level. However, undergraduate credits that make up deficiencies may not be counted toward the master's degree.

Any student who wishes to study at the graduate level must first be admitted to the program. However, an applicant may be permitted to take graduate courses as a nonmatriculated student if they meet the general requirements mentioned above.

Thesis and the external research options

The inclusion of a research thesis as a formal part of the MS degree program is optional. The research thesis option carries a minimum of nine and a maximum of 16 credit hours, subject to the review and approval of the project. In place of a thesis, a project option is available that carries a minimum of four credit hours and maximum of eight credit hours.

The external research option allows participants to continue their studies in their work environment, thus enhancing job satisfaction. In-plant work experience in materials-related areas may include independent study and creative research. This external research option may be applied, for a minimum of four and a maximum of eight credit hours, toward the completion of the master of science degree.

Additional information

Part-time study

The program offers courses in the late afternoon and evenings to encourage practicing scientists and engineers to pursue the degree program without interrupting their employment. (This may not apply to courses offered off campus at selected industrial sites.) Students employed full time are normally limited to a maximum of two courses, or eight credit hours, each quarter. A student who wishes to register for more than eight credit hours must obtain the permission of his or her adviser.

Advanced certificate

An advanced certificate in materials science and engineering is available primarily for part-time students. It requires the completion of 24 credit hours of course work.

Accelerated dual degree programs

The Center for Materials Science and Engineering offers several combined BS/MS programs for undergraduate students: a BS in chemistry and an MS in materials science and engineering, a BS in microelectronic engineering and an MS in materials science and engineering, a BS in electrical engineering and an MS in materials science and engineering, and a BS in physics and an MS in materials science and engineering are available. These degree programs may be completed in five years. Consult with the director of the Center for Materials Science and Engineering for more details.

Maximum limit on time

The required credits for the master's degree must be completed within seven years of the oldest credits applied toward the degree.

Department of Physics/School of Mathematical Sciences/Center for Imaging Science

Astrophysical Sciences and Technology, Ph.D.

http://www.rit.edu/cos/astrophysics/

Andrew Robinson, Graduate Program Director
(585) 475-2726, axrsps@rit.edu

Program overview

There has never been a more exciting time to study the universe beyond the confines of the Earth. A new generation of advanced ground-based and space-borne telescopes and enormous increases in computing power are enabling a golden age of astrophysics. The doctorate program in astrophysical sciences and technology focuses on the underlying physics of phenomena beyond the Earth and on the development of the technologies, instruments, data analysis, and modeling techniques that will enable the next major strides in the field. The multidisciplinary emphasis of this program, jointly offered by the department of physics, the School of Mathematical Sciences, and the Center for Imaging Science, sets it apart from conventional astrophysics graduate programs at traditional research universities.

Curriculum

The doctoral degree comprises 99 quarter credit hours. The curriculum consists of 27 credits of core courses (including a three research credit graduate seminar sequence), a minimum of 36 credits of graduate elective courses, a master's-level research project (12 credits), and doctoral-level research culminating with a dissertation (15 credits). Thus, there are a minimum of 60 total graduate course credits required and 30 research credits. An additional nine credits of either course or research credit must be taken to meet the required 99 total credits for the degree.

Core courses (24 credit hours)

1060-701, 702, 703	Graduate Research Seminar I, II, III (3 research credits total)
1060-710	Mathematical and Statistical Methods for Astrophysics
1060-711	Astronomical Observational Techniques and Instrumentation
1060-720	Stellar Structure and Evolution I
1060-730	Radiative Processes I
1060-740	Galactic Astrophysics and the Interstellar Medium I
1060-750	Extragalactic Astrophysics I

Electives

Elective courses that can be taken to meet the minimum total of 60 credit hours of course work include additional courses in astrophysics, detector development, digital image processing, computational techniques, optics, and entrepreneurship, among others. Each of the core courses listed is followed by a second, one-quarter course (e.g., Radiative Processes II) and additional domain specific astrophysics electives are offered on a rotating basis. Many additional elective courses offered in other RIT graduate programs (e.g. imaging science, computer science, engineering) are available.

Master's level research project

Typically following the first year, but sometimes initiated the first year for well prepared students, candidates will begin a master's level research project under the guidance of a faculty member who will not necessarily be the dissertation research adviser. The topic will frequently be different from the dissertation topic. The project will normally be worth twelve credit hours. Assessment will be a combination of the written project report and an oral presentation of the report.

Admission to candidacy

Students must pass a qualifying examination after completing the core curriculum and prior to embarking on the Ph.D. dissertation project. The purpose of the examination is to ensure the student has the necessary background knowledge and intellectual skills to carry out doctoral-level research in the subject areas of astrophysical sciences and technology. The examination consists of two parts: a written examination based on the core courses and an oral examination based on a research portfolio consisting of a written report on the master's-level research project and a record of graduate research seminar activities.

A committee chaired by the astrophysical sciences and technology director, which includes the student's research adviser and two additional faculty members, will assess the student's overall qualifications. Students must pass the qualification examination to continue in the program.

Dissertation research adviser

After passing the qualifying examination, the student chooses a dissertation research adviser who is approved by the program's director. The choice of adviser is based on the student's research interests, faculty research interests, and available research funding.

Research committee

After passing the qualifying examination, a four-member dissertation committee is appointed for the duration of the student's tenure in the program. One of the committee members must be a faculty member in a program other than astrophysical sciences and technology. This committee member, who is approved by the dean of graduate studies, acts as the institutional chair of the final dissertation examination. The committee must also include the student's dissertation research adviser and at least one other member of the program's faculty. The fourth member may be an RIT faculty or staff member, a professional affiliated in industry, or a representative from another institution. The program director must approve committee members who are not RIT faculty.

Ph.D. project validation

Within six months of the appointment of the dissertation committee, the student will give an oral defense of their chosen research project to faculty, who will provide constructive feedback on the project plan.

Annual review

During each fall quarter, the program director conducts an annual review. Students are interviewed, concerns (if any) are raised, and progress is reported on the student's work toward meeting the requirements for either the qualifying examination (during the first two years), or the Ph.D. (after passing the qualifying examination).

In addition, as part of the Graduate Research Seminar, the student will give an annual presentation summarizing progress made during the preceding year.

Final examination of the dissertation

Once the dissertation has been written, distributed to the dissertation committee, and the committee agrees to administer the final examination, the doctoral candidate can schedule the final examination. The candidate must distribute a copy of the dissertation to the committee and make the dissertation available to interested faculty at least four weeks prior to the dissertation defense.

The final examination of the dissertation is open to the public and is primarily a defense of the dissertation research. The examination consists of an oral presentation by the student, followed by questions from the audience. The dissertation committee will privately question the candidate following the presentation. The dissertation committee will caucus immediately following the examination and thereafter notify the candidate and the program director of the results.

Admission requirements

To be considered for admission to the Ph.D. program in astrophysical sciences and technology, candidates must fulfill the following requirements:

- Hold a baccalaureate degree in physical science, mathematics, computer science, or engineering at a regionally accredited college or university (for students with a bachelor's degree in another area or those lacking adequate academic preparation, bridge and foundation course work may be necessary prior to full admission),
- Have a minimum undergraduate GPA of 3.2 (out of 4.0) in course work in mathematical, science, engineering, and computer subject areas,
- Submit official transcripts (in English) from all previously completed undergraduate and graduate course work,
- Submit two letters of recommendation,
- Submit scores from the Graduate Record Exam (GRE), and
- Complete a graduate application.
- For international applicants whose native language is not English, scores from the Test of English as a Foreign Language (TOEFL) must be submitted. Minimum scores of 550 (paper-based), 213 (computer-based), or 79 (Internet-based) are required. International English Language Testing System (IELTS) scores will be accepted in place of the TOEFL exam. Minimum scores will vary; however, the absolute minimum score required for unconditional acceptance is 6.5. For additional information about the IELTS, please visit www.ielts.org.

Additional information

Residency

All students in the program must spend at least three consecutive quarters (summer quarter excluded) in residence as full-time students to be eligible to receive the doctorate degree. A full-time academic course load is defined as a minimum of nine quarter credit hours or an equivalent amount of research as certified by the graduate coordinator.

Time limitations

All candidates for the Ph.D. must maintain continuous enrollment during the research phase of the program. Normally, full-time students complete the course of study for the doctorate in approximately four to five years. A total of seven years is allowed to complete the requirements after first attempting the qualifying examination.

MS to Ph.D. transfer

Depending on each student's progress in their course work and the research project, students may be allowed to attempt the Ph.D. qualifying examination. On successfully passing the exam, students may choose to proceed to Ph.D. candidacy rather than accepting a terminal master of science degree. This is contingent on the availability of an adviser and research funding.

Astrophysical Sciences and Technology, MS

Andrew Robinson, Graduate Program Director
(585) 475-2726, axrsps@rit.edu

Program overview

There has never been a more exciting time to study the universe beyond the confines of the Earth. A new generation of advanced ground-based and space-borne telescopes and enormous increases in computing power are enabling a golden age of astrophysics. The MS program in astrophysical sciences and technology focuses on the underlying physics of phenomena beyond the Earth, and on the development of the technologies, instruments, data analysis, and modeling techniques that will enable the next major strides in the field. The multidisciplinary emphasis of this program, jointly offered by the department of physics, the School of Mathematical Sciences, and the Center for Imaging Science, sets it apart from conventional astrophysics graduate programs at traditional research universities.

Curriculum

The MS program comprises a minimum of 45 credit hours of study. The curriculum consists of 27 credits of core courses (including a three credit research graduate seminar sequence), a minimum of 12 credits of graduate elective courses, and a research project culminating in a thesis (12 research credits).

Core courses (24 credit hours):

1060-701, 702, 703	Graduate Research Seminar I, II, III (3 research credits total)
1060-710	Mathematical and Statistical Methods for Astrophysics
1060-711	Astronomical Observational Techniques and Instrumentation
1060-720	Stellar Structure and Evolution I
1060-730	Radiative Processes I
1060-740	Galactic Astrophysics and the Interstellar Medium I
1060-750	Extragalactic Astrophysics I

Electives

Elective courses available to fulfill the minimum total of 27 credit hours of course work include additional courses in astrophysics, detector development, digital image processing, computational techniques, optics, and entrepreneurship, among others. These may be courses offered by the astrophysical sciences and technology program or by other RIT graduate programs (e.g. imaging science, computer science, engineering).

Master's thesis

Typically following the first year, but sometimes initiated during the first year for well-prepared students, candidates begin a research project under the guidance of a faculty research adviser. A thesis committee is appointed by the program director, consisting of the student's adviser and at least two additional members, one of whom must be a program faculty member. The final examination of the thesis consists of a public oral presentation by the student, followed by questions from the audience. The thesis committee will privately question the candidate following the presentation. The committee will caucus immediately following the examination and thereafter notify the candidate and the program director of the results.

Admission requirements

To be considered for admission to the MS program in astrophysical sciences and technology, a candidate must fulfill the following requirements:

- Hold a baccalaureate degree in physical science, mathematics, computer science, or engineering at an accredited college or university,
- Have a minimum undergraduate GPA of 3.2/4.0 in undergraduate work in mathematical, science, engineering, and computer subject areas,
- Submit official transcripts (in English) for all previously completed undergraduate and graduate course work,
- Submit two letters of recommendation,
- Submit scores from the Graduate Record Exam (GRE), and
- Complete a graduate application.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language (TOEFL). A minimum score of 550 (paper-based), 213 (computer-based), or 79 (Internet-based) is required. International English Language Testing System (IELTS) scores will be accepted in place of the TOEFL exam. Minimum scores will vary; however, the absolute minimum score required for unconditional acceptance is 6.5. For additional information about the IELTS, please visit www.ielts.org.
- For candidates with a bachelor's degree in another area or lacking in adequate academic preparation, bridge and foundation course work may be necessary prior to full admission.

Additional information

MS to Ph.D. transfer

Depending on each student's progress in their course work and the research project, students may be allowed to attempt the Ph.D. Qualifying Examination. On successfully passing the exam, students may choose to proceed to Ph.D. candidacy rather than accepting a terminal master of science degree. This is contingent on the availability of an adviser and research funding.

Chester F. Carlson Center for Imaging Science

Color Science, Ph.D.

http://www.cis.rit.edu/GraduateColor

James A. Ferwerda, Graduate Program Director
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Program overview

Color has been a topic of intense interest and inquiry for hundreds if not thousands of years. As a generalization, color science can be defined as the quantification of our perception of color. Its mastery requires an interdisciplinary educational approach encompassing physics, chemistry, physiology, statistics, computer science, and psychology. Color science is used in the design and control of most man-made colored materials including textiles, coatings, and polymers and to specify such diverse materials as soil and wine. It is used extensively in color reproduction including digital photography, desktop and projection display, and printing. As we begin the 21st century, color science is ubiquitous.

Color science research at RIT encompasses such diverse fields as medical data visualization, computer graphics and animation, art conservation, spectral and spatial measurements of materials, color printing, digital photography, motion picture and television, and modeling of our perceptions for use in defining color quality. RIT has a long history of scholarship in color science.

The program is designed for students whose undergraduate degrees are in physics, chemistry, mathematics, computer science, engineering, experimental psychology, imaging, or any applied discipline pertaining to the quantitative description of color, for example, textiles, graphic arts, animation, material science, and polymer science. All students must earn 99 quarter credit hours as a graduate student. For full-time students, entering with a baccalaureate degree, the program requires three or more years of study at the graduate level. The curriculum is a combination of required courses in color science, elective courses appropri-

ate for the candidate's background and interests, a three quarter research project during the second year of study, and a research dissertation. Students must pass a qualifying examination during their second year of study and a candidacy examination at least one year prior to completing their dissertation. Candidates who wish to enter the program, but lack adequate preparation, may be required to complete as many as 36 credits of undergraduate foundation courses in mathematics, statistics, computer science, and general science before matriculating with graduate status.

Curriculum

The degree requires 99 quarter credit hours of course work and research, which includes a minimum of 60 credit hours of course work, including the core curriculum; a minimum of 27 credit hours of research, including the second-year research project; and three years of full-time study (or an equivalent of part-time study).

Core courses (24 credit hours)

The following core courses are completed during the first year of study:

1051-720	Human Visual System
1050-702	Applied Colorimetry
1050-703	Color Appearance
1050-721	Color Measurement Laboratory I
1050-722	Color Measurement Laboratory II
1050-801	Color Science Seminar
1050-813	Color Modeling

Elective courses (36 credit hours)

Elective courses are selected depending on the student's interests and background. The color science graduate program director or the student's dissertation research adviser must approve all electives.

Typically, 4 credit hours of electives are taken each quarter in years one through three, until 36 quarter credit hours are completed.

Program scheduling

Year One

COURSE		QTR. CR. HRS.
Fall		
	Human Visual System	4
	Applied Colorimetry	4
	Color Science Seminar	1
	Graduate Elective	4
	Course Credits	13
	Research Credits	0
Winter		
	Color Appearance	3
	Color Measurement I Lab	3
	Color Science Seminar	1
	Graduate Elective	4
	Course Credits	11
	Research Credits	0
Spring		
	Color Modeling	4
	Color Measurement Lab II	3
	Color Science Seminar	1
	Graduate Elective	4
	Course Credits	12
	Research Credits	0
Total		36

Year Two

COURSE		QTR. CR. HRS.
Fall		
	Research and Thesis	3
	Graduate Elective	4
	Course Credits	4
	Research Credits	3
Winter		
	Research and Thesis	3
	Graduate Elective	4
	Course Credits	4
	Research Credits	3
Spring		
	Research and Thesis	3
	Graduate Elective	4
	Course Credits	4
	Research Credits	3
Total		57

Year Three

COURSE		QTR. CR. HRS.
Fall		
	Research and Thesis	3
	Graduate Elective	4
	Course Credits	4
	Research Credits	3
Winter		
	Research and Thesis	3
	Graduate Elective	4
	Course Credits	4
	Research Credits	3
Spring		
	Research and Thesis	3
	Graduate Elective	4
	Course Credits	4
	Research Credits	3
Total		78

Years four and beyond

Students will follow their study plan consisting of research credits, thesis credits, and elective courses.

Second year project

During the second year, the student will engage in graduate-level research. The topic may or may not be the same as the dissertation topic. Nine credit hours are normally taken. One of the pur-

poses of this research project is to evaluate the student's research capabilities and suitability for doctorate-level research.

Qualifying examination

All students must pass a qualifying examination, which determines whether the student has a sufficient depth of knowledge in color science and the ability to perform research at the doctoral level.

The qualifying exam consists of a written test and an evaluation of the second-year research project. The written test is given twice each year, during the first and sixth weeks of spring quarter. The written test is based on the core curriculum in color science and any material deemed appropriate by the committee. Note that these courses' required readings include textbooks and current literature. An evaluation of the second-year research project includes depth of research, productivity, quality, analytical skills, and the ability to communicate results. A written document is submitted in the style of a published proceeding.

The student must successfully pass the qualifying examination to continue in the Ph.D. program. Students who do not pass the qualifying examination may request, in writing, to the color science graduate coordinator to change their program to the MS program. Requests must be received before the end of the quarter in which the second written test is taken. Students with permission to enter the MS program will use their second year research project as an MS research thesis topic. A written thesis is required. Students can graduate with an MS in color science. Note that they will have completed the identical degree requirements as students matriculated into the MS program (except for having completed additional elective courses).

Dissertation research adviser and committee

After the student passes the qualifying examination, a dissertation research adviser will be selected based on the student's research interests, faculty research interests, and discussions with the color science graduate coordinator. A dissertation committee of four members is appointed for the duration of the student's tenure in the program. The committee will include the dissertation research adviser, one member of the color science faculty, and an external chair appointed by the dean of graduate studies. The external chair must be a member of the RIT faculty who is not a current member of the color or imaging science faculty, preferably with tenure. The fourth member may be an RIT faculty member, or affiliated with industry or another institution. The color science graduate coordinator must approve committee members who are not RIT faculty.

The dissertation committee will prepare and administer the examination for admission to candidacy; assist in planning and coordinating research; provide research advice; supervise the writing of the dissertation; and conduct the final examination of the dissertation.

Study plan

During the first quarter of study, the student and the color science graduate program director will develop a study plan. This plan may be revised as necessary, subject to approval by the graduate program director. For example, the dissertation research adviser or the dissertation committee may recommend a revised study plan to include specific graduate electives.

Admission to candidacy

When the student thoroughly understands the dissertation research topic, the dissertation committee will administer an examination to determine if the student can be admitted to candidacy for the doctoral degree in color science. The purpose of the examination is to ensure the student has the necessary intellectual skills and background knowledge to carry out their specific doctoral-level research project. The dissertation research adviser will define the type of examination and any requirements prior to the examination. Requirements include a dissertation proposal and may additionally include a review of literature, preliminary experiments, and the preparation of an oral presentation. The examination must be administered no later than one year prior to defending the dissertation.

Final examination of dissertation

Once the dissertation has been written, distributed to the dissertation committee, and the committee agrees to administer the final examination, the doctoral candidate can schedule the final examination.

The final examination of the dissertation is open to the public and is primarily a defense of the dissertation research. The examination consists of an oral presentation by the student, followed by questions from the audience. The dissertation committee may also elect to privately question the candidate following the presentation. The dissertation committee will immediately notify the candidate and the color science graduate program director of the result of the examination.

Teaching experience

All candidates for the Ph.D. must serve as a teaching assistant for a minimum of one course before scheduling the final examination of the dissertation. Candidates are encouraged to serve as a teaching assistant for two courses.

Public presentation experience

All candidates for the Ph.D. must present research in a public forum before scheduling the final examination of the dissertation. The preferred public forum is a technical conference.

Admission requirements

To be considered for admission to the Ph.D. program in color science, candidates must fulfill the following requirements:

- Hold a baccalaureate degree from an accredited university,
- Submit scores from the Graduate Record Examination (GRE),
- Submit official transcripts (in English) for all previously completed undergraduate and graduate course work,
- Have a GPA of 3.0 or higher (or a minimum GPA of 3.0 in foundation course work),
- Submit two professional recommendations,
- Participate in an on-campus interview (when possible), and
- Complete a graduate application.

- For international applicants, whose native language is not English, scores from the Test of English as a Foreign Language must be submitted. Minimum scores of 240 (computer-based), 587 (paper-based), or 94 (Internet-based) are required. International English Language Testing System (IELTS) scores will be accepted in place of the TOEFL exam. Minimum scores will vary; however, the absolute minimum score required for unconditional acceptance is 6.5. For additional information about the IELTS, please visit www.ielts.org.

Candidates without adequate undergraduate work in related sciences must take foundation courses prior to matriculation into the graduate program. Such students may be required to take as many as 36 credits in these subjects. A written agreement between the candidate and the program coordinator will identify the required foundation courses. Foundation courses must be completed with an overall B average before a student can matriculate into the graduate program. A maximum of nine graduate-level credit hours may be taken prior to matriculation into the graduate program.

The required undergraduate-level foundation courses as are follows: one year of calculus, one year of college physics, one year of college physics laboratory, one course in computer programming, one course in matrix algebra, one course in statistics, and one course in introductory psychology.

Additional information

Assistantships

Students receiving fully funded assistantships tend to have minimum undergraduate cumulative grade point averages of 3.5 and exceptional GRE scores. International applicants who must submit TOEFL scores, must have scores above 250 (computer-based), 600 (paper-based), or 100 (Internet-based). Students who submit IELTS scores must have a minimum IELTS score is 7.0. Applicants seeking financial assistance must submit all application documents to the Office of Graduate Enrollment Services by January 15 for the following academic year.

Residency

All students in the program must spend at least three consecutive quarters (summer quarter may be excluded) as resident full-time students to be eligible to receive the Ph.D. A full-time academic course load is defined as a minimum of nine academic credits per quarter or an equivalent amount of research as certified by the color science graduate coordinator.

Time limitations

All candidates for the Ph.D. must maintain continuous enrollment during the research phase of the program. The maximum number of research credits that apply to the degree does not limit such enrollment. Normally, full-time students complete the course of study for the doctorate in approximately four to five years. Requirements for the degree must be completed within seven years of the date students pass the qualifying examination.

Color science MS graduates

Graduates from the MS program in color science, who are interested in the doctoral program, should contact the color science graduate program director to discuss their suitability for doctoral-level research. Before matriculating into the program, students must pass the qualifying examination. Once the examination has been passed successfully, students can be admitted into the doctoral program. Up to 45 credits can be applied toward the degree, including 24 credits of core courses, 12 credits of graduate elective courses, and 9 credits of master's-level research. The doctoral degree can be completed on a full- or part-time basis as long as the residency requirements are met.

MS and MA graduates from related disciplines

Because of the interdisciplinary nature of color science, it is anticipated that students with MS and MA degrees will apply to the Ph.D. program. Graduate courses in related disciplines can be used as elective courses toward the degree. Furthermore, for degrees that required a research thesis, the second year research project may be waived. Thus, it may be possible for students with graduate degrees in a related discipline to take the qualifying examination during their first year of study. The total number of graduate credits that can be applied to the Ph.D. in color science cannot exceed 45 credit hours, limited to 36 credit hours of course work and 9 credit hours of master's-level research. The color science graduate coordinator determines the specific courses and credit hours that can be applied toward the Ph.D. in color science.

Munsell advisory board

The Munsell Color Science Laboratory advisory board ensures that research activities surrounding the degree program are relevant to current industrial needs. Board members have expertise in color vision, color measuring instrumentation, psychophysics, color imaging, instrument-based color matching, lighting, art, and applied color technology. The advisory board is an excellent resource for students in the selection of both a thesis topic and future employment opportunities.

Color Science, MS

http://www.cis.rit.edu/GraduateColor

James A. Ferwerda, Graduate Program Director
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Program overview

Color science is broadly interdisciplinary, encompassing physics, chemistry, physiology, statistics, computer science, and psychology. The curriculum, leading to a master of science degree in color science, educates students using a broad interdisciplinary approach. This is the only graduate program in the country devoted to this discipline and it is designed for students whose undergraduate majors are in physics, chemistry, imaging science, computer science, electrical engineering, experimental psychol-

ogy, physiology, or any discipline pertaining to the quantitative description of color.

Graduates are in high demand and have accepted industrial positions in electronic imaging, color instrumentation, colorant formulation, and basic and applied research. Companies that have hired graduates include Apple Inc., Benjamin Moore, Canon Corp., Dolby Laboratories, Eastman Kodak Co., Hallmark, Hewlett Packard Corp., Microsoft Corp., Pantone, Qualcomm Inc., Ricoh Innovations Inc., Samsung, and Xerox Corp.

The color science degree provides graduate-level study in both theory and practical application. The program gives students a broad exposure to the field of color and affords them the unique opportunity of specializing in an area appropriate for their background and interest. This objective will be accomplished through the program's core courses, selection of electives, and completion of a thesis or graduate project.

The degree program in color science revolves around the activities of the Munsell Color Science Laboratory within the Center for Imaging Science. The Munsell Laboratory is the pre-eminent academic laboratory in the country devoted to color science. Research is currently under way in color appearance models; image-quality, data-visualization, and color-tolerance psychophysics; spectral-based image capture, archiving, and reproduction of artwork; analytical and empirical multi-ink printing models; spectral color rendering, color management, computer graphics; and material appearance.

Since the inauguration of the program in 1984, a number of conferences have drawn participants from around the world. Industrial seminars are held each summer on a wide range of color topics, including color perception and appearance, colorimetry, color-difference equations, instrumental tolerances, spectrophotometry, instrument-based color matching, color- and image-appearance models, color management, psychophysics, visualization and rendering, and spectral imaging. The Munsell Laboratory has many contacts that provide students with summer and full-time job opportunities across the United States and abroad.

Curriculum

Students must earn 45 credits as a graduate student, 36 of which must be taken at RIT, to earn the master of science degree. For full-time students, the program requires four to six quarters of study at the graduate level. Part-time students generally require two to four years of study at the graduate level. The curriculum is a combination of required courses in color science, elective courses appropriate for the candidate's background, and either a research thesis or graduate project. Students must enroll in either the research thesis or graduate project option at least one year before completion of required course work.

Prerequisites: The foundation program

The color science program is designed for the candidate with an undergraduate degree in a scientific or nonscientific discipline. Candidates with adequate undergraduate work in related sciences start the program as matriculated graduate students.

Candidates without adequate undergraduate work in related sciences must take foundation courses prior to matriculation into the graduate program. Such students may be required to take as many as 36 credits in these subjects. A written agreement between the candidate and the program coordinator will identify the required foundation courses.

Foundation courses must be completed with an overall B average before a student can matriculate into the graduate program. A maximum of nine graduate-level credit hours may be taken prior to matriculation into the graduate program.

The foundation courses, representative of those often required, are as follows: one year of calculus, one year of college physics (with laboratory), one course in computer programming, one course in matrix algebra, one course in statistics, and one course in introductory psychology.

Core courses

All graduate students in the MS program are required to complete the following core courses:

COURSE		QTR. CR. HRS.
1051-720	Human Visual System	4
1050-702	Applied Colorimetry	4
1050-721	Color Measurement Laboratory I	3
1050-703	Color Appearance	3
1050-722	Color Measurement Laboratory II	3
1050-813	Color Modeling	4
1050-801	Color Science Seminar	3

Elective courses

Appropriate elective courses should be selected to bring course work to 36 credit hours for the research thesis option or 41 credit hours for the graduate project option. Approval by the color science coordinator is required. (Some courses might require special permission for enrollment.) The following is a partial list:

COURSE		QTR. CR. HRS.
0307-801, 802	Design of Experiments I, II	6
0307-834	Multivariate Statistics for Imaging Science	4
4005-761	Fundamentals of Computer Graphics	4
1051-728	Design and Fabrication of Solid State Cameras	4
1051-739	Principles of Solid State Imaging	4
1051-749	Color Reproduction	4
1051-782	Introduction to Digital Image Processing	4
1051-790	Image Rendering	4
1051-816	Color Systems	4

Typical full-time schedule of courses

COURSE		QTR. CR. HRS.
Fall		
1051-720	Human Visual System	4
1050-702	Applied Colorimetry	4

COURSE		QTR. CR. HRS.
1050-801	Color Science Seminar	1
	Graduate elective	4
Winter		
1050-703	Color Appearance	3
1050-721	Color Measurement I Lab	3
1050-801	Color Science Seminar	1
	Graduate elective	4
Spring		
1050-722	Color Measurement II Lab	3
1050-813	Color Modeling	4
1050-801	Color Science Seminar	1
	Graduate elective	4

During the second year, full-time students enroll in research and thesis, to total nine credits.

Research thesis option

Students without research experience are encouraged to select the research thesis option (nine credits). The thesis is performed during the second year of study. Topics are chosen that complement the candidate's undergraduate education and career interests. The technical advisory board of the Munsell Color Science Laboratory, as well as the program coordinator, can aid in the selection of a thesis topic. Full-time students receiving full-time assistantships are required to perform a research thesis.

Graduate project option

Students with research experience may select the graduate project option (four credits). The project has the same intellectual level as a research thesis but is less lengthy. It might take the form of an experiment, demonstration, research project, or critical review. The graduate project is normally performed during the last quarter of study. Part-time students often select this option.

Admission requirements

To be considered for admission to the MS program in color science, candidates must fulfill the following requirements:

- Hold a baccalaureate degree from an accredited institution,
- Submit scores from the Graduate Record Examination (GRE),
- Submit official transcripts (in English) for all previously completed undergraduate and graduate course work,
- Submit two professional recommendations,
- Complete an on-campus interview (when possible),
- Have an average GPA of 3.0 or higher,
- Have completed foundation course work with GPA of 3.0 or higher (if required), and
- Complete a graduate application.
- International applicants, who native language is not English, must submit scores from the Test of English as a Foreign Language. Minimum scores of of 587 (paper-based), 240 (computer-based), or 94 (Internet-based) are required. International English Language Testing System (IELTS) scores will be accepted in place of the TOEFL exam. Minimum scores will vary; however, the absolute minimum score required for unconditional acceptance is 7.0. For additional information about the IELTS, please visit www.ielts.org.

Additional information

Scholarships and assistantships

The scholarships and assistantships available for qualified color science applicants include the Macbeth-Engel Fellowship, Grum Memorial Scholarship, Saltzman Memorial Scholarship, Munsell Color Science Laboratory Assistantship, and research assistantships associated with ongoing grants and contracts. Students receiving fully funded assistantships tend to have undergraduate cumulative grade point averages of 3.5 and higher and exceptional GRE scores. Applicants whose native language is not English must submit TOEFL, TSEA, or IELTS scores. (Please see admission requirements for minimum scores.) Applicants seeking financial assistance from the center must submit all application documents to the Office of Graduate Enrollment Services by January 15 for the next academic year.

Imaging Science, Ph.D.

http://www.cis.rit.edu/node/401

Anthony Vodacek, Graduate Program Director
(585) 475-7816, vodacek@cis.rit.edu

Program overview

The doctor of philosophy degree in imaging science signifies high achievement in scholarship and independent investigation in the diverse aspects of imaging science. Candidates for the doctoral degree must demonstrate proficiency by:

- Successfully completing course work, including a core curriculum, as defined by the student's plan of study;
- Passing a series of examinations; and
- Completing an acceptable dissertation under supervision of the student's research adviser and dissertation committee.

Curriculum

All students must complete a minimum of 60 credit hours of course work. The courses are defined by the student's study plan and must include the completion of the core sequences, plus at least two three-quarter sequences in topical areas. Some examples of topical areas are remote sensing, digital image processing, color imaging, digital graphics, electro-optical imaging systems, medical imaging, and microlithographic imaging technologies.

Students may take a maximum of 16 credits in other departments and must complete research credits to bring the total credits earned to 99. Three credits of research are associated with the research seminar course (1051-706, 707, 708).

The core curriculum includes courses that span and integrate a common body of knowledge essential to an understanding of imaging processes and applications. The core courses are:

COURSE		QTR. CR. HRS.
1051-716	Fourier Methods for Imaging	4
1051-718	Digital Imaging Mathematics	4
1051-719	Radiometry	4
1051-720	Human Visual System	4
1051-733	Optics	4
1051-713	Probability, Noise and System Modeling	4
1051-782	Digital Image Processing	4

Advancement to candidacy

Advancement to candidacy will proceed through the following steps:

- Adviser selection
- Submission and approval of preliminary study plan
- Passing a written comprehensive exam
- Study plan revision based on outcome of comprehensive exam and adviser recommendation
- Research committee appointment
- Candidacy exam based on thesis proposal

If the faculty decision, following the comprehensive exam, is not to permit the candidate to continue in the doctoral track, the adviser and graduate program director will counsel the student about options that may include pursuit of an MS degree. If the faculty decision is to permit the candidate to continue in the doctoral track, the program continues with the study plan revision, research committee appointment, candidacy/proposal exam, and, finally, dissertation defense.

Research committee

Prior to the candidacy exam, the student, in consultation with the adviser, must present a request to the graduate program director for the appointment of a research committee. The committee will be composed of at least four people: the adviser, at least one faculty member who is tenured (or tenure-track) and whose primary affiliation is the Carlson Center for Imaging Science (excluding research faculty), a person competent in the field of research who is an RIT faculty member or affiliated with industry or another university and has a doctorate degree, and the external chair. The external chair must be a tenured member of the RIT faculty who is not a faculty member of the center and who is appointed by the dean of graduate studies. The research committee will supervise the student's research, beginning with a review of the research proposal and concluding with the dissertation defense.

Research proposal

The student and the research adviser select a research topic for the dissertation. The proposed research must be original and publishable. Although the topic may deal with any aspect of imaging, the research is usually concentrated in an area of current interest within the center.

Final examination of the dissertation

The research adviser, on behalf of the student and the student's research committee, must notify the graduate program director of the scheduling of the final examination of the dissertation by forwarding to the graduate program director the title and abstract of the dissertation and the scheduled date, time, and location of the examination. The final examination of the dissertation may not be scheduled within six months of the date on which the student passed the candidacy exam (at which the thesis proposal was presented and approved). Barring exceptional circumstances (requiring permission from the graduate program director), the examination may not be scheduled sooner than four weeks after formal announcement (i.e. center-wide hallway postings and email broadcast) has been made of the dissertation title and abstract, and the defense date, time, and location.

The final examination of the dissertation is open to the public and is primarily a defense of the dissertation research. The examination consists of an oral presentation by the student, followed by questions from the audience. The research committee may also elect to privately question the candidate following the presentation. The research committee will immediately notify the candidate and the graduate program director of the examination result.

Admission requirements

To be considered for admission to the Ph.D. program in imaging science, candidates must fulfill the following requirements:

- Hold a baccalaureate degree in engineering, computer science, applied mathematics, or one of the natural sciences,
- Have completed courses in calculus, university physics (one year), modern physics, and a computer language,
- Submit scores from the Graduate Record Exam (GRE),
- Submit official transcripts (in English) from all previously completed undergraduate and graduate course work,
- Submit two letters of recommendation from individuals well-qualified to judge their abilities for graduate study, and
- Complete a graduate application.
- International students, whose native language is not English, must submit scores from the Test of English as a Foreign Language. A minimum score of 600 (paper-based), 250 (computer-based), or 100 (Internet-based) is required. Students may also submit scores from the International English Language Testing System. A minimum score of 7.0 is required.

Imaging science encompasses a wide variety of scientific disciplines. Exceptional candidates from other fields and with diverse backgrounds are accepted into the program.

Admissions decisions are made by a committee comprised of graduate faculty of the Center for Imaging Science.

Students with an MS degree in a related field may be granted up to 36 credits toward the doctoral degree after successful completion of the comprehensive examination and approval of their study plan. The required research credits may not be waived by experience or examination.

Additional information

Residency

All students in the program must spend at least three consecutive quarters (summer quarter excluded) as resident full-time students to be eligible to receive the doctoral degree. A full-time academic

workload is defined as a minimum of nine academic credits per quarter or an equivalent amount of research, as certified by the graduate coordinator. If circumstances warrant, the residency requirement may be waived via petition to the graduate program director, who will decide on the student's petition in consultation with the adviser and graduate faculty. The request must be submitted at least nine months prior to the thesis defense.

Time limitations

All candidates must maintain continuous enrollment during the research phase of the program. Such enrollment is not limited by the maximum number of research credits that apply to the degree. Normally, full-time students complete the course of study for the doctorate in approximately three to five years. A total of seven years is allowed to complete the degree after first attempting the comprehensive exam.

Financial aid, scholarships, and assistantships

Graduate assistantships and tuition remission scholarships are available to qualified students. Applicants seeking financial assistance from the center must have all application documents submitted to the Office of Graduate Enrollment Services by January 15 for the next academic year. Students whose native language is not English are advised to obtain as high a TOEFL or IELTS score as possible if they wish to apply for a teaching or research assistantship. These candidates also are encouraged to take the Test of Spoken English in order to be considered for financial assistance.

Imaging Science, MS

http://www.cis.rit.edu/node/401

Anthony Vodacek, Graduate Program Director
(585) 475-7816, vodacek@cis.rit.edu

Program overview

The objective of this program is to prepare students holding a bachelor's degree in science or engineering for positions in research in the imaging industry, or in the application of various imaging modalities to problems in engineering and science. Formal course work includes consideration of the physics and chemistry of radiation-sensitive materials and processes, the applications of physical and geometrical optics to electro-optical systems, the mathematical evaluation of image forming systems, and the statistics of experimental design and quality control. Technical electives at the graduate level may be selected from courses offered in imaging science, color science, engineering, computer science, science, and mathematics. Both thesis and project options are available. In general, full-time supported students are required to pursue the thesis option, with the project option targeted to part-time students who can demonstrate that they have sufficient practical experience through their professional activities.

Faculty within the Center for Imaging Science supervise thesis research in areas of the physics and chemistry of radiation-sensitive materials and processes, digital image processing, remote sensing, nanoimaging, electro-optical instrumentation, medical imaging, color imaging systems, and astronomical imaging. Interdisciplinary efforts are possible with the Kate Gleason College of Engineering and the College of Science.

The degree requirements can be completed on a full- or a part-time basis. An online version of the MS program is available in the areas of color science, remote sensing, medical imaging, and digital image processing. Interested students should consult the website (www.cis.rit.edu) or contact the graduate director.

Curriculum

The MS degree in imaging science is available as a full- or part-time program. All students must earn 45 credits as a graduate student, 37 of which must be taken at RIT, to earn the master of science degree. The curriculum is a combination of required core courses in imaging science and elective courses appropriate for the candidate's background and interests.

Core courses

1051-713	Probability, Noise, and System Modeling
1051-716	Fourier Methods for Imaging
1051-718	Digital Imaging Mathematics
1051-719	Radiometry
1051-720	The Human Visual System
1051-733	Optics
1051-782	Digital Image Processing

Tracks

Students may choose from a variety of tracks or concentrations (e.g., digital image processing, medical imaging, electro-optical imaging systems, remote sensing, color imaging, optics, hard copy materials and processes, and nanoimaging). Additional tracks may be created for students interested in pursuing additional fields of study. Students must enroll in either the research thesis or graduate paper/project option at the beginning of their studies.

All graduate students in the MS program are required to complete five of the seven graduate program core courses, with the only required course being Fourier Methods for Imaging (1051-716). All non-imaging science courses must be approved by the graduate program director as acceptable for credit.

Research thesis option

Full-time students who elect this option begin their thesis work during the first year of study. Part-time students may defer the beginning of their thesis work until their second or subsequent years. Full-time students receiving funding assistance are required to choose the research thesis option. Students will take 36 credit hours of course work (including the core) and nine credit hours of thesis/research, three of which are associated with the graduate research seminar course (1051-706, 707, 708).

The thesis is based on experimental evidence obtained by the candidate in an appropriate field, as arranged between the candidate and his or her adviser. The minimum number of thesis credits required is nine and may be fulfilled by experiments in the

university's laboratories. In some cases, the requirement may be fulfilled by work done in other laboratories. An example might be the candidate's place of employment, under the following conditions:

- The results must be fully publishable.
- The candidate's adviser must be approved by the graduate program director.
- The thesis must be based on the candidate's independent, original work, as it would be if the work were done in the university's laboratories.

A student's thesis committee is composed of a minimum of three people: the student's adviser and two additional members who hold at least an MS in a field relevant to the student's research. Two committee members must be from the graduate faculty of the center.

Graduate paper/project option

Students with demonstrated practical or research experience, approved by the graduate program director, may choose the graduate project option (5 credit hours) in addition to 40 hours of core and elective courses. This option takes the form of a systems course and an associated project/paper. The graduate paper is normally performed during the final quarter of study. Both part- and full-time students may choose this option, with the approval of the graduate program director.

Typically, two years are required for the MS degree, if pursued on a full-time basis. Whether a student pursues the thesis or project/paper option, all degree requirements must be completed within seven years of the first course taken for the degree.

Admission requirements

To be considered for admission to the MS in imaging science, candidates must fulfill the following requirements:

- Hold a baccalaureate degree from an accredited institution (undergraduate studies should include the following: mathematics, through calculus and including differential equations; and a full year of calculus-based physics, including modern physics. It is assumed that students can write a common computer program),
- Submit a one- to two-page statement of educational objectives,
- Submit official transcripts (in English) of all previously completed undergraduate or graduate course work,
- Submit letters of recommendation from individuals familiar with the applicant's academic or research capabilities,
- Submit scores from the Graduate Record Exam (GRE) (requirement may be waived for those not seeking funding from the Center for Imaging Science), and
- Complete a graduate application.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language. Minimum scores of 600 (paper-based), 250 (computer based), or 100 (Internet-based) are required. Students may also submit scores from the International English Language Testing System. The minimum IELTS score is 7.0. International students who are interested in applying for a teaching or research assistantship are advised to obtain as high a TOEFL or IELTS score as possible. These candidates also are encouraged to take the Test of Spoken English in order to be considered for financial assistance.

Applicants seeking financial assistance from the center must have all application documents submitted to the Office of Graduate Enrollment Services by January 15 for the next academic year.

Candidates who wish to enter the program but lack adequate preparation may have to take bridge courses in mathematics, chemistry, or physics before matriculating with graduate status.

Environmental Forecasting, Disaster Preparedness and Response, MS

www.cis.rit.edu/EnvironmentalForecasting

Anthony Vodacek, Graduate Program Director
(585) 475-7816, vodacek@cis.rit.edu

Program overview

Floods, tornadoes, terrorist attacks—emergency responders navigate myriad disasters with increasing reliance on technology.

The MS program in environmental forecasting, disaster preparedness and response is helping to prepare the next generation of emergency responders to take the disaster management chain—planning, response, and recovery—to the next level.

The program is an integrated science master's program focusing on environmental forecasting, disaster preparedness and response. The National Science Foundation-funded program wraps around existing master's degrees in imaging science (with an emphasis in remote sensing), computer science, and environmental science. Graduates will apply the specialty training to their main field of study and gain a comprehensive understanding of the links among the business, policy, and scientific components of disaster management.

Curriculum

Students enrolled in the MS programs in imaging science, computer science, or environmental science are eligible for the program. In addition to fulfilling the full degree requirements for one of those programs, students enrolled in the environmental forecasting, disaster preparedness and response program will also complete the following requirements:

- three core courses in professional skills related to environmental forecasting, infrastructure assessment, and disaster response;
- an interdisciplinary research project; and
- a paid internship at an industry or government partner.

Core courses

0521-700	Readings-Public Policy
0105-778	Commercializing and Marketing New Products
4002-748	Spatial Modeling and Visualization

Project and internship

Students participate in a multidisciplinary community research project in the spring of their first year and a summer internship in industry, at an NGO, or a government agency between their first and second years. The project and internship are designed to give students real-world experiences working in multidisciplinary, multifunctional teams to solve real-world problems, first in projects working actively with faculty and still within a largely academic setting, and then within an external setting, without faculty involvement. This creates a stepping-stone process to familiarize students with career opportunities and challenges.

Admission requirements

To be considered for admission to the MS program in environmental forecasting, disaster preparedness and response, students should apply to one of the MS programs in imaging science, environmental science, or computer science. (Please refer to each individual program for specific admission requirements.) The course work for this program is completed in addition to each of those programs' full degree requirements.

Additional information

Council of Graduate Schools

The integrated master's program in environmental forecasting and disaster preparedness and response is affiliated with the Council of Graduate Schools. RIT's professional science master's programs in imaging science, environmental science, and computer science were added to its list at www.sciencemasters.com.

Financial aid and scholarships

A limited number of stipend and tuition waivers are available and will be awarded to students based upon merit.

Graduate Faculty

Sophia A. Maggelakis, BS, MS, Ph.D., Old Dominion University—Dean

School of Biological and Medical Sciences

Gary R. Skuse, BA, University of Rochester; Ph.D., Syracuse University—Interim Head, School of Biomedical and Medical Sciences; Professor, Bioinformatics

Larry Buckley, BA, University of Missouri; MS, Southern Illinois University at Edwardsville; Ph.D., Southern Illinois University at Carbondale—Associate Professor, Biology

Jean A. Douthwright, BA, Skidmore College; MS, Pennsylvania State University; MS, Ph.D., University of Rochester—Professor, Biology: DNA repair and mutagenesis in microbial organisms

Irene Evans, AB, University of Rochester; MS, Wesleyan University; Ph.D., University of Rochester—Professor, Biology

Maureen Ferran, BA, Fordham University; MS, Ph.D., University of Connecticut—Associate Professor, Biology: virus-host interactions, viral genetics

G. Thomas Frederick, BS, MS, Ph.D., The Ohio State University—Professor, Biology

Elizabeth Hane, BA, Rice University; MA, University of Kansas; Ph.D., Brown University—Associate Professor, Biology: plant community ecology, ecosystem biology, conservation biology

André Hudson, BS, Virginia Union University; Ph.D., Rutgers University—Assistant Professor, Biology: amino acid metabolism, bacteria-plant interactions

Karl F. Korfmacher, BA, Carleton College; MS, Ph.D., Duke University—Associate Professor, Environmental Sciences: environmental applications of GIS

David A. Lawlor, BA, University of Texas; MS, Ph.D., University of Texas Health Science Center at San Antonio—Associate Professor, Biology

Jeffrey S. Lodge, BA, University of Delaware; Ph.D., University of Mississippi—Associate Professor, Biology: bioremediation of oil-contaminated sites and industrial waste streams

Douglas Merrill, BS, Ph.D., State University of New York College of Environmental Science and Forestry—Professor, Biology

Dina L. Newman, BS, Cornell University; MS, Ph.D., University of Chicago—Assistant Professor

Michael V. Osier, BS, University of Vermont; Ph.D., Yale University—Associate Professor; Interim Program Director, Bioinformatics

Harvey Pough, BA, Amherst College; MA, Ph.D., University of California—Professor

Vicente Reyes, BS (chemistry), BS (mathematics) University of the Philippines; Ph.D., California Institute of Technology—Assistant Professor, Biology: computational biology, structural bioinformatics/structural biology

Robert H. Rothman, BA, Ph.D., University of California, Berkeley; MA, California State University at San Diego —Professor, Biology

Michael A. Savka, BSF, West Virginia University; MS, Ph.D., University of Illinois at Urbana-Champaign—Professor, Plant Biology: molecular plant-microbe interactions, plant physiology, and plant biotechnology

Paul Shipman, BSE, MS, Emporia State University; Ph.D., Oklahoma State University—Associate Professor, Biology

Hyla Sweet, BS, Union College; Ph.D., University of Texas at Austin—Associate Professor, Biology: developmental biology, evolution of developmental processes

Bolaji Thomas, BSc, MSc, Ph.D., University of Lagos—Assistant Professor, Biology: immunology/infectious disease, molecular parasitology, genetics

John M. Waud, BS, Lehigh University; MS, University of Pennsylvania; Ph.D., Lehigh University—Professor: migrant bird studies, water quality measurements, distribution of persistent organic toxins, wetland restoration

Leslie Kate Wright, BS, Rochester Institute of Technology; MS, Ph.D., University of Rochester—Assistant Professor, Biology: human bladder cancer biology, cell biology, molecular biology

School of Mathematical Sciences

Anurag Agarwal, MS, India Institute of Technology; Ph.D., State University of New York at Buffalo—Assistant Professor, Number Theory, Cryptography

Ephraim Agyingi, BS, MS, University of Ilorin; Ph.D., University of Manchester—Assistant Professor, Numerical Analysis

David S. Barth-Hart, BS, Syracuse University; MA, University of Rochester—Associate Professor, Algebra, Number Theory

William Basener, BA, Marist College; Ph.D., Boston University—Professor, Dynamical Systems

Maurino P. Bautista, BS, Ateneo de Manila University; MS, Ph.D., Purdue University—Professor, Numerical Analysis, Applied Mathematics

Bernard Brooks, BS, University of Toronto; MS, Ph.D., University of Guelph—Associate Professor, Mathematical Biology

Nathan Cahill, BS, MS, Rochester Institute of Technology; Ph.D., Oxford University—Associate Professor, Biomedical Image Computing

Manuela Campanelli, Laurea in Mathematics, University of Perugia; Ph.D., University of Bern (Switzerland)—Professor, Numerical Relativity

Linlin Chen, BS, Beijing University; MA, Ph.D., University of Rochester—Assistant Professor, Data Analysis, Computational Biology

Elizabeth Cherry, BS, Georgetown University; Ph.D., Duke University—Assistant Professor, Computational Cardiac Dynamics

Patricia A. Clark, SB, SM, Massachusetts Institute of Technology; Ph.D., University of Rochester—Professor, Fluid Dynamics

Matthew Coppenbarger, BS, University of Arizona; MA, Ph.D., University of Rochester—Associate Professor, Mathematical Physics, Spectral Theory

Alejandro B. Engel, BS, Universidad de Chile; MS, Ph.D., State University of New York at Buffalo—Professor, Mathematical and Statistical Technology

Joshua Faber, BS, State University of New York at Stony Brook; Ph.D., Massachusetts Institute of Technology—Assistant Professor, Numerical Relativity

David L. Farnsworth, BS, Union College; MA, Ph.D., University of Texas at Austin—Professor, Nonparametric Statistics

Raluca Felea, BS, University of Iasi; Ph.D., University of Rochester—Associate Professor, Micro Analysis

Marvin H. Gruber, BS, Brooklyn College; MA, Johns Hopkins University; MS, Rochester Institute of Technology; MA, Ph.D., University of Rochester—Professor, Linear Models, Bayes Estimation, Reliability

James J. Halavin, BS, Clarkson University; MA, Ph.D., State University of New York at Buffalo—Professor, Statistics

John Hamilton, BA, Cornell University; MA, Ph.D., Indiana University—Visiting Research Faculty

Anthony J. Harkin, BS, State University College at Brockport; MS, Massachusetts Institute of Technology; Ph.D., Boston University—Associate Professor, Applied and Computational Mathematics, Partial Differential Equations

Jobby Jacob, BS, Bharata Mata College; MS, Ph.D., Clemson University—Assistant Professor, Graph Theory

Akhtar Khan, MS, Technical University Kaiserslautern; Ph.D., Michigan Technological University—Assistant Professor, Applied Math, Optimization, Medical Imaging

Chulmin Kim, BS, Kyunghe University; MS, Wichita State University; Ph.D., University of Iowa—Assistant Professor, Multivariate Analysis

Seshavadhani Kumar, BS, MS, University of Madras; Ph.D., University of Delaware—Professor, Operations Research, Simulation

Manuel Lopez, AB, Princeton University; Ph.D., Wesleyan University—Associate Professor, Homological Algebra

Carlos Lousto, MS, Universidad Nacional De La Plata; Ph.D., Universidad De Buenos Aires—Associate Professor, Numerical Relativity

Carl V. Lutzer, BS, Michigan State University; MA, Ph.D., University of Kentucky—Professor, Mathematical Physics

Sophia A. Maggelakis, BS, MS, Ph.D., Old Dominion University—Professor, Biomathematics

Carol E. Marchetti, BS, Case Institute of Technology; MS, Weatherhead School of Management; MA, Ph.D., University of Rochester—Associate Professor, Statistics

James E. Marengo, BA, MS, California State University; Ph.D., Colorado State University—Professor, Statistics, Probability

Douglas S. Meadows, BS, Stanford University; MS, New York University; Ph.D., Stanford University—Professor, Topology, Computer Science

Darren A. Narayan, BS, State University of New York at Binghamton; MS, Ph.D., Lehigh University—Professor, Graph Theory, Discrete Math

Richard J. Orr, BS, John Carroll University; MS, Case Institute of Technology; MS, State University of New York at Buffalo—Professor, Logic, Computability

Michael Radin, BA, Rowan University; MS, Ph.D., University of Rhode Island—Associate Professor, Differential Equations

David Ross, BA, Columbia College; Ph.D., New York University—Professor, Differential Equations and Numerical Analysis

Hossein Shahmohamad, BS, MA, California State University at Long Beach; Ph.D., University of Pittsburgh—Professor, Graph Theory

Likin Simon Romero, BS, Universidad Nacional Autonoma de Mexico; Ph.D., West Virginia University—Assistant Professor, Continuum Theory and Hyperspaces of Sets, Graph Theory

Wanda Szpunar-Lojasiewicz, BS, Jagiellonian University; MS, Ph.D., University of Cracow—Associate Professor, Analysis

Wondimu Tekalign, BS, MS, Addis Ababa University; Ph.D., State University of New York at Buffalo—Visiting Assistant Professor, Numerical Analysis, Partial Differential Equations

Christopher W. Wahle, BS, MS, Illinois Institute of Technology; Ph.D., Northwestern University—Assistant Professor, Engineering Sciences and Applied Mathematics

John Whelan, BA, Cornell University; Ph.D., University of California at Santa Barbara—Associate Professor, Quantum Physics

Tamas Wiandt, BS, Jozsef Attila University; Ph.D., University of Minnesota—Associate Professor, Dynamical Systems

Paul R. Wilson, BA, MA, University of Cincinnati; Ph.D., University of Illinois—Professor, Algebra

Elmer L. Young, BA, Amherst College; MS, Ph.D., The Ohio State University—Associate Professor, Topology

Yosef Zlochower, BS, Ph.D., University of Pittsburgh—Assistant Professor, Numerical Relativity

Chemistry

Jeremy Cody, BS, Indiana University of Pennsylvania; Ph.D., University of Rochester—Assistant Professor, Organic Chemistry: synthetic organic chemistry

Christina Collison, BA, Colby College; Ph.D., University of Rochester—Associate Professor, Organic Chemistry: synthetic organic chemistry

Christopher Collison, BS, Ph.D., Imperial College of London—Associate Professor, Physical Chemistry: polymer chemistry

Michael G. Coleman, BS, Ph.D., University of Buffalo—Visiting Assistant Professor, Medicinal chemistry: synthethic organometallic methodologies towards medicinally relevant targets

Paul A. Craig, BS, Oral Roberts University; Ph.D., University of Michigan—Professor, Analytical Biochemistry

Joseph P. Hornak, BS, Utica College of Syracuse University; MS, Purdue University; Ph.D., University of Notre Dame—Professor, Joint Appointment with Imaging Science, Physical Chemistry: magnetic resonance spectroscopies and imaging

Marvin L. Illingsworth, BS, Lafayette College; Ph.D., University of Massachusetts—Professor, Inorganic Chemistry: nonlinear optical polymers, atomic oxygen-resistant polymers, synthesis of eight-coordinate complexes and mixed ligand complexes

Thomas D. Kim, BS, Loyola College; Ph.D., University of Wisconsin at Madison—Associate Professor, Biochemistry: pharmacology

Lea V. Michel, BA, Colgate University; Ph.D., University of Rochester—Assistant Professor, Biochemistry: structural biology, biophysics

Massoud J. Miri, BS, MS, Ph.D., University of Hamburg—Associate Professor, Polymer Chemistry: polymerization mechanisms, polymer properties, catalysis

Suzanne O'Handley, BS, Rutgers University; MS, Ph.D., University of Rochester—Associate Professor, Biochemistry: cloning characteristics of nudix hydrolases, novel phosphatase families, novel antibiotic targets, enzyme-substrate specificity

Christian G. Reinhardt, BS, Lafayette College; Ph.D., University of Rochester—Professor, Biophysical Chemistry: biological drug receptor recognition, binding and stereochemistry, quantitative structure-activity studies and biomolecular design

L. Paul Rosenberg, BS, Bridgewater State College; Ph.D., University of New Hampshire—Professor and Department Head, Analytical Chemistry: pharmaceutical analysis, physical properties of drug compounds, chemical separations techniques

K. S. V. Santhanam, BSc, MA, Ph.D., Sri Venkateswara University—Director, Center for Materials Science and Engineering; Professor, Analytical Chemistry: organic conducting polymers, electrochemistry, sensors and carbon nanotubes

Thomas W. Smith, BS, John Carroll University; Ph.D., University of Michigan—Professor, Organic/Polymer Chemistry: synthesis and device applications of block copolymer systems and nano composites

Gerald A. Takacs, BS, University of Alberta; Ph.D., University of Wisconsin—Professor, Physical Chemistry: chemical kinetics, atmospheric chemistry, plasma chemistry, and photochemistry

Loraine T. Tan, BS, Rensselaer Polytechnic Institute; Ph.D., University of Buffalo—Visiting Assistant Professor, Analytical Chemistry.

Laura Ellen Tubbs, BA, Hood College; Ph.D., University of Rochester—Professor, Physical Chemistry: accelerator-based ultrasensitive mass spectroscopy, natural radioisotope dating, aqueous polymer solutions

Physics

John D. Andersen, BS, State University of New York at Buffalo; MA, Ph.D., University of Rochester—Professor, Physics: theoretical solid state physics, transport phenomena, electron-photon interactions, nonlinear phenomena, electronic properties of molecular crystals, experimental low-temperature physics, large-scale computations, parallel processing

David John Axon, BSc, Ph.D., University of Durham—Research Professor, Physics: astronomy, active galactic nuclei

Linda S. Barton, BS, Massachusetts Institute of Technology; MS, Ph.D., University of Illinois—Associate Professor, Physics: magnetic materials and magnetic measurements, calorimetry, bulk transport measurements, properties of materials at or near phase transitions, critical phenomena

Peter A. Cardegna, BS, Loyola College; Ph.D., Clemson University—Professor, Physics: experimental solid state physics: transport phenomena in solids, amorphous (glassy) materials, silver halide physics, superconductivity, ceramics

Tracy A. Davis, BA, BS, Wofford College; Ph.D., Clemson University—Associate Professor, Physics: experimental solid-state physics, optics, low temperature physics, computer models of chaotic systems

Alan B. Entenberg, AB, Washington University; Ph.D., University of Rochester—Professor, Physics: stress and adhesion in thin films; surface modification by glow discharge plasma and/or ion bombardment

Scott V. Franklin, BA, University of Chicago; Ph.D., University of Texas—Professor, Physics: theoretical and experimental investigations of nonlinear dynamics, granular materials, and dislocation phenomena, physics education research (PER) and curriculum development, especially for non-science majors

Edwin Hach, III, BS, MS, St. Bonaventure University; Ph.D., University of Arkansas—Lecturer, Physics: theoretical quantum optics

Ian Hodge, BS, MS, University of Auckland; Ph.D., Purdue University—Lecturer, Physics: nonlinear kinetics of the glass, polymers, electrical conductivity in solid electrolytes (glass, crystalline, and poly crystalline)

Dawn Hollenbeck, BS, University of California at Davis; MS, Ph.D., University of Texas at Dallas—Associate Professor, Physics: nonlinear and quantum optics, computational optics, computational physics

Seth M. Hubbard, BS, Drexel University; MS, Case Western Reserve University; Ph.D., University of Michigan—Assistant Professor, Physics: epitaxial crystal growth, growth and characterization of nanomaterials, high-efficiency photovoltaic devices, semiconductor device design and fabrication, thin films

James R. Kern, BS, Indiana University of Pennsylvania; MA, Indiana University; Ph.D., Clemson University—Professor, Physics: acquisition and analysis of the light curves of eclipsing binary stars, imaging and surface photometry of galaxies and comets, asteroid photometry and astrometry, automated telescopes, computer modeling of physical systems

Brian Koberlein, BS, Southern Illinois University; MS, Ph.D., University of Connecticut—Senior Lecturer, Physics: general relativity, astrophysics

Michael Kotlarchyk, BS, MS, Ph.D., Massachusetts Institute of Technology—Professor, Physics: characterization of structure and phase transitions in surfactant systems (micelles, microemulsions, and liquid crystals) using scattering techniques; mass and surface fractals in condensed matter systems, theories of liquids; chaos in simple non-linear physical systems

Vern W. Lindberg, BSc, University of Alberta; MS, Ph.D., Case Western Reserve University—Professor, Physics: deposition of metals onto polymeric substrates, effects of surface modification of polymer substrates on growth of PVD (physical vapor deposited) films, glow discharge and ion bombardment, stress in sputtered thin films, adhesion of PVD thin films, multilayer optical filters

Amir Maharjan, B.Sc., Tri-chandra College (Nepal); M.Sc., Tribhuban University (Nepal); MS, Ph.D., University of Cincinnati—Lecturer, Physics: optical and electrical properties of nanowires, nanotubes, device fabrication

Manasse Mbonye, BS, University of Pennsylvania; MA, Wayne State University; Ph.D., University of Connecticut—Visiting Assistant Professor, Physics: astrophysics

David Merritt, BS, Santa Clara University; Ph.D., Princeton University—Professor, Physics: theoretical astrophysics, galaxy dynamics, supermassive black holes, gravitational N-body problem, computational dynamics

Evelyn H. Monsay, BA, University of Pennsylvania; MA, Ph.D., Princeton University; MBA, Syracuse University—Lecturer, Physics: theoretical particle physics and astrophysics; experimental sensor design employing optics/photonics, acousto-optics, acoustics and magnetism.

Vivek Narayanan, M.Sc., Indian Institute of Technology (India); MA, Ph.D., University of Texas—Lecturer, Physics: mathematical physics, applications of geometry and topology to physics, gravitation, theoretical physics

Christopher O'Dea, BS, Massachusetts Institute of Technology; Ph.D., University of Massachusetts—Professor, Physics: astronomy, active galactic nuclei (Seyfert galaxies, radio galaxies, quasars), clusters of galaxies, cooling flows

Michael W. Richmond, BA, Princeton University; MA, Ph.D., University of California at Berkeley—Professor, Physics: observational astronomy, supernovae, variable stars, reduction of optical data, automatic telescopes

Andrew Robinson, BSc, Ph.D., University of Manchester—Professor, Physics: astronomy, active galactic nuclei, supermassive black holes, radio galaxies, high redshift quasars

Joel D. Shore, BS, Haverford College; Ph.D., Cornell University—Lecturer, Physics: statistical physics, computational physics, organic light-emitting diodes (OLEDs) global climate change

Grover Swartzlander, BS, Drexel University; MS, Purdue University; Ph.D., Johns Hopkins University—Associate Professor, Physics: optics

Robert B. Teese, BS, North Carolina State University; MA, Ph.D., University of Texas—Professor, Physics: physics education research and curriculum development

George M. Thurston, AB, Oberlin College; Ph.D., Massachusetts Institute of Technology—Professor, Physics: biophysics

Greg Trayling, BSc, Simon Fraser University; MSc, University of Victoria; Ph.D., University of Windsor—Lecturer, Physics: Clifford algebra, particle physics, physics beyond the Standard Model, quantum field theory

David J. Urminsky, B.Sc., McMaster University; M.Sc., University of British Columbia; Ph.D., University of Edinburgh—Lecturer, Physics: Stellar Dynamics, Dynamical Systems, Chaos.

Jerome Wagner, BS, Case Institute of Technology; MS, Ph.D., University of Wisconsin—Professor, Physics: solid state physics, nuclear physics, medical physics, diagnostic nuclear medicine, defect properties in insulating materials, radiation-induced defects, color centers

Eric J. West, BS, BA, University of Minnesota Duluth; MS, Ph.D., Syracuse University—Visiting Assistant Professor, Physics: theoretical cosmology, relativity, high energy physics

John J. Zielinski, BS, University of Notre Dame; MS, University of Illinois; Ph.D., University of Texas—Lecturer, Physics: experimental plasma physics, plasma diagnostics, non-linear dynamics

Center for Materials Science and Engineering

(College of Science and Kate Gleason College of Engineering)

John Andersen, BS, State University of New York at Buffalo; MA, Ph.D., University of Rochester—Professor, Physics: theoretical solid-state physics, transport phenomena, electron-photon interactions, nonlinear phenomena, electronic properties of molecular crystals, experimental low-temperature physics, large-scale computations, parallel processing

Linda Barton, BS, Massachusetts Institute of Technology; MS, Ph.D., University of Illinois—Associate Professor, Physics: magnetic materials and magnetic measurements, calorimetry, bulk transport measurements, properties of materials at or near phase transitions, critical phenomena

David A. Borkholder, BS, Rochester Institute of Technology; MS, Ph.D., Stanford University—Associate Professor, Electrical Engineering

Robert J. Bowman, BS, Pennsylvania State University; MS, San Jose State University; Ph.D., University of Utah—Professor, Electrical Engineering

Peter Cardegna, BS, Loyola College; Ph.D., Clemson University—Professor, Physics: superconductivity, low temperature physics, photographic materials

Robert A. Clark, BS, Massachusetts Institute of Technology; Ph.D., University of Maryland—Professor Emeritus, Chemistry: plasma modification of organic polymers, polymer science, chemistry of microlithographic imaging systems, kinetics and thermodynamics of thermal and photochemical transformations of small hydrocarbon molecules

Tracy Davis, BA, BS, Wofford College; Ph.D., Clemson University—Associate Professor, Physics: experimental solid-state physics, optics, low temperature physics, computer models of chaotic systems

Alan B. Entenberg, AB, Washington University; Ph.D., University of Rochester—Professor, Physics: stress and adhesion in thin films; surface modification by glow discharge plasma and/or ion bombardment

Surendra K. Gupta, B.Tech., India Institute of Technology; MS, University of Notre Dame; Ph.D., University of Rochester—Professor, Mechanical Engineering: x-ray diffraction, atomic force microscopy, micromechanics modeling, digital image analysis

Richard K. Hailstone, BS, Northern Illinois University; MS, Indiana University—Associate Professor, Imaging Science: silver halide materials and processing, imaging materials

Joseph P. Hornak, BS, Utica College of Syracuse University; MS, Purdue University; Ph.D., University of Notre Dame—Professor, Chemistry: physical chemistry, magnetic resonance spectroscopy and imaging

Marvin L. Illingsworth, BS, Lafayette College; Ph.D., University of Massachusetts—Professor, Chemistry: inorganic polymers, synthesis and characterization of coordination polymers, ferroelectric thin films, specialty materials

Michael A. Jackson, BS, MS, Ph.D., State University of New York at Buffalo—Associate Professor, Microelectronic Engineering: microelectronic device design, fabrication, and test; material characterization techniques, surface analytical instrumentation; vacuum processing, including CVD, plasma, and ion beam techniques, micromachining, ferroelectric thin films, amorphous silicon and polysilicon film deposition and characterization

Michael Kotlarchyk, BS, MS, Ph.D., Massachusetts Institute of Technology—Professor, Physics: characterization of structure and phase transitions in surfactant systems (micelles, microemulsions, and liquid crystals) using scattering techniques; mass and surface fractals in condensed matter systems, theories of liquids; chaos in simple non-linear physical systems

Kathleen Lamkin-Kennard, BS, Worcester Polytechnic Institute; MS, Ph.D., Drexel University—Assistant Professor, Mechanical Engineering: biomedical engineering and biomaterials.

Vern Lindberg, BS, University of Alberta; MS, Ph.D., Case Western Reserve University—Professor, Physics: deposition of metals onto polymeric substrates, effects of surface modification of polymer substrates on growth of PVD (physical vapor deposited) films, glow discharge and ion bombardment, stress in sputtered thin films, adhesion of PVD thin films, multilayer optical filters

Massoud Miri, BS, MS, Ph.D., University of Hamburg—Associate Professor, Chemistry: polymerization mechanisms, polymer properties, catalysis

Ali Ogut, B.Ch.E., Hacettepe University; MS, Ph.D., University of Maryland—Associate Professor, Mechanical Engineering: polymer processing, heat and mass transfer, rheology, transport phenomena

Sannasi Ramanan, BS, BE, M.Tech., Ph.D., Indian Institute of Technology—Associate Professor, Electrical Engineering: semiconductor materials, IC processing, epitaxial growth of semiconductors, quantumwell heterostructures, simulation and design of solid state devices

Andrew Robinson, BSc, Ph.D., University of Manchester—Professor, Physics: astronomy, active galactic nuclei, supermassive black holes, radio galaxies, high redshift quasars

K. S. V. Santhanam, BSc, MA, Ph.D., Sri Venkateswara University—Director, Center for Materials Science and Engineering; Professor, Analytical Chemistry: organic conducting polymers, electrochemistry, sensors and carbon nanotubes

Bruce Smith, BS, MS, Ph.D., Rochester Institute of Technology—Professor, Microelectronic Engineering: 193 nm lithography, multilayer resist processing, attenuated phase shift mask materials

Thomas W. Smith, BS, John Carroll University; Ph.D., University of Michigan—Professor, Chemistry: synthesis and device applications of block copolymer systems and nano composites

David A. Sumberg, BA, Utica College of Syracuse University; MS, Ph.D., Michigan State University—Associate Professor, Electrical Engineering: fiber optics and applications of fiber optics (polarization properties, microwave transmission on optical fiber, sensors, couplers); integrated optics (couplers, materials for integrated optics)

Gerald A. Takacs, BS, University of Alberta; Ph.D., University of Wisconsin—Professor, Chemistry: physical chemistry, chemical kinetics, photochemistry, atmospheric chemistry, plasma etching and modification of materials

Jayanthi Venkataraman, BS, MS, Bangalore University; Ph.D., Indian Institute of Science—Professor, Electrical Engineering: electromagnetic fields

Jerome Wagner, BS, Case Institute of Technology; MS, Ph.D., University of Wisconsin—Professor, Physics: solid state physics, nuclear physics, medical physics, diagnostic nuclear medicine, defect properties in insulating materials, radiation-induced defects, color center

Scott Williams, BS, Purdue University; Ph.D., Montana University—Associate Professor, CIAS: printed electronics, bioactive paper technology, ink chemistry and formulation

Astrophysical Sciences and Technology

David John Axon, BSc, Ph.D., University of Durham—Research Professor, Physics: astronomy, active galactic nuclei

Stefi A. Baum, BA, Harvard University; Ph.D., University of Maryland—Director; Professor, Imaging Science: astrophysics, astronomical imaging, and astronomical mission development, including radio, optical, UV, and x-ray observations; active galaxies, black holes, galaxies and cluster of galaxies

Manuela Campanelli, Laurea in Mathematics, University of Perugia (Italy); Ph.D., University of Bern (Switzerland)—Professor, Mathematics: numerical relativity, computational astrophysics, black holes, gravitational waves

Joshua Faber, BS, State University of New York at Stony Brook; Ph.D., Massachusetts Institute of Technology—Assistant Professor, Mathematics: numerical relativity, general relativistic magnetohydrodynamics, relativistic astrophysics

Donald F. Figer, BA, Northwestern University; MS, University of Chicago; Ph.D., University of California—Professor, Imaging Science: massive stars, massive star clusters, galactic center, imaging detectors

Joel Kastner, BS, University of Maryland; MS, Ph.D., University of California—Professor, Imaging Science: astronomical imaging, including x-ray, infrared and radio spectroscopy; young stars and planet formation; evolved stars and planetary nebulae

Carlos Lousto, MS, Universidad Nacional De La Plata; Ph.D., Universidad De Buenos Aires—Associate Professor, Mathematics: numerical relativity, relativistic astrophysics, black hole physics, perturbation theory

Manasse Mbonye, BS, University of Pennsylvania; MA, Wayne State University; Ph.D., University of Connecticut—Visiting Assistant Professor, Physics: astrophysics

David Merritt, BS, Santa Clara University; Ph.D., Princeton University—Professor, Physics: theoretical astrophysics, galaxy dynamics, supermassive black holes, gravitational N-body problem, computational dynamics

Zoran Ninkov, BSc, University of Western Australia; MS, Monash University; Ph.D., University of British Columbia—Professor, Imaging Science: detector array development and characterization, development of novel astronomical instrumentation, studies of young stellar clusters, planetary detection

Christopher O'Dea, BS, Massachusetts Institute of Technology; Ph.D., University of Massachusetts—Professor, Physics: astronomy, active galactic nuclei (Seyfert galaxies, radio galaxies, quasars), clusters of galaxies, cooling flows

Michael W. Richmond, BA, Princeton University; MA, Ph.D., University of California at Berkeley—Professor, Physics: observational astronomy, supernovae, variable stars, reduction of optical data, automatic telescopes

Andrew Robinson, BSc, Ph.D., University of Manchester—Professor, Physics: astronomy, active galactic nuclei, supermassive black holes, radio galaxies, high redshift quasars

John Whelan, Ph.D., University of California at Santa Barbara—Associate Professor, Mathematics: quantum physics, gravitational wave data analysis, astrophysical relativity

Yosef Zlochower, BS, Ph.D., University of Pittsburgh—Assistant Professor, Mathematics: numerical relativity, relativistic astrophysics, black hole physics

Chester F. Carlson Center for Imaging Science

Stefi A. Baum, BA, Harvard University; Ph.D., University of Maryland—Director and Professor, Imaging Science: astrophysics, astronomical imaging, and astronomical mission development, including radio, optical, UV, and x-ray observations; active galaxies, black holes, galaxies and cluster of galaxies

Roy S. Berns, BS, MS, University of California; Ph.D., Rensselaer Polytechnic Institute—Director, Munsell Color Science Laboratory, Richard S. Hunter Professor, Color Science: spectral-based digital-image capture, digital archiving, and reproduction of works of art; art conservation science including pigment identification for in painting and quantifying the optical properties of painting varnishes; spectral models and color profiles for multi-ink printing; colorimetry

Roger Dube, BS, Cornell University; Ph.D. Princeton University—Research Professor, Imaging Science: space weather, cosmology, holographic data storage, security

Roger L. Easton, BS, Haverford College; MS, University of Maryland; MS, Ph.D., University of Arizona—Professor, Imaging Science: application of imaging technologies to manuscripts of cultural importance; optical holography; digital and optical signal/image processing

Mark D. Fairchild, BS, MS, Rochester Institute of Technology; Ph.D., University of Rochester—Professor, Imaging Science and Color Science: color appearance perception and modeling; image quality metrics and models; image rendering; cross-media color reproduction

James Fewerda, BA, MS, Ph.D., Cornell University—Associate Professor, Color Science: high dynamic range imaging, perceptually-based rendering, material appearance, display systems, low vision and assistive technologies

Donald F. Figer, BA, Northwestern University; MS, University of Chicago; Ph.D., University of California—Professor, Imaging Science: massive stars, massive star clusters, galactic center, imaging detectors

Jinwei Gu, BS, MS, Tsinghua University (China); Ph.D., Columbia University—Assistant Professor, Imaging Science: computational photography, physics-based computer vision, data-driven computer graphics

Richard Hailstone, BS, Northern Illinois University; MS, Indiana University—Associate Professor, Imaging Science: interaction between electromagnetic radiation and matter, photochemistry, computer simulation of imaging processes

Maria Helguera, BS, National Autonomous University of Mexico; MS, University of Rochester; Ph.D., Rochester Institute of Technology—Assistant Professor, Imaging Science: medical imaging, ultrasound tissue characterization, digital image processing

Joseph P. Hornak, BS, Utica College of Syracuse University; MS, Purdue University; Ph.D., University of Notre Dame—Professor, Joint Appointment with Department of Chemistry: physical chemistry, magnetic resonance spectroscopy and imaging

Emmett Ientilucci, BS, MS, Ph.D., Rochester Institute of Technology—Associate Research Professor, Imaging Science: remote sensing, hyperspectral image processing, multivariate statistics, target detection, radiometry

Joel Kastner, BS, University of Maryland; MS, Ph.D., University of California—Professor, Imaging Science: astronomical imaging, including x-ray, infrared and radio spectroscopy; young stars and planet formation; evolved stars and planetary nebulae

John P. Kerekes, BS, MS, Ph.D., Purdue University—Associate Professor, Imaging Science: multispectral remote sensing systems, multidimensional imaging system, pattern recognition

Robert L. Kremens, BS, The Cooper Union; MS, University of Rochester; MS, Ph.D., New York University—Associate Research Professor, Imaging Science: wildland fire behavior and effects, remote sensing instrumentation, autonomous remote instruments for environmental monitoring, electronics measurement systems

David W. Messinger, BS, Clarkson University; Ph.D., Rensselaer Polytechnic Institute—Associate Research Professor, Imaging Science: remote sensing image exploitation, gaseous effluent detection in LWIR hyperspectral imagery, target detection in hyperspectral imagery

Zoran Ninkov, BSc, University of Western Australia; MS, Monash University; Ph.D., University of British Columbia—Professor, Imaging Science: detector array development and characterization, development of novel astronomical instrumentation, studies of young stellar clusters, planetary detection

Jake Noel-Storr, MSci, University of Birmingham; MA, M.Phil., Ph.D., Columbia University—Assistant Research Professor, Imaging Science: Supermassive black holes, active galactic nuclei, science education and learning, outreach

Jeff Pelz, BFA, MS, Rochester Institute of Technology; Ph.D., University of Rochester—Professor, Imaging Science: visual perception and cognition, understanding high-level visual processing by examining eye movements in the execution of complex tasks in natural environments

Navalgund Rao, MS, Banaras Hindu University; Ph.D., University of Minnesota—Professor, Imaging Science: industrial and medical applications of ultrasound imaging, digital signal processing; modeling and analysis of medical imaging systems

Harvey E. Rhody, BS, University of Wisconsin; MS, University of Cincinnati; Ph.D., Syracuse University—Professor, Imaging Science: imaging algorithms

Carl Salvaggio, BS, MS, Rochester Institute of Technology; Ph.D., State University of New York College of Environmental Science and Forestry—Professor: novel techniques for the measurement of spectral optical properties, quantitative reflective and emissive remote sensing, digital image processing, and scene simulation and modeling

John Schott, BS, Canisius College; MS, Ph.D., Syracuse University—Frederick and Anna B. Wiedman Professor, Imaging Science: quantitative radiometric remote sensing, synthetic image generation, spectroscopy, calibration and atmospheric correction of satellites imaging systems, remote assessment of the Great Lakes water resources

Grover Swartzlander, BS, Drexel University; MS, Purdue University; Ph.D., Johns Hopkins University—Associate Professor, Joint Appointment with Department of Physics: optical vortices, optical coronagraphs and high contrast imaging, pattern formation in linear and nonlinear optics, optical tweezers, optical coherence

Jan van Aardt, BSc, University of Stellenbosch; MS, Ph.D., Virginia Polytechnic Institute—Associate Professor, Imaging Science: remote sensing of natural resources, application of hyperspectral, light detection and ranging for spectral-structural characterization of natural systems, integrated modeling approaches, scaling of natural resources remote sensing solutions through sensor interoperability

Anthony Vodacek, BS, University of Wisconsin; MS, Ph.D., Cornell University—Associate Professor, Imaging Science: imaging spectrometry applications environmental characterization and monitoring; remote sensing data assimilation in environmental models; thermal and non-thermal techniques for wildland fire detection; coastal remote sensing and aquatic optics

Graduate Program Faculty

David John Axon, BSc, Ph.D., University of Durham—Research Professor, Physics: astronomy, active galactic nuclei

Peter Bajorski, BS, MS, University of Wroclaw; Ph.D., Technical University of Wroclaw—Associate Professor, Center for Quality and Applied Statistics: target detection and unmixing in hyperspectral images, multiwave analysis, regression analysis

Nathan Cahill, BS, MS, Rochester Institute of Technology; D.Phil., University of Oxford—Associate Professor, School of Mathematical Sciences: image alignment and stitching, 3-D medical image registration, variational techniques and partial differential equations for image processing

Sohail A. Dianat, BS, Aria-Mehr University (Iran); MS, Ph.D., George Washington University—Professor, Electrical Engineering: digital communication, signal processing and image processing

Marcos Esterman, BS, MS, Massachusetts Institute of Technology; Ph.D., Stanford University—Assistant Professor, Industrial and Systems Engineering: systems engineering, product development, design robustness

Franziska Frey, MS, University of Zurich; Ph.D., Swiss Federal Institute of Technology—Associate Professor, McGhee Distinguished Professor, School of Print Media: materials and digital imaging, digital archiving, digital libraries

Roger S. Gaborski, BS, MS, State University of New York at Buffalo; Ph.D., University of Maryland—Professor, Computer Science: visual and acoustic scene understanding, computer vision, video processing, artificial intelligence, blind source separation, machine learning

Seth Hubbard, BS, Drexel University; MS, Case Western Reserve University; Ph.D. University of Michigan—Assistant Professor, Physics: next generation photovoltaic devices, nanomaterials, novel and wide bandgap semiconductors, semiconducting polymers and devices

Michael Kotlarchyk, BS, MS, Ph.D., Massachusetts Institute of Technology—Professor, Physics: radiation scattering techniques, laser light scattering, small-angle neutron and x-ray scattering, photon correlation spectroscopy, structure and interactions in complex fluids, optics and photonics

Raghuveer Rao, BS, Mysore University; ME, Indian Institute of Science; Ph.D., University of Connecticut—Professor, Electrical Engineering: digital signal and image processing, digital communication

Eli Saber, BS, State University of New York at Buffalo; MS, Ph.D., University of Rochester—Associate Professor, Electrical Engineering: signal, image and video processing; communications

Andreas Savakis, BS, MS, Old Dominion University; Ph.D., North Carolina State University—Associate Professor, Computer Engineering: digital image processing, computer vision

Bruce Smith, BS, MS, Ph.D., Rochester Institute of Technology—Professor, Microelectronic Engineering: immersion lithography, high NA and polarization, aberration metrology, UV/VUV thin films, high index fluids, optical extension and imaging theory

Thomas W. Smith, BS, John Carroll University; Ph.D., University of Michigan—Professor, Chemistry and Microsystems Engineering: synthesis and device applications of block polymer systems and nano composites

Richard Zanibbi, BA, MSc, Ph.D., Queen's University—Assistant Professor, Computer Science: pattern recognition, machine learning, document recognition, CAPTCHAs, human-computer interaction, and programming languages

Carlson Fellow

Robert MacIntyre, BS, Boston University; MA, University of Rochester—Carlson Fellow: geometrical optics

Affiliate Faculty

Alfred Garrett, BS, Texas A&M University; MS, Massachusetts Institute of Technology; Ph.D., University of Texas—Savannah River National Laboratory: remote sensing, computational fluid dynamics, thermodynamics, meteorology

Garrett Johnson, BS, MS, Ph.D. Rochester Institute of Technology—Apple Computer: high dynamic range imaging, color appearance modeling, image appearance modeling

Noboru Ohta, BS, MS, Ph.D., Tokyo University—Fuji Film (retired): color science, digital color imaging, color reproduction

Biological Sciences

1001-700 Cell and Molecular Genetics I
This course will introduce cellular and molecular biology to graduate students with limited background in the biological sciences. The approach taken entails the use of empirical data to support the basic concepts presented. Upon completion of this course, students will not only be familiar with cellular and molecular biology, but will also be acquainted with the theoretical foundations of modern laboratory techniques. Topics covered in this course include cellular evolution, small molecules, energy and biosynthesis, macromolecules, protein functions, genetic mechanisms, recombinant DNA technologies, the nucleus, regulation of gene expression, membrane structure and function, and intracellular protein trafficking. (1001-251, 252, 1011-211-213, 1011-205-207, or equivalent) **Class 3, Credit 3 (F)**

1001-701 Cell and Molecular Genetics II
This course will introduce cellular and molecular biology to graduate students with limited background in the biological sciences. The approach to be taken entails the use of empirical data to support the basic concepts presented. Upon completion of this course, students will not only be familiar with cellular and molecular biology, but will also be acquainted with the theoretical foundations of modern laboratory techniques. Topics covered in this course include energy conversion in mitochondria and chloroplasts, cell signaling, the cytoskeleton, the cell cycle, cell division, intercellular interactions, germ cells and development, cellular differentiation, immunity and cancer. (1001-700) **Class 3, Credit 3 (W)**

1001-703 Animal Behavior
This course is a comparative study of animal behavior from an evolutionary perspective. Lectures examine the physiological organization of behaviors, survival behaviors, social dynamics, and human behavior. Discussion section focuses on analysis of primary literature. (Graduate standing, one year of introductory biology or equivalent, 1001-365, 1016-319, or permission of instructor) **Class 4, Credit 4 (S)**

1001-705 Bioinformatics Resources
Bioinformatics Resources will focus on the types of analyses, tools, and databases that are available and commonly used in bioinformatics. The labs will apply the lecture material in the analysis of real data. (Graduate student standing; permission of instructor) **Class 2, Lab 3, Credit 3 (F)**

1001-715 Genetic Diseases and Disorders Seminar
The identification of genetic causes of disease has been one of the major scientific breakthroughs of recent history. In this course, we will examine a range of inherited diseases, how causative genetic variations were identified, and what this means for the treatment of diseases. Scientific literature will be utilized, both current and historical. (1001-421) **Class 3, Credit 3 (S, alternating years) (offered 2010-2011)**

1001-722 Bioinformatics Seminar
Sufficient opportunities will be afforded for students and faculty to develop and share professional interests while discussing current trends and developments in bioinformatics through readings, presentations, and the development of scientific writing skills. Material for this course will be drawn from the current scientific literature including, but not limited to, journals such as Bioinformatics, Genome Research, Biology Direct, and the Journal of Computational Biology, among others. Students from outside the Bioinformatics MS program may take this course with permission of the instructor. **Class 2, Credit 2 (F)**

1001-725 Ethics in Bioinformatics
This course will be focused on individual and organizational responsibilities in bioinformatics research and product development and commercialization. Students from outside the Bioinformatics MS program may take this class with permission of the instructor. **Class 3, Credit 3 (W)**

1001-760 Advanced Conservation Biology
This course concentrates on the application of ecological principles to conservation issues. Human impact on species diversity will be emphasized as it relates to agricultural, forest, coastal and wetland ecosystems. Case studies of management practices used to manage and restore disturbed ecosystems will be included. Laboratory exercises will concentrate on methodologies for assessing human impacts on ecosystems using advanced field techniques and statistical methods, in addition to the GIS technology to conservation issues. (1001-340 or comparable General ecology course, 1016-319 or equivalent) **Class 3, Lab 3, Credit 4 (W)**

1001-765 Case Studies in Genomics
This course will focus on the field of genomics by reviewing the current state of the art in relevant laboratory and computer applications. Topics to be discussed include, but are not limited to, the application of genomics to infectious and genetic diseases, diagnosis and treatment of cancer, production of biopharmaceuticals, development of new therapeutic chemicals, gene and cell therapies. Students will be asked to develop written case studies featuring genomics and biotechnology companies that will be discussed in class and considered as part of their evaluation for this course. They will be encouraged to select both successful and unsuccessful companies in order to identify viable strategies for applying genomics technologies in an industrial setting. (Permission of instructor) **Class 3, Credit 3 (W)**

1001-767 Environmental Microbiology
This is an advanced course in the principles of soil microbiology, groundwater microbiology, wastewater microbiology, composting microbiology, and bioremediation. The class will also focus on practical applications of microorganisms isolated from various types of environments. Examples of commercial use of microorganisms will also be presented. The lab consists of a series of experiments looking at the microbial flora of soils, plant surfaces, air particles, and water. Students will attempt to isolate microorganisms from soil samples that are capable of degrading organic compounds. Students will use various methods to determine degradative capabilities of soil microorganisms such as carbon dioxide evolution and oxygen depletion. Students will do an independent lab project selecting an oil contaminated site and attempt to isolate various oil degrading bacteria. (1001-404) **Class 3, Lab 3, Credit 4 (S)**

1001-794 Molecular Modeling and Proteomics
This course will explore two facets of protein molecules: their structure and their expression. The structure component will build upon information from the bioinformatics course and will add further sophistication with analysis of intermolecular interactions and ligand/receptor pairing. Software that permits molecular docking experiments will be employed. Tissue-specific protein expression will be addressed in lectures with description of microarray technology and, in the laboratory, with two-dimensional protein gel electrophoresis. Each student will be assigned a project designed to integrate salient principles in each course and provide an opportunity for each student to give an oral presentation to his or her peers. (4002-763) **Class 3, Lab 3, Credit 4 (S)**

1001-890 Bioinformatics MS Thesis
Each student's experience in this course will be different. The individual student's thesis project will be tailored to fit his or her interests under the guidance of a faculty mentor. That mentor will be identified as the individual within our faculty who has professional interests most closely aligned with those of the student. Typically a mentor will be identified and a thesis proposal will be prepared and approved by the student's thesis advisory committee before the start of the second year of study. Thesis work and the preparation and defense of the written thesis will take place during the second year of study. **Credit variable (F, W, S)**

Environmental Science

1006-710 Graduate Readings Seminar
This course helps graduate and upper-level undergraduate students learn how to assess journal articles, government reports, whitepapers, and essays as well as other relevant sources of information. Students will also refine their discussion and presentation skills and gain experience in clarifying their comments and responding to questions by an audience. **Class 3, Credit 3 (W)**

1006-711 Environmental Science Graduate Study I
This is the first course of a three course sequence (1006-711, 712, 713) designed to introduce new graduate students in the Environmental Science program to the entire process of graduate study that will culminate in their completion of all required course work as well as a research project under the direct supervision of a member of the faculty. This first course will introduce students to careers in environmental science, to graduate studies in environmental science at RIT and to the process of proposing, conducting, presenting, and defending a research project in partial fulfillment of the requirements for the Master of Science degree in environmental science. (Graduate status in Environmental Science) **Class 2, Credit 2 (F)**

1006-712 Environmental Science Graduate Study II
This is the second of a three course sequence (1006-711, 712, 713) designed to introduce new graduate students in the Environmental Science program to the entire process of graduate study that will culminate in their completion of all required course work as well as a research project under the direct supervision of a member of the faculty. This course will focus on the creation of a carefully researched and written draft of their thesis or project proposal. Students will learn modern conventions for analyzing and reporting scientific data. Peer review and editing of scientific writings will be emphasized. (1006-711) **Class 2, Credit 2 (W)**

1006-713 Environmental Science Graduate Study III
This is the third course of a three course sequence (1006-711, 712, 713) designed to introduce new graduate students in the Environmental Science program to the entire process of graduate study that will culminate in their completion of all required course work as well as a research project under the direct supervision of the program faculty. This course will focus on developing and practicing techniques for making oral presentations of research proposals to an audience of peers in environmental science, and to providing peer review of oral presentations. (1006-712) **Class 2, Credit 1 (S)**

1006-750 Ecological and Environmental Applications of GIS
Aerial photography, satellite imagery, Global Positioning Systems (GPS), and Geographic Information Systems (GIS) are extremely useful tools in ecological and environmental applications such as biological monitoring, environmental assessment, habitat restoration, change analysis, resource management, and risk assessment. This course will: 1) introduce students to spatial analysis, theories, techniques and issues associated with ecological and environmental applications; 2) provide hands-on training in the use of spatial tools while addressing a real problem; 3) provide experience linking GIS analyses to field assessments and monitoring activities; and 4) enable students to solve a variety of spatial and temporal ecological and environmental problems. (1006-350 or 1006-450, or permission of instructor) **Class 3, Lab 3, Credit 4 (S)**

1006-759 Special Topics: Environmental Science
Special topics courses are courses that are of current interest and/or logical continuations of courses already offered. These courses are structured as ordinary courses and may have specified prerequisites, contact hours, and examination procedures. **Class variable, Credit variable (F, W, S, Su)**

1006-799 Independent Study
Independent study is a faculty directed study of appropriate topics on a tutorial basis. Independent study enables an individual to pursue studies of existing knowledge available in literature. **Class variable, Credit variable (F, W, S, Su)**

1006-879 Environmental Science Graduate Research
This course is taken by graduate students in the Environmental Science MS and BS/MS programs to begin the process of developing an environmental research (thesis or project) plan under the guidance of an RIT faculty mentor, who will become the student's graduate thesis/project advisor. This process will culminate with the completion and defense of a graduate research proposal. Graduate students are required to complete a total of three quarter credit hours of this course to fulfill the requirements of the Master of Science degree in Environmental Science. (Graduate status in the Environmental Science MS program.) **Credit variable 1–3 (F, W, S, Su)**

1006-890 Environmental Science Graduate Thesis
The thesis option will be available to environmental science graduate students only with prior written approval of program faculty. Students will submit a proposal to a faculty member who agrees to serve as the student's thesis committee chair. The proposal will describe the basic research question to be investigated and the experimental protocols to be employed. Proposals will be reviewed by the program faculty who will give permission to register for thesis credit. This course may be taken several times over the course of a student's graduate program, for variable credits totaling no fewer than 5 credit hours and no more than 9 credit hours as determined by the program faculty. A written thesis and oral defense are required at the completion of the thesis research. **Credit variable 1–9 (F, W, S, Su)**

1006-891 Environmental Science Graduate Project
This course is used to fulfill the project requirement under the non thesis option in environmental science. The project may take the form of original research designed to address a specific environmental issue or a paper on some important or controversial topic in environmental science. Students will submit a proposal to a faculty member who agrees to serve as the student's project committee chair. Proposals will be reviewed by the program faculty who will give permission to register for project credit. This course may be taken several times over the course of a student's graduate program, for variable credits totaling no fewer than 5 credit hours and no more than 9 credit hours as determined by the program faculty. A written report and oral presentation are required at the completion of the project. **Credit variable 1–9 (F, W, S, Su)**

Chemistry

1008-711 Instrumental Analysis
Theory, applications and limitations of selected instrumental methods in qualitative, quantitative and structural analysis are discussed. Possible topics include electrochemistry, surface analysis, NMR spectroscopy, mass spectroscopy, ICP, and other modern instrumentation. A term paper and oral presentation will be required based on an analytical technique agreed upon by instructor and student. (1014-441) **Class 3, Credit 3 (F, W-X*)**

1008-785 Lab Techniques for Microsensors and Actuators
This course is designed on practical aspects of fabrication measurement. It will discuss the construction and characterization of a few sensors and actuators. The practical limitation of the microsensors will be evaluated. (Baccalaureate degree in chemistry or permission of instructor) **Lab variable, Credit 2-4**

1009-702 Biochemistry: Biomolecular Conformation and Dynamics
This is the first course in our graduate sequence in biochemistry. Molecular transport and enzymatic catalysis are related to the three dimensional structures of biomolecules and the laws of thermodynamics. Also provides an introduction to membrane structure as preparation for 1009-703 Biochemistry: Metabolism. Also offered in distance-learning format. (Baccalaureate degree or permission of instructor) **Class 3, Credit 3 (F, W, S)**

1009-703 Biochemistry: Metabolism
Metabolic processes involved in energy consumption and production as well as the synthesis and degradation of biomolecules are discussed. Metabolic pathways are described in terms of thermodynamic principles, cellular localization and regulation mechanisms. Finally, the metabolic basis of several diseases is presented. (Baccalaureate degree or permission of instructor. **Class 3, Credit 3 (F, W, S)**

1009-704 Biochemistry: Nucleic Acids
Nucleic acid structures, including the classical Watson-Crick model for DNA are introduced. The flow of genetic information by replication (DNA to DNA), transcription (DNA to RNA) and translation (RNA to protein) as well as gene expression and regulation in prokaryotes are discussed. The methodology of new techniques, such as DNA sequencing and recombinant DNA, and their role in medicine and forensics are presented. The genetic aspects of viruses and oncogenes are also reviewed. (Baccalaureate degree or permission of instructor) **Class 3, Credit 3 (F, W, S)**

1009-705 Biochemistry: Experimental Techniques
An introduction to the theory and practice of modern experimental biochemical laboratory techniques and concepts. The weekly one-hour lecture provides a theoretical framework for the various experimental techniques and includes a discussion of the properties of biomolecules and how those properties are exploited in the separation and characterization of the molecules. Practical laboratory techniques include the preparation of buffers, centrifugation, gel exclusion chromatography, electrophoretic methods, and UV/visible and fluorescence spectrophotometry as applied to the isolation and characterization of proteins and nucleic acids, the manipulation of genetic material in *E. coli* will also be examined. (Baccalaureate degree or permission of instructor) **Class 1, Lab 3, Credit 2 (F, W)**

1009-710 Advanced Protein Biochemistry: Structure and Function
In this course, we will analyze protein structure-function relationships. We will investigate how proteins function and how the structure relates to that function. The principles that explain enzyme rate enhancements, mechanistic enzymology will be examined. We will also explore protein superfamilies for phylogenetic relationships to enhance our understanding of protein structure function relationships. We will do this by reading and discussing current scientific literature and classic papers. (1009-702) **Class 3, Credit 3 (S)**

1009-794 Molecular Modeling and Proteomics
The course will explore two facets of protein molecules: their structure and their expression. The structure component will build upon information from the biochemistry prerequisite course and will add further sophistication with analysis of inter-molecular interactions and ligand/receptor pairing. Software that permits molecular docking experiments will be employed. Tissue-specific protein expression will be addressed in lectures with description of micro-array technology and, in the laboratory, with two-dimensional protein gel electrophoresis. The course will include student initiated discussions and presentations on late-breaking developments in molecular visualization and proteomics. Course cannot be taken by students who have credit for 1009-594, 1001-494 or 1001-794. (1009-702, 1009-503 or 1009-703, or equivalent) **Class 3, Lab 3, Credit 4 (S)**

1010-772 Special Topics
Advanced courses which are of current interest and/or logical continuations of the courses already being offered. These courses are structured as ordinary courses and have specified prerequisites, contact hours and examination procedures. Recent courses taught as Special Topics have included nuclear chemistry, polymer morphology, advanced chromatographic methods and applications of computer interfacing. **Class variable, Credit variable**

1010-870 Chemistry Seminar
Matriculated students are required to attend the weekly chemistry seminar series and to present one-hour seminars on their thesis or project research**. Credit 1**

1010-877 External Research
Industrial internship research. **Credit 1–16**

1010-879 Research and Thesis
Guidance hours and credits to be arranged. Chemical research in a field chosen by the candidate, subject to approval of the department head and advisor. (1010-879-99 Continuation of Thesis, Credit 0) **Credit 1–16**

1010-899 Chemistry Independent Study: Graduate
Credit variable

1012-764 Modern Inorganic Chemistry
This course introduces the more sophisticated tools with which an inorganic chemist investigates inorganic molecules and materials. These physical methods are applied to inorganic reactions that distinguish the chemistries of the elements and to current research directions in the field. An oral presentation is required. Literature project required for graduate credit. (1014-441) **Class 4, Credit 4 (offered alternate years) (S)**

1012-765 Preparative Inorganic Chemistry Lab
In this laboratory, the chemistries of different elements in the periodic table are examined, and advanced synthetic and characterization methods are utilized. (Inorganic chemistry or permission of instructor) **Class 1, Lab 7, Credit 3 (W, S)**

1013-710 Literature Exploration of Organic Synthesis
This course will be a survey of the recent literature in organic chemistry with a focus on the chemistry concerning those that synthesize natural products and/or methodology towards synthesizing natural products. During each week of the course a student is selected to lead a discussion based on an article from a premier journal. Repeatable for credit. (1013-537 or 1013-757 or permission of instructor) **Class 1, Credit 1 (F, W)**

1013-736 Spectrometric Identification of Organic Compounds
This course discusses the theory and application of proton, carbon and 2-D nuclear magnetic resonance, infrared and mass spectrometry as applied to organic structure determination. (1013-433) **Class 4, Credit 4 (W-X*)**

1013-737 Advanced Organic Chemistry
Advanced topics in organic synthesis, novel reagents and synthetic strategies such as retrosynthetic analysis are covered. In addition, previously studied reactions will be revisited with the added focus on stereospecificity. Protecting groups are covered in depth as well as sigmatrophic rearrangements. Several classics in total synthesis are included with a strong emphasis on syntheses published in the current chemical literature. Time permitting, a survey of the most widely used organo-palladium couplings will be introduced.(1013-433**) Class 4, Credit 4 (F)**

1013-739 Advanced Organic Chemistry
This course covers topics in physical organic chemistry including techniques for elucidation of mechanism: kinetics, linear free, energy relationships, isotope effects, thermodynamics, molecular orbital theory, electrocyclic reactions. (1013-433, 1014-443) **Class 4, Credit 4 (offered alternate years) (S)**

1014-730 Magnetic Resonance Imaging
This course is an introduction to the principles of magnetic resonance imaging (MRI). The course covers spin physics, Fourier transforms, basic imaging principles, Fourier imaging, imaging hardware, imaging techniques, image processing, image artifacts, safety and advanced imaging techniques. (1008-311, 1014-442, Calculus) **Class 4, Credit 4 (S-X*)**

1014-740 Basics of Pulsed NMR
This course is an introduction to the principles of pulsed nuclear magnetic resonance (NMR) spectroscopy. Lectures on instrumentation, pulse sequences, Fourier transforms and artifacts are presented. (1008-311) **Class 1, Credit 1 (F)**

1014-741 Advanced Chemical Thermodynamics
This course is a study of the basic fundamentals of thermodynamics, including an introduction to statistical mechanics and their use in deriving the interrelationships of thermodynamic functions. Thermodynamic properties of gases are calculated based on spectroscopic data. Theory of solutions and phase equilibria are discussed. (1014-443, 1016-306) **Class 4, Credit 4 (offered upon sufficient request)(W-X*)**

1014-742 Survey of Physical Chemistry
This course is a study of the fundamental principles of physical chemistry. Kinetic molecular theory, quantum mechanics, spectroscopy, thermodynamics and kinetics are presented. This course provides a high-level, comprehensive survey of essential topics in physical chemistry. **Class 3, Credit 3 (W)**

1014-743 Advanced Chemical Kinetics
Methods of investigating the kinetics of chemical reactions and the theories used to interpret their results are presented with a focus on homogeneous reactions in gas and liquid phases. Discussions of references from recent chemical literature are provided. (1014-443) **Class 4, Credit 4 (offered upon sufficient request) (W-X*)**

1014-744 Advanced Quantum Mechanics
This course provides a review of basic quantum theory and models; variation and perturbation methods, atomic and molecular orbital theory, emphasis on relationship of spectroscopy and quantum chemistry. (1014-442) **Class 4, Credit 4 (offered upon sufficient request) (S, X*)**

1014-747 Principles of Magnetic Resonance
This course is a series of lectures designed to introduce the principles of magnetic resonance spectroscopies with emphasis on pulsed nuclear magnetic resonance (NMR) spectroscopy. Topics covered include classical and quantum mechanical theory, Fourier transform techniques, pulse sequences, instrumentation, instrumental techniques and modern applications such as 2-D NMR and solid-state NMR. (1014-443; 1014-740) **Class 4, Credit 4 (offered alternate years) (W-X*)**

1029-701 Organic Chemistry of Polymers
The synthesis and chemistry of high molecular weight organic polymers is broadly surveyed. Chemistry relating to the formation of carbon chain polymers and polymers containing heteroatoms in-chain is detailed. Kinetics, thermodynamics and mechanisms of step growth and chain growth polymerization reactions are reviewed with particular attention being given to stereospecific and living polymerization processes, block and graft copolymers, functional polymers and polymeric reagents. (1013-433) **Class 4, Credit 4 (W)**

1029-702 Polymer Chemistry: Chains and Solutions
Although most polymeric materials find utility as solids, polymer fabrication and characterization techniques are generally liquid phase processes. This course is concerned with the fundamental physical chemistry of polymers in liquid solutions. Topics to be addressed include: polymerization kinetics and chain structure, molecular weight distributions and determination, polymer solution thermodynamics and transport phenomena, and solution phase transitions. The study of polymeric solids is the focus of 1029-703. (Baccalaureate degree in science or engineering, or permission of instructor) **Class 4, Credit 4 (S-X*)**

1029-703 Polymer Chemistry: Properties of Bulk Materials
This course is designed to give the student with a chemistry or materials science background a thorough grounding in the main concepts which describe bulk polymer structure, behavior and properties and to give the student practical tools to predict them. Basic to the understanding of polymer behavior is the fact that it is time-dependent. To emphasize this idea, the course is designed to build up to a study of the thermo-mechanical behavior of viscoelastic materials. (Baccalaureate degree in a science or engineering, or permission of instructor) **Class 4, Credit 4 (F-X*)**

1029-704 Polymer Characterization Laboratory
Many students in the Chemistry and Materials Science and Engineering graduate programs are involved in polymer research. This course gives these students an opportunity to acquire proficiency in using the tools of polymer characterization. Techniques for studying 1) molecular weight distributions, 2) spectroscopic analysis of chemical structure, 3) thermal stability, 4) morphology and phase transitions, and 5) mechanical properties will be introduced and mastered. Techniques may concentrate on particular research topics. (Baccalaureate degree in a science or engineering discipline, or permission of instructor) **(offered alternate years) Lab 6, Credit 2 (S)**

1029-705 Preparative Polymer Chemistry Laboratory
Students will carry out about eight experiments. About half of the experiments conducted will be step-growth polymerizations; the other half will be chain-addition polymerizations. The polymers produced will include: Nylon 6-10, Nylon 11, a polyurethane, polystyrene, high density polyethylene, and a copolymer of styrene and methyl methacrylate. More specifically, the types of polymerizations and reactions introduced will be crosslinking of polymers, interfacial and bulk step-growth polymerizations, cyclopolymerization, radical, ionic, and coordinative chain polymerizations. Instructors may add and/or delete polymer related experiments of their choice. The students in this course will also analyze the polymers produced and use literature data to confirm structural features. (1013-437) **Lab 6, Credit 2 (offered alternate years) (F)**

Mathematics

1016-705 Difference Equations
This course is an introduction to the basic theory of difference equations. It begins by solving linear difference equations with constant coefficients and examining the long-term behavior of solutions for convergence, periodicity and boundedness. Other difference equations are studied by analyzing the behavior of the transient term, convergence, periodic and eventually periodic solutions and unbounded solutions. The course also includes techniques such as transformation from nonlinear to linear difference equations, inequalities, and invariant and attracting intervals. (1016-432 or permission of instructor) **Class 4, Credit 4 (S) (Offered upon sufficient enrollment)**

1016-706 Advanced Differential Equations
This course provides a study of first order, linear high order and systems of differential equations and their applications in the physical sciences. Mathematical modeling will be used to illustrate the concepts. Applications and computer projects will be used to involve students in intense problem solving experiences. Topics such as existence, uniqueness, theory and methods of solutions, linear systems, stability, Sturm-Liouville problems and asymptotic methods of solution will be studied. (1016-306 or equivalent, 1016-331 desirable) **Class 4, Credit 4 (F)**

1016-707 Dynamical Systems
This course is a study of dynamical systems theory motivated by nonlinear differential equations. Basic definitions of dynamical systems are followed by fundamental theorems about local behavior close to fixed points and stability theory of solutions of differential equations. Simplification methods such as center manifold theory and normal forms are introduced. Asymptomatic behavior of solutions is investigated through limit sets, attractors, Poincare-Bendixson theory, and index theory. The notion of local bifurcation is introduced and investigated. (1016-306 and 1016-432 or permission of instructor) **Class 4, Credit 4 (W)**

1016-709 Chaotic Dynamical Systems
This course is a study of chaotic dynamical systems theory in discrete dynamical systems. Definitions and examples of discrete dynamical systems are followed by the study of symbolic dynamics and its connection to mappings. The notion of topological conjugacy and equivalency is introduced and different definitions of chaos are investigated. Sharkovskii Theorem about the ordering of prime periods in a discrete dynamical system is discussed. The notion of local and global bifurcation is introduced and investigated as well as the period doubling route to chaos. (Permission of instructor) **Class 4, Credit 4 (S)**

1016-711 Numerical Analysis
This course is a rigorous study of floating point arithmetic, numerical techniques for finding roots of nonlinear equations, interpolations and approximation of functions, approximations of definite integrals and numerical solutions to initial boundary value problems for ordinary differential equations with a study of the errors produced. This course requires independent study of certain topics that are not covered in the class lectures. Software packages such as MATLAB will be utilized. (1016-306, 1016-331, and graduate standing) **Class 4, Credit 4 (F)**

1016-712 Numerical Linear Algebra
This course is a rigorous study of theoretical concepts and computational issues in linear algebra. Topics include an analysis of Gaussian elimination with pivoting, its error and its stability, iterative methods for solving linear systems, matrix factorizations, eigenvalues, singular value decomposition, Krylov subspace methods and application to least squares, systems of nonlinear equations and partial differential equations. This course requires independent study of certain topics that are not covered in the class lectures. Software packages like MATLAB will be utilized through several computing projects. (1016-331, and graduate standing, 1016-432 recommended) **Class 4, Credit 4 (W)**

1016-713 Mathematical Methods in Scientific Computing
This course examines the use of discrete Fourier transforms, simulation methods, optimization techniques, and number theory algorithms that are employed in modern scientific computing. (1016-511 or 512, or 1016-711 or 712, or permission of instructor) **Class 4, Credit 4 (S)**

1016-715 Statistical Models for Bioinformatics
Organic evolution over thousands of years has provided us with one of the most complicated statistical models imaginable. This course will investigate some of the statistical models that have proved useful in analyzing biological information. Examples include Markov models, such as the Jukes-Cantor and Kimura evolutionary models and hidden Markov models, and multivariate models used for discrimination and classification. (1016-415 or permission of instructor) **Class 4, Credit 4 (W)**

1016-719 Biostatistics
This course is an introduction to the probabilistic models and statistical techniques used in the analysis of biological and medical data. Topics include univariate and multivariate summary techniques, one and two way sample parametric and nonparametric inference, censoring, one and two way analysis of variance, and multiple and logistic regression analysis. (Permission of instructor) **Class 4, Credit 4 (S)**

1016-720 Complex Variables
This course introduces the student to the basic elements of calculus of complex valued functions of a complex variable. The major emphasis is on integration, with the goal of using these results to evaluate certain types of real integrals. The course includes the concept of analyticity, complex integration, Cauchy's integral theorem and integral formulas, Taylor and Laurent series, residues, real integrals by complex methods, and conformal mappings. (1016-305 or equivalent) **Class 4, Credit 4 (F)**

1016-725 Stochastic Processes
This course is an introduction to stochastic processes. Important random processes that appear in various applications are studied. It covers basic properties and applications of Poisson processes and Markov processes as well as applications in renewal theory, queuing models, and optimal stopping. (1016-351 and 1016-331) **Class 4, Credit 4 (W)**

1016-764 Topics in Logic, Set Theory and Computability
This course surveys logic and set theory and their connections to computer science and the foundations of discrete mathematics. Starting with the abstract construction of integers and real numbers, it proceeds to axiomatic set theory and logic stressing questions of completeness, consistency, decidability and recursive enumerability. The course includes a survey of NP (non-deterministic polynomial) and NP complete problems. The student should gain a greater awareness of the paradoxical, the impossible and the slow. (1016-411 and 1016-532 and graduate standing, or permission of instructor) **Class 4, Credit 4 (S)**

1016-766 Optimization Theory
This course provides a study of the theory of optimization of linear and nonlinear functions of several variables with or without constraints. Applications of this theory to solve problems in business, management, engineering, and the sciences are considered. Algorithms for practical applications will be analyzed and implemented. Students taking this course will be expected to complete applied projects and/or case studies. (1016-331 or equivalent, 1016-465 desirable) **Class 4, Credit 4 (S)**

1016-767 Combinatorics
This course introduces the fundamental concepts of combinatorics and graph theory. Topics to be studied include counting techniques, generating functions, recurrence relations, the inclusion-exclusion principle, special graphs. Applications such as design of experiments, traffic routing, tournaments will be considered. (Graduate standing or permission of instructor) **Class 4, Credit 4 (W)**

1016-768 Graph Theory
This course studies advanced concepts in graph theory and their applications. After a review of basic terminology, the topics of coverings, matchings, connectivity, and coloring will be studied. Applications to areas such as optimal routing, transport networks, network design, tournaments, and scheduling will be considered. The interplay between graph theory, counting techniques, and algebra will also be studied. (1016-767) **Class 4, Credit 4 (F)**

1016-785 Number Theory
This course is an introduction to the standard results and techniques of Number Theory. Topics include induction, divisibility, congruences, Mobius inversion, quadratic reciprocity, and primitive roots. Cryptography and other applications will be discussed. Projects may be required. (1016-265 or permission of instructor) **Class 4, Credit 4 (W)**

1016-789 **Mathematics of Cryptography**
This course is an introduction to the mathematical foundations of modern cryptographic techniques. The material covered includes: classical cryptosystems; some aspects of computational number theory; primality tests; private encryption schemes and public key encryption schemes (like DES, AES and RSA); further applications, such as digital signatures, one way functions, and zero knowledge proofs. Optional topics such as elliptic curve cryptography may be covered. (1016-485 or 1016-785, or permission of instructor) **Class 4, Credit 4 (S)**

1016-802 **Methods of Applied Mathematics**
This course is an introduction to classical techniques used in applied mathematics. Models arising in physics and engineering are introduced. Topics include dimensional analysis, scaling techniques, regular and singular perturbation theory, and calculus of variations. (1016-306 or permission of instructor) **Class 4, Credit 4 (F)**

1016-807 **Boundary Value Problems**
This course is an introduction to methods of applied mathematics that are used in the solution of problems in physics and engineering. Models such as heat flow, vibrating strings and membranes will be formulated from physical principles and solution methods such as separation of variables, Fourier series, and integral transforms will be studied. (1016-306 and Graduate standing) **Class 4, Credit 4 (S)**

1016-808 **Partial Differential Equations**
This is a continuation of 1016-807 Boundary Value Problems and deals with advanced methods for solving partial differential equations arising in physics and engineering problems. Topics to be covered include first order linear and nonlinear equations, second order equations, Green's functions, integral equations, transform methods, and wave phenomena. (1016-802) **Class 4, Credit 4 (S)**

1016-811 **Numerical Methods for Partial Differential Equations**
This is an advanced course in numerical methods that introduces students to computational techniques for solving partial differential equations (PDEs), especially those arising in applications. Topics include: finite difference methods for hyperbolic, parabolic, and elliptic PDEs, consistency, stability and convergence of finite difference schemes. (1016-713 or permission of instructor) **Class 4, Credit 4 (S)**

1016-812 **Wavelets and Applications**
A mathematical introduction to the theory and applications of orthogonal wavelets and their use in analyzing functions and function spaces is provided. Topics include a brief survey of Fourier series representation of functions, Fourier transform and the Fast Fourier Transform (FFT) before proceeding to the Haar wavelet system, multiresolution analysis, decomposition and reconstruction of functions, Daubechies wavelet construction, and other wavelet systems. Applications such as data compression, noise reduction, and image processing will be studied. (1016-432) **Class 4, Credit 4 (S)**

1016-862 **Topics in Mathematical Biology**
This course introduces areas of biological sciences in which mathematics can be used to capture the essential interactions within a system. Different modeling approaches to various biological and physiological phenomena are developed (e.g., population and cell growth, spread of disease, epidemiology, biological fluid dynamics, nutrient transport, biochemical reactions, tumor growth, genetics). The emphasis is on the use of mathematics to unify related concepts. (Permission of instructor) **Class 4, Credit 4 (W)**

1016-879 **Thesis**
This is the capstone of the program in which the student works on a problem in applied mathematics under the guidance of the advisory committee. A formal written proposal of the problem to be studied must be presented before embarking on the project. A written report and an oral defense of the project/thesis are required at the completion of the work. This course may be repeated for a maximum of 12 quarter credit hours. (Consent of the adviser)

1016-899 **Independent Study**
A topic of special interest to the student and related to the student's area of concentration may be taken for independent study with the approval of the adviser and the instructor who will offer the course. The student submits a proposal for independent study to the advisory committee for consideration and approval. (Consent of the adviser and the instructor) **Credit variable (maximum of 4 credits/quarter)**

Clinical Chemistry (Program is part of CHST)

1023-705 **Mechanisms of Disease**
Mechanisms of cellular injury, the healing process, atherosclerotic heart disease, hypertension, infectious disease, and many other disease states are presented. **Class 4, Credit 4 (S)**

1023-724 **Scientific Writing for Clinical Research**
Managing a clinical research or clinical trials program means managing information and communication. This course will develop familiarity and provide experience with the government regulations, standard operating procedures (SOPs), and documents used to communicate processes and results in clinical research projects. (Graduate standing in the MS in Professional Studies program with a concentration in Clinical Research Management or by permission of the instructor) **Class 4, Credit 4 (W)**

1023-725 **Product Development in the Pharmaceuticals**
This course is designed as an overview of the product development process. The course will describe activities used to bring these different types of products from concept through testing to product approval. Regulatory requirements for product approval in the USA as well as international requirements will be discussed. Overall product development will be outlined with an emphasis on clinical research activities toward market approval. Students will learn the activities and requirements to get products through clinical research to FDA approval. (Permission of instructor) **Class 4, Credit 4 (W)**

1023-726 **Good Clinical Practices**
This course is designed to provide the student with an understanding of the regulatory framework that governs clinical research activities. The general principles of good clinical practice and the responsibilities of the key figures involved in a clinical research study will be discussed. The history of the regulations and significant milestones in U.S. Food and Drug Law will also be presented. (Permission of instructor) **Class 4, Credit 4 (S)**

1023-727 **Ethical Foundations and Issues in Human Subject Research**
A comprehensive course in clinical research ethics. The course will present the history of ethical issues in research involving human subjects and the resulting development of regulatory requirements globally. Critical processes such as informed consent and institutional review boards will be reviewed extensively. Current issues such as conflict of interest and research involving genetic material will also be discussed and understanding the role of good science as good ethics will be included. **Class 4, Credit 4 (F)**

1023-728 **Clinical Trial Design**
This course is designed to provide graduate and upper-level undergraduate students with the basic principles behind the design of clinical research trials to effectively test medical hypotheses. The critical components of a well designed clinical research protocol will be explored. Students will be exposed to the different types of clinical trials used in the industrial, government and academic sectors for pharmaceutical, medical device, or biologic interventions. (1023-724 and 1023-725) **Class 4, Credit 4**

1023-820 **Advanced Clinical Chemistry I**
Electrolytes, acid-base physiology, renal function, trace metals, lipids, carbohydrate metabolism, enzymes, and various standard methods are covered. **Class 4, Credit 4 (offered alternate years)**

1023-821 **Advanced Clinical Chemistry II**
A study of the concepts and applications of therapeutic drug monitoring, pharmacokinetics, toxicology, inherited disorders of metabolism, liver function tests, protein measurement, hepatitis, hemoglobinopathies, vitamins, and gene probes. **Class 4, Credit 4 (offered alternate years)**

1023-822 **Advanced Clinical Chemistry III**
A survey of endocrinology and of the immunoassay methods used in performing endocrine assays. The endocrine systems covered include the thyroid, the adrenals, calcium metabolism, growth hormone, the human reproductive system, and the fetal-placental unit. Basic principles of clinical trials will also be presented. **Class 4, Credit 4 (offered alternate years)**

1023-870 **Clinical Chemistry Seminar**
A seminar offered for one credit to graduate students presenting final research outcomes to their graduate committee. **Credit 1**

1023-872 **Special Topics: Clinical Chemistry**
In response to student and/or faculty interest, special courses that are of current interest and/or logical continuations of regular courses are presented. These courses are structured as ordinary courses with specified prerequisites, contact hours and examinations. **Class variable, Credit variable (offered upon sufficient request)**

1023-877 External Clinical Chemistry Research
Research carried out in a laboratory outside of the College of Science. Prior to the initiation of external research, a proposal from the student as well as a commitment of support and direction from the laboratory are evaluated. **Credit variable**

1023-879 Clinical Chemistry Research
Research carried out in the College of Science laboratories under the direction of RIT faculty members. The amount of credit awarded for such projects is determined after evaluation of a research proposal. **Credit variable**

1023-899 Clinical Chemistry: Independent Study
Individual projects or studies carried out under the direction of a faculty member. Study objectives and design are developed through faculty-student interaction with evaluation and credit to be awarded determined after review of a study proposal. **Credit variable**

1023-999 Clinical Chemistry Graduate Co-op
Cooperative work experience for MS clinical chemistry students. Credit 0

Materials Science and Engineering

1028-701 Introduction to Materials Science
The course provides an understanding of the relationship between structure and properties for development of new materials. Topics include atomic and crystal structure, crystalline defects, diffusion theories, strengthening mechanisms, ferrous alloys, cast irons, structure of ceramic and polymeric materials, and corrosion principles. (Graduate standing or permission of instructor) **Class 4, Credit 4 (F)**

1028-702 Introduction to Polymer Science
A study of the chemical nature of plastics detailing the relationships between polymerization conditions, structure and properties in both the solid and fluid states. **Class 4, Credit 4 (W)**

1028-703 Solid State Science
Survey of topics in the physics of solids. Included are crystal symmetry, structure and binding; mechanical, thermal, and electrical properties of insulators, semiconductors and conductors, including band theory. **Class 4, Credit 4 (W)**

1028-704 Introduction to Theoretical Methods
Treatment of waves and fields; selected topics of interest in electrodynamics and fluid mechanics; statistical mechanics; Maxwell Boltzmann, Bose-Einstein and Fermi-Dirac distributions, and their applications. (Graduate standing or permission of instructor) **Class 4, Credit 4 (F)**

1028-705 Introduction to Experimental Techniques
Introduction to laboratory equipment for hardness testing, impact testing, tensile testing, x-ray diffraction, and thermal treatment of metallic materials. Experiments illustrating the characterization of high molecular weight organic polymers are conducted. **Class variable, Lab variable, Credit 4 (S)**

1028-706 Experimental Techniques: Thin Films
Production of thin films of metals and dielectrics by physical vapor deposition. Lectures cover vacuum systems, evaporation, sputtering, nucleation and growth of thin films, analysis and characterization of thin films, and application of thin films. Laboratories cover use of vacuum systems in evaporation and sputtering and some methods of characterizing the thin films thus produced. (Permission of instructor) **Class variable, Lab variable, Credit 4**

1028-707 Experimental Techniques: Microscopy and Spectroscopy
An in-depth look at various techniques used to characterize thin film materials. Lectures will cover resistivity measurements, ellipsometry, reflectance techniques, optical microscopy, electron microscopy, and scanning probe microscopy. The lab provides hands-on training in these techniques and is conducted in the cleanroom housed in the Center for Microelectronic Engineering. Students will be required to perform an in-depth study on a material of their choice using these techniques or to research an associated technique not covered in lecture. (Permission of instructor) **Class variable, Lab variable, Credit 4**

1028-708 Experimental Techniques
Provides an in-depth integrated approach to the analysis, investigation and development of materials, concentrating on specific types or classes. (1028-701 or equivalent) **Class variable, Lab variable, Credit 4**

1028-710 Material Properties and Selections
Study of the principles of material behavior as applied to design. Application of materials according to these principles is stressed. Ferrous, nonferrous, and nonmetallic materials are considered. (1028-701 or equivalent) **Class 4, Credit 4**

1028-714 Glass Science
Topics include the structure and properties of glass, applied areas such as glass melting and processing, and various technological applications of glass. (1028-701 or equivalent; 1028-704) **Class 4, Credit 4**

1028-717 Material Degradation: Corrosion
This course introduces the basic electrochemical nature of corrosion and considers the various factors that influence the rate of corrosion in a variety of environments. Various means of controlling corrosion are considered. (1028-701 or equivalent) **Class 4, Credit 4**

1028-720 Organic Polymers
Meets the needs of students in the area of organic chemistry related to synthesis, polymerization mechanism, structures, stereochemistry of reactions of organic polymers and their industrial usage. (1028-702 or equivalent) **Class 4, Credit 4**

1028-721 Physical Chemistry of Polymers
A study of the theoretical and experimental methods available for designing plastics products and selecting appropriate materials, with special emphasis on the interrelationships between materials, product design, tooling construction, and manufacturing producibility. (1028-702 or equivalent) **Class 4, Credit 4**

1028-722 Polymer Processing
A study of the basic principles and methods involved in the technology of processing polymeric materials, including treatments of heat transfer, mass transfer, and mixing and shaping or molding of these materials. (1028-702 or equivalent) **Class 4, Credit 4**

1028-730 Optical Properties of Materials
Fundamentals of geometrical and physical optics, interaction of radiation with matter, dielectrics and thin films, introduction to electro-optic and acousto-optic effects. (1028-704 or equivalent) **Class 4, Credit 4**

1028-733 Magnetic Properties of Materials
Magnetostatics, creation and measurement of magnetic fields, galvano-magnetic and magneto-optic effects, magnetic materials, applications. (1028-701 and 704 or equivalent) **Class 4, Credit 4**

1028-734 Advanced Optics
Lasers: theory, types and construction; optics of metals; multilayer dielectrics; electro- and acousto-optic modulators and deflectors; optical detectors. (1028-730 or equivalent) **Class 4, Credit 4**

1028-736 Amorphous and Semicrystalline Materials
Electrical, thermal, and optical properties of amorphous materials; model of conduction. (1028-701, 703, 704 or equivalents) **Class 4, Credit 4**

1028-740 Nuclear Science and Engineering
Systemics of the atomic nuclei, radioactivity, nuclear reactions, fission, nuclear reactor principles, designs, materials, and safety. (1028-701 and 704 or permission of instructor) **Class 4, Credit 4**

1028-760 Plasma Science
An introduction to plasma science; a study of the basic phenomena and application of plasma to etching, deposition, polymerization, plasma production of materials, analytical emission spectroscopy, and atmospheric science. (1028-701 or equivalent) **Class 4, Credit 4**

1028-770 Physics and Chemistry of IC Processes
Study of the various processing steps used in integrated circuit fabrication technology with special emphasis on diffusion, thermal oxidation, ion implantation and plasma-assisted deposition, and etching processes. Process modeling using SUPREM. (1028-703 or permission of instructor) **Class 4, Credit 4**

1028-780 **Theory of Microsensors and Actuators**
This course gives a broad background to the theory and development of sensors at the molecular and ionic levels. The mechanistic details of operation of the sensors and actuators limited to selected examples will be considered. Fundamental aspects related to chemical, biochemical, piezo resistive, magnetic, thermal and luminescent sensors will be discussed with an orientation towards development of innovative products. Control systems based on ion selectivity for biomedical applications will be dealt with rigorously. Special topics to be covered will be neurotransmitters, neural network and directional selectivity using conducting polymers. (Permission of instructor) **Class 4, Credit 4 (F, W)**

\1028-800 **Special Topics**
In addition to in-depth study of any of the courses listed under Elective Courses, special topics may be selected from such areas as elastomers, organometallics, radiation damage, processing of materials, superconductivity, sensors, and actuators, etc. (Permission of instructor) **Class variable, Credit 4**

1028-877 **External Research**
Research using equipment and facilities at a site other than RIT. Prior to enrollment in the course, a proposal from the student that includes a letter of support from the host facility is evaluated for determination of credit to be awarded upon successful completion of the project. A total of 8 quarter credit hours, with a maximum of 4 quarter credit hours per quarter, can be applied toward the MS degree. For matriculated MSE students employed full time by local companies. (Permission of program director) **Credit variable**

1028-879 **Research and Thesis Guidance**
A project involving research on a topic in materials science and engineering. An oral examination and written thesis are required. **Credit variable**

1028-890 **Seminar**
Required for completion of the program and involves a one-hour presentation on some topic in materials science in engineering. **Class variable, Credit 1 (F, S)**

1028-899 **Independent Study**
This course number should be used by students wishing to study a topic on an independent study basis. (Permission of instructor) **Credit variable**

1028-999 **Materials Science Graduate Co-op**

Color Science

1050-702 **Applied Colorimetry**
This course covers the principles of color science including theory and application. Topics include CIE colorimetry, the use of linear algebra for color transformations, color order systems, color measurement including spectral sensitivity optimization, metamerism, color inconstancy, history and theory of color tolerance equations and spaces, and an overview of color management. (Graduate status in Color Science or permission of instructor) **Class 4, Credit 4 (F)**

1050-703 **Color Appearance**
This course is for students who have an understanding of the applications of colorimetry. It presents the transition from the measurement of color patches and differences to the description and measurement of color appearance. This seminar course is based mainly on review and discussion of primary references. Topics include appearance terminology, appearance phenomena, viewing conditions, chromatic adaptation and color appearance modeling. (1050-701, 702) **Class 3, Credit 3 (W)**

1050-704 **Computing for Color Science**
This course explores the computational techniques and methods needed to conduct research in color science. Lectures will introduce students to programming in MATLAB and will specifically address: manipulation of instrumental data, image processing, data analysis and optimization techniques, 2D and 3D graphics, user interface design, color management, and psychophysical experimentation. Programming assignments will reinforce lecture concepts and will provide the students with a library of color science functions to use in their course work and research. (Graduate status in Color Science or permission of instructor) **Class 4, Credit 4 (F)**

1050-721 **Color Measurement Laboratory I**
This course is the first part of a two-course sequence in which students develop the background and skills required for successful laboratory practice for color science research including data management and analysis, technical writing, and basic programming. Topics include the instrumentation and standardization required for high quality optical radiation measurements, analysis techniques for determining the accuracy and precision of those measurements, the optical properties of objects and radiation, optical and electronic design of spectroradiometric and spectrophotometric instrumentation, the use of standard reference materials for calibration, and evaluation of instrumentation and psychophysical experimentation. (1050-702) **Class 1, Lab 3, Credit 3 (W)**

1050-722 **Color Measurement Laboratory II**
This course is the second part of a two-quarter sequence in which students develop the background and skills required for successful laboratory practice for color science research including data management and analysis, technical writing, and basic programming. The focus of this course is on psychophysical methods in color science. Topics include: display characterization and control; stimulus presentation; data collection/analysis; methods for determining visual contrast sensitivity; color difference and corresponding color psychophysics; and measurement of observer metamerism. (1050-721) **Class 1, Lab 3, Credit 3 (S)**

1050-751 **Special Topics**
Advanced topics of current interest, varying from quarter to quarter, selected from the field of color science. Specific topics announced in advance. (Not offered every quarter. Consult the color science graduate program coordinator.) **Credit variable**

1050-752 **Special Topics**
Advanced topics of current interest, varying from quarter to quarter, selected from the field of color science. Specific topics announced in advance. (Not offered every quarter. Consult the color science graduate program coordinator.) **Credit variable**

1050-753 **Special Topics**
Advanced topics of current interest, varying from quarter to quarter, selected from the field of color science. Specific topics announced in advance. (Not offered every quarter. Consult the color science graduate program coordinator.) **Credit variable**

1050-799 **Independent Study**
An independent project in an area of color science not covered in the available courses. This project can be experimental research, literature review, or other appropriate work. This course requires a formal proposal and a faculty sponsor. **Credit variable**

1050-801 **Color Science Seminar**
A seminar course in which students will study the literature in particular areas of color science and present that material to the class. Topics will be based on student interest and current issues in the field. May be taken more than once for credit with permission of coordinator. (Graduate status in Color Science or permission of instructor) **Class 1, Credit 1 (F, W, S)**

1050-813 **Color Modeling**
This course explores mathematical techniques for predicting the spectral and colorimetric properties of colored materials and images from user-controlled drive signals. Color systems that are modeled include paint, computer-controlled LCD and projector, continuous and halftone printing, and spectral cameras. Accompanying laboratory stresses the use of multivariate statistics, nonlinear optimization, and technical writing. Final laboratory consists of spectral-based color reproduction system including input, display, and printed output. (1050-702, 721, corequisite 1050-722) **Class 4, Credit 4 (S)**

1050-840 **Color Science MS Project**
An independent project in an area of color science that serves as the major culminating experience for students in the Graduate Project Option of the color science MS program. This project can be an experiment, critical literature review, demonstration or other appropriate work. This course requires a formal proposal and faculty sponsor; a written technical report and oral presentation of the results. **Credit 4**

1050-890 **Research and Thesis**
Thesis based on experimental evidence obtained by the candidate in an appropriate topic as arranged between the candidate and the coordinator of the program. **Credit variable** (minimum of 9 credits for MS)

1050-999 **Color Science Co-op**
Cooperative work experience for graduate color science students. **Credit 0**

Imaging Science

1051-706 Introduction to Imaging Science Research
This course is focused on familiarizing students with research activities in the Carlson Center, research practices in the university, research environment and policies and procedures impacting graduate students. The course is coupled with the research seminar sponsored by the Center for Imaging Science (usually weekly presentations). The students are expected to attend and participate in the seminar as part of the course. The course will also address issues and practices associated with technical presentation and technical writing. Credits earned in this course apply to research requirements. **Class 1, Credit 1 (F)**

1051-707 Introduction to Imaging Science Research
This course is focused on familiarizing students with research activities in the Carlson Center, research practices in the university, research environment and policies and procedures impacting graduate students. This course is coupled with the research seminar sponsored by the Center for Imaging Science (usually weekly presentations). Students are expected to attend and participate in the seminar as part of the course. The course will also address issues and practices associated with technical presentation and technical writing. Credits earned in this course apply to research requirements. **Class 1, Credit 1 (W)**

1051-708 Introduction to Imaging Science Research
This course is focused on familiarizing students with research activities in the Carlson Center, research practices in the university, research environment and policies and procedures impacting graduate students. The course is coupled with the research seminar sponsored by the Center for Imaging Science (usually weekly presentations). Students are expected to attend and participate in the seminar as part of the course. The course also addresses issues and practices associated with technical presentation and technical writing. Credits earned in this course apply to research requirements. **Class 1, Credit 1 (S)**

1051-713 Probability, Noise, and System Modeling
The purpose of this course is to develop an understanding and ability in modeling noise and random processes within the context of imaging systems. The focus will be on stationary random processes in both one dimension (time) and two dimensions (spatial). Power spectrum estimation will be developed and applied to signal characterization in the frequency domain. The effect of linear filtering will be modeled and applied to signal detection and maximization of SNR. The matched filter and the Wiener filter will be developed. Signal detection and amplification will be modeled, using noise figure and SNR as measures of system quality. At completion of the course, the student should have the ability to model signals and noise within imaging systems. Also offered online. (1051-716, 718, 719 or permission of instructor) **Class 4, Credit 4 (S)**

1051-716 Fourier Methods for Imaging
This course develops the mathematical methods required to describe continuous linear systems, with special emphasis on tasks required in the analysis or synthesis of imaging systems. The classification of systems as linear/nonlinear and shift variant/invariant is discussed first, followed by development and use of the convolution integral, and by a discussion of Fourier methods as applied to the analysis of linear systems, including the Fourier series and Fourier transform. Emphasis is placed on the physical meaning and interpretation of these transform methods. Within the context of image analysis, imaging systems as a linear filter, image enhancement and information extraction, and several basic image processing techniques are also introduced. Also offered online. (Graduate standing in a science or engineering program or permission of instructor) **Class 4, Credit 4 (F)**

1051-718 Digital Imaging Mathematics
This course provides a basic understanding of imaging systems, image transformations and associated mathematics and computational processes needed for upper-level classes in the imaging science graduate program. Topics covered include: camera models; image projections and rectification; image statistics and point processing; linear and nonlinear image filters; image transforms; image mathematics; and computer algorithms. Some laboratory experiments are included. Also offered online. (1051-716) **Class 4, Credit 4 (W)**

1051-719 Radiometry
This course is focused on the fundamentals of radiation propagation as it relates to making quantitative measurements with imaging systems. It includes an introduction to common radiometric terms and derivation of governing equations with an emphasis on radiation propagation in both non-intervening and turbid media; and an introduction to detector figures of merit and noise concepts. Includes some laboratory experiments. Also offered online.(Graduate standing in a science or engineering program, or permission of instructor) **Class 4, Credit 4 (F)**

1051-720 The Human Visual System
This course describes the underlying structure of the human visual system and the psychophysical techniques used to measure its performance. The visual system's optical and neural systems responsible for collecting and detecting spatial, temporal, and spectral signals from the environment are described. The sources and extent of limitations in the subsystems are described and discussed in terms of the "enabling limitations" that allow practical imaging systems. Some laboratory/homework projects are included. Also offered online. (Graduate standing in a science or engineering program, or permission of instructor) **Class 4, Credit 4 (F)**

1051-724 Introduction to Microscopy Using Light, Electrons and Scanning Probes
This is the first course in a three-quarter microscopy sequence. The purpose of this course is to give the student an overview of the various modes of microscopy for the study of materials. The first part of the course will focus on various modes of light microscopy. The bulk of the course will be devoted to electron microscopy, with the final part of the course devoted to scanning tunneling and atomic force microscopy. Demonstrations will be held in the Nano Imaging Lab to reinforce the lecture material. (Graduate student standing in science or engineering, or permission of instructor) **Class 4, Credit 4 (W)**

1051-728 Design and Fabrication of Solid State Cameras
The purpose of this course is to provide the student with hands-on experience in building a CCD camera. The course provides the basics of CCD operation including an overview, CCD clocking, analog output circuitry, cooling, and evaluation criteria. **Class 1.5, Lab 7.5, Credit 4 (W)**

1051-730 Magnetic Resonance Imaging
This course is an introduction to the principles of magnetic resonance imaging (MRI). The course covers spin physics, Fourier transforms, basic imaging principles, Fourier imaging, imaging hardware, imaging techniques, image processing, image artifacts, safety and advanced imaging techniques. Also offered online. (1016-305 or equivalent and one of the following: 1008-311, or equivalent; 1014-442, or equivalent; 1017-313, or equivalent; or permission of instructor) **Class 4, Credit 4 (S-X*)**

1051-733 Optics
This course will provide the requisite introductory knowledge in optics needed by a student in the graduate program in imaging science. The course will cover geometrical optics; wave nature of light, the Fresnel equations, interference and diffraction, and resolution of imaging systems. Some laboratory experiments are included. Also offered online. (1051-716, 719) **Class 4, Credit 4 (W)**

1051-736 Geometrical Optics and Lens Design
This course leads to a thorough understanding of the geometrical properties of optical imaging systems and detailed procedures for designing any major lens system. Automatic lens design, merit functions and optimization are applied to real design problems. The course will utilize a modern optical design program to illustrate the design process for various lenses and imaging systems. Also offered online. (1051-733) **Class 4, Credit 4 (F)**

1051-737 Physical Optics
The wave properties of light and their application to imaging systems and metrology. Polarization, birefringence, interference and interferometers, spatial and temporal coherence, scalar diffraction theory are covered. (1051-716) **Class 4, Credit 4 (Upon sufficient demand)**

1051-739 Principles of Solid State Imaging
This course covers the basics of solid state physics, electrical engineering, linear systems and imaging needed to understand modern focal plane array design and use. The course emphasizes knowledge of the working of infrared arrays. (Optics, Linear Systems) **Class 4, Credit 4 (F)**

1051-742 Testing of Focal Plane Arrays
An introduction to the techniques used for the testing of solid state imaging detectors such as CCDs, CMOS and Infrared Arrays is provided. Focal plane array users in industry, government and university need to ensure that key operating parameters for such devices either fall within an operating range or that the limitation to the performance is understood. This is a hands-on course where the students will measure the performance parameters of a particular camera in detail. While this course can be taken individually, students will obtain maximum educational value by taking it as the third part of a sequence of imaging science courses preceded by 1051-739 Principles of Solid State Imaging Arrays and then 1051-728 Design and Fabrication of a Solid State Camera. (Graduate status in imaging science or permission of instructor) **Class 2, Lab 6, Credit 4 (S)**

1051-743 Fundamentals of Radiation-Matter Interactions
This is the first course in a three-quarter sequence on the interactions between radiation and matter. The purpose of this course is to present an overview of the many interaction mechanisms involving electromagnetic radiation, charged particles, and neutrons with material systems. The course introduces both classical and basic quantum treatments of these interactions. Topics include the dispersion, scattering, absorption, and emission of electromagnetic radiation by atoms and molecules, the scattering of light by small particles, the concept of a cross-section, mechanism of energy loss by charged particles, the attenuation of different types of radiation, and a brief introduction to how x-rays and neutrons can be used to probe the structure of materials. (Graduate status in science or engineering, or permission of instructor) **Class 4, Credit 4 (S, alternate years)**

1051-749 Color Reproduction
This course presents the concepts required for an understanding of the relationships between mean-level input and output in various color imaging systems. Analog, digital, and hybrid color imaging systems will be covered. Special emphasis will be given to mean-level reproduction in photography, printing, and television. Offered online alternate odd years. Next offering 2011. (Graduate status in imaging science or color science, or permission of instructor) **(W, alternate years)**

1051-753 Special Topics: Imaging Science
Advanced topics of current interest, varying from quarter to quarter, selected from the field of imaging science. Specific topics announced in advanced. (Not offered every quarter. For more information see www.cis.rit.edu/node/309 or consult the imaging science graduate program coordinator.) **Credit variable**

1051-759 Elements of Photogrammetry I
The course will introduce the basic fundamentals essential to describing photogrammetry and its uses for deriving point positions, 3-D coordinates, digital elevation models, image maps, and topographic maps from airborne or space borne imaging systems. It will cover the geometry of film and digital cameras, calibration of cameras, image measurements and refinements such as atmospheric refraction, distortion corrections, image measurements, and transformation of coordinates. Derivation and use of collinearity equations are emphasized to demonstrate their applicability to ground surveyed coordinates, global positioning systems, and inertial management units for positioning and orientation of the camera images for aerial triangulation and least squares adjustments. (1016-273, 1016-331, and 1016-319 or equivalent or permission of instructor) **Class 4, Credit 4 (W or S)**

1051-762 Remote Sensing: Sensors, Radiometric Image Analysis
Introduction to the governing equations for radiance reaching an aerial or satellite based imaging system, covering the properties of these imaging systems with an emphasis on their use as quantitative scientific instruments. Methods for inverting the remotely sensed image data using the governing radiometric equation are assessed. Multidimensional image analysis (e.g. multispectral, polarimetric, multidate) is emphasized and includes issues such as image registration to support image analysis. Parameters and processes governing spatial, spectral and radiometric image fidelity are studied with an emphasis on how each step in the image chain impacts the final image or image product. Also offered online.(1051-719) **Class 4, Credit 4 (W)**

1051-763 Remote Sensing: Spectral Image Analysis
This course is focused on analysis of high dimensional remotely sensed data sets. A review of the properties of matter that control the spectral nature of reflected and emitted energy is followed by analysis of image noise characterization and mitigation, radiometric calibration, atmospheric compensation and dimensionality characterization and reduction. The remainder of the course focuses on spectral image analysis algorithms employing the three conceptual approaches to characterizing the data for image segmentation, subpixel detection and pixel unmixing, and target detection. The analysis methods include treatment of signal processing theory and application and incorporation of physics based algorithms into spectral image analysis. Also offered online. (1051-719 and 1051-762)**Class 4, Credit 4 (S)**

1051-765 Remote Sensing Systems
This course is designed to draw on the student's knowledge of linear system theory, digital image processing, and noise concepts and apply it to an end-to-end system in an area associated with remote sensing. Generalized concepts from these fields will be focused to show how they can be applied to solve remote sensing image analysis and systems design and evaluation problems. An overriding objective is on the application of theory to practice. (Permission of instructor) **Credit 4**

1051-769 Spectral Methods and Instrumentation
This course examines methods and instrumentation for spectral sensing as applied to earth observation. Spectral dispersion and selection methods, with an emphasis on gratings, will be studied. The data collection and analysis procedures for spectral and radiometric calibration of a field spectroradiometer and an airborne spectral imager will be performed by the students in a research laboratory setting. Other methods and practices in spectral instrumentation for both passive and active sensing across the electromagnetic spectrum will be described. (1051-719 or permission of instructor) **Class 4, Credit 4 (offered upon demand)**

1051-775 Applied Colorimetry
This course covers the principles of color science including theory and application. Topics include CIE colorimetry, the use of linear algebra for color transformations, color order systems, color measurement including spectral sensitivity optimization, metamerism, color inconstancy, history and theory of color tolerance equations and spaces, and an overview of color management. (Graduate status in CIS or permission of instructor) Also offered online. **Class 4, Credit 4 (F)**

1051-776 Color Modeling
This course explores mathematical techniques for predicting the spectral and colorimetric properties of colored materials and images from user-controlled drive signals. Color systems that are modeled include paint, computer-controlled LCD, continuous and halftone printing, and spectral cameras. Accompanying laboratory stresses the use of multivariate statistics, nonlinear optimization, and technical writing. Final laboratory consists of a spectral-based color reproduction system including input, display, and printed output. (1051-775) **Class 4, Credit 4 (S)**

1051-779 Astronomical Instrumentation and Techniques
This course provides an in-depth look at various pieces of instrumentation used in many low light imaging applications with emphasis on astronomical requirements. Aspects of hardware, systems analysis, and performance calculation will be covered. **Class 4, Credit 4 (offered occasionally)**

1051-782 Digital Image Processing
This course follows up on concepts introduced in 1051-718 Digital Imaging Mathematics. Topics covered include linear vector spaces, image mathematics, image statistics and point processing, linear and nonlinear image filters, image transforms and computer algorithms. Computational methods and techniques for essential processes for imaging systems are used as the course framework. Also offered online. (1051-718 or permission of instructor) **Class 4, Credit 4 (S)**

1051-784 Pattern Recognition
This course develops a fundamental understanding of adaptive pattern recognition and a basic working knowledge of techniques for use in a broad range of applications. Inherent in adaptive pattern recognition is the ability of the system to learn by supervised or unsupervised training, or by competition within a changing environment. The effectiveness of the system depends upon it structure, adaptive properties and specifics of the application. Particular structures developed and analyzed include Bayes decision theory, parametric and nonparametric techniques, multilayer perceptrons and unsupervised clustering methods. The goal is to gain both a fundamental and working knowledge of each kind of technique and the ability to select the most appropriate one when faced with a real application design. Also offered online. (1051-716, 718, 726, and 0304-834 or equivalent) **Class 4, Credit 4 (S, alternate years)**

1051-786 Advanced Digital Image Processing
This course investigates algorithms and techniques for a variety of imaging applications. The techniques build on the background that is established in the course 1051-782 Introduction to Digital Image Processing, which focuses on basic image processing methods. The course is taught using a lecture and group project format, in which the lectures focus on advanced techniques and provide applications of their use in selected applications. The group projects enable students to work on substantial designs that require the understanding of the task domain, exploration of solution methods by analysis and prototyping, and implementation of a selected approach. Each team presents a preliminary plan, an approach with feasibility analysis, and a final demonstration. (1051-726, 1051-782 or permission of instructor) **Class 4, Credit 4 (offered alternate years) (F)**

1051-790 Image Rendering
This course covers the fundamental principles of computer image synthesis with a focus on rendering techniques. Topics include geometric scene specification, shading (e.g., flat, Gouraud, Phong), and global illumination rendering (e.g., ray tracing, radiosity). Commercial software such as OpenGL and Radiance will be briefly described. Lastly, the design, advantages and limitations of modern computer graphics hardware are discussed. Students implement fundamental computer graphics techniques and produce images using IDL (or similar) environment. (Graduate status CIS or permission of instructor, 1051-726 or equivalent, Matrix Algebra) **Class 4, Credit 4 (offered occasionally)**

1051-797 Principles of Computed Tomographic Imaging
Image reconstruction from projections is introduced as a mathematical problem. Technique for reconstruction via Fourier domain is explained using Fourier slice theorem. Simple and Filtered Backprojection and iterative methods are analyzed. Algorithms for various techniques are developed and artifacts and noise in discrete case are considered. Applications to several medical imaging modalities are outlined, with brief consideration of the physics of imaging involved in each case. **Class 4, Credit 4 (S)**

1051-799 Independent Study
An independent project in an area of imaging science not covered in the available courses. This project can be experimental research, literature review, or other appropriate work. This course requires a formal proposal and a faculty sponsor. **Credit variable**

1051-812 Medical Imaging Systems
This is an advanced graduate level course that describes existing medical imaging systems in terms familiar to imaging scientists and electrical engineers. These include impulse response, the transfer functions, and the signal to noise ratio. The course considers in detail, four different imaging modalities: conventional projection X-ray, CT, ultrasonic imaging, and magnetic resonance imaging. A complete system is examined piece by piece in terms of subsystems. **Class 4, Credit 4 (W)**

1051-816 Color Systems
This course builds on the theory and concepts presented in the Color Reproduction and Color Modeling courses to cover the key techniques utilized in device-independent color imaging systems. Topics covered include: device calibration and characterization (input, output, display), device profiles, multidimensional look-up table construction, inversion, and interpolation, gamut mapping, appearance matching, and color-management systems. Also offered online. (1051-775 or permission of instructor) **Class 4, Credit 4**

1051-840 MS Project Paper
The analysis and solution of Imaging Science Systems problems for students enrolled in Systems Capstone option. **Credit 1**

1051-890 Research and Thesis
Thesis (MS) or dissertation (Ph.D.) based on experimental data obtained by the candidate for an appropriate topic as arranged between the candidate and the research adviser. **Credit variable**

1051-999 Imaging Science Graduate Co-op
Cooperative work experience for graduate imaging science students. **Credit 0**

Astrophysical Sciences and Technology

1060-701 Astrophysical Sciences Graduate Seminar I
This course is focused on familiarizing students with research activities and practices in the university research environment as well as policies and procedures impacting graduate students. The course is coupled with the research seminar sponsored by the Astrophysical Sciences and Technology Program (usually weekly presentations). The students are expected to attend and participate in the seminar as part of the course. The course will also address issues and practices associated with technical presentation and technical writing. Credits earned in this course apply to research requirements. (Graduate standing in Astrophysical Sciences and Technology) **Class 1, Credit 1 (F)**

1060-702 Astrophysical Sciences Graduate Seminar II
This course is focused on familiarizing students with research activities in the Astrophysical Sciences and Technology, research practices in the university research environment and policies and procedures impacting graduate students. This course is coupled with the research seminar sponsored by the Astrophysical Sciences and Technology graduate program (usually weekly presentations). Students are expected to attend and participate in the seminar as part of the course. The course will also address issues and practices associated with technical presentation and technical writing. Credits earned in this course apply to research requirements. (Graduate standing in Astrophysical Sciences and Technology) **Class 1, Credit 1 (W)**

1060-703 Astrophysical Science Graduate Seminar III
This course is focused on familiarizing students with research activities in Astrophysical Science and Technology, research practices in the university, research environment and policies and procedures impacting graduate students. The course is coupled with the research seminar sponsored by the Astrophysical Sciences and Technology Graduate Program (usually weekly presentations). Students are expected to attend and participate in the seminar as part of the course. The course also addresses issues and practices associated with technical presentation and technical writing. Credits earned in this course apply to research requirements. (Graduate standing in Astrophysical Sciences and Technology) **Class 1, Credit 1 (S)**

1060-710 Mathematical and Statistical Methods for Astrophysics
This course provides an introduction to the applied mathematical and statistical tools used frequently in astrophysics ° including data reduction and analysis and computational astrophysics. Topics will include numerical methods, probability and statistics, frequency domain analysis. (Graduate standing in a science or engineering program or permission of instructor) **Class 4, Credit 4 (F)**

1060-711 Astronomical Observational Techniques and Instrumentation
This course will survey multiwavelength astronomical observing techniques and instrumentation. Students will gain an understanding of how the telescopes, detectors, and instrumentation in the major ground based and space based observatories function and how to use them. Observatories to be studied may include the Very Large Array, GBT, ALMA, Spitzer, HST, Gemini, JWST, and Chandra. Students will plan and carry out a multiwavelength archival program on a topic of their choice. (Graduate standing in a science or engineering program or permission of instructor) **Class 4, Credit 4 (S)**

1060-712 Astronomical Systems
This is a practical course that will teach students the requisite knowledge needed to design and fabricate modern astronomical instrumentation systems. It would be useful for those who are interested in either fabricating or using such instruments. The course will cover aspects of optical design, electronics design, mechanical design, computer control, and project management, Knowledge of the performance of the individual components making up the system will be required as will their interplay with each other. The specific measurement challenge will vary from year to year but may include designing a fiber-fed imaging spectrometer, a sub millimeter detector system, or an infrared camera. **Class 4, Credit 4**

1060-714 Computational Methods in Astrophysics I
This course surveys the different ways that scientists use computers to address problems in astrophysics. The course will choose several common problems (time-series analysis, N-body simulations, etc.); for each one, it will provide an introduction to the problem, review the literature for recent examples, and illustrate the basic mathematical technique. In each of these segments, students will write their own code in an appropriate language. **Class 4, Credit 4**

1060-715 Computational Methods in Astrophysics II
This course is the second part of a two quarter series. This course continues to explore the methods scientists use to study problems in astrophysics which cannot be solved analytically. The first half of the course will introduce the student to new techniques (adaptive mesh, smoothed particle hydrodynamics, etc.) which do not appear in the first course (Computational Methods in Astrophysics I). In the second half of the course, students will plan and execute a large software project, more detailed and sophisticated than those small projects done in the first course. **Class 4, Credit 4**

1060-720 Stellar Structure and Evolution I
An overview of the physical principles governing the internal structures and energy generation mechanisms of stars, as well as brief introductions to the processes of star formation and the late stages of stellar evolution. Topics covered include: static stellar structure; stellar energy generation and transport; simple stellar atmospheres; characteristic timescales for and stages of stellar formation and evolution; the transition from main-sequence star to red giant and stellar remnant. (Graduate standing in a science or engineering program or permission of instructor) **Class 4, Credit 4 (W)**

1060-721 Stellar Structure and Evolution II
The second of a two-course sequence concerning the internal structures and temporal evolution of stars. Topics covered include: stellar pulsation and mass loss; binary star systems; protostellar contraction, accretion, and outflow; planetary nebulae and supernovae; degenerate stars. (1060-720) **Class 4, Credit 4**

1060-730 Radiative Processes I
This course will survey the emission mechanisms which produce radiation in astrophysical environments, including thermal bremstrahlung, synchrotron, comptonization, and pair production. (Graduate standing in a science or engineering program or permission of instructor) **Class 4, Credit 4 (F)**

1060-731 Radiative Processes II
This course is the second quarter of a two quarter sequence. This course will survey the emission mechanisms which produce radiation in astrophysical environments, including atomic and molecular line emission; and the process which scatter radiation, e.g., Thompson, Raleigh, and Mie scattering. (1060-730) **Class 4, Credit 4**

1060-732 High Energy Astrophysics I
This course will survey violent astrophysical phenomena including supernovae, X-ray binaries, active galactic nuclei and gamma ray bursts. It will examine physical processes associated with the emission of high-energy radiation, with the production of high energy particles, with accretion discs around compact objects and with the production and propagation of astrophysical jets. It will review current models for the sources of high-energy phenomena. Emphasis will be placed on current models for active galactic nuclei, which produce a wide range of high-energy phenomena. **Class 4, Credit 4**

1060-733 High Energy Astrophysics II
This course is the second in a two quarter sequence. This course will survey the properties Active Galactic Nuclei (AGN) including distances, luminosities and size scales; observational classification; the central engine. Standard black-hole model; AGN accretion disks; the Eddington limit; evidence for supermassive black holes; continuum emission; radio sources; broad emission lines; unification theories; lifecycles of AGN. **Class 4, Credit 4**

1060-740 Galactic Astrophysics and the Interstellar Medium I
First course in a two-course sequence on Galactic Astrophysics and the Interstellar Medium. This course will cover stellar and galactic dynamics with special application to the Milky Way galaxy. Topics will include theory of orbits; Jeans's theorem and equilibrium of stellar systems; the virial theorem; the Jeans equations; gravitational instabilities; structure and kinematics of the Milky Way. (Graduate standing in a science or engineering program or permission of instructor) **Class 4, Credit 4 (W)**

1060-741 Galactic Astrophysics and the Interstellar Medium II
Second course in a two-course sequence on Galactic Astrophysics and the Interstellar Medium. This course will cover the structure and energetics of the interstellar medium (ISM), with special application to the Milky Way galaxy. Topics will include properties of the ISM; molecular clouds and cloud cores; HII regions; outflows and shock waves; dust. (1060-740) **Class 4, Credit 4**

1060-750 Extragalactic Astrophysics I
First course in a two-course sequence on extragalactic astrophysics. Topics in this first course are the properties of galaxies, the formation and evolution of galaxies, and the intergalactic medium. (Graduate standing in a science or engineering program or permission of instructor) **Class 4, Credit 4 (S)**

1060-751 Extragalactic Astrophysics II
Second course in a two-course sequence on extragalactic astrophysics. Topics in this course are the properties of clusters of galaxies, the formation and evolution of clusters, the intracluster medium, and activity in galaxies. (1060-751) **Class 4, Credit 4**

1060-752 Cosmology I
First course in a two-course sequence on cosmology. The course will present the foundations of cosmology, including the cosmological principle and its consequences, Newtonian cosmology, and types of universes. **Class 4, Credit 4**

1060-753 Cosmology II
Second course in a two-course sequence on cosmology. This will present the studies of the early universe and inflation; thermal evolution of the universe; nucleosynthesis; baryogenesis; cosmic microwave radiation; large scale structure and galaxy formation models; dark matter; current universe: dark energy and the cosmic acceleration. **Class 4, Credit 4**

1060-760 General Relativity I
This course is the first in a three course sequence that introduces Einstein's theory of general relativity as a tool in modern astrophysics. The course will cover various aspects of both special and general relativity, with applications to situations in which strong gravitational fields play a critical role, such as black holes and gravitational radiation. Topics include differential geometry, curved spacetime, gravitational waves, and the Schwarzschild black hole. (Graduate standing in a science, computer science, or engineering program and permission of instructor) **Class 4, Credit 4 (S)**

1060-761 General Relativity II
This course is the second in a three course sequence that introduces Einstein's theory of general relativity as a tool in modern astrophysics. The course will cover various aspects of general relativity, with applications to situations in which strong gravitational fields play a critical role, such as black holes and gravitational radiation. Topics include advanced differential geometry, generic black holes, energy production in black-hole physics, black-hole dynamics, introductory cosmology, and methods for solving the Einstein equations.(1060-760) **Class 4, Credit 4**

1060-762 Advanced Topics in General Relativity
This course is the third in a three course sequence on general relativity. The main topics include modern differential geometry applied to general relativity, including differential manifolds, geometrical descriptions of tensors, set theory, and differential forms and integration; techniques for solving the Einstein equations, such as the classic 3+1 and characteristic decompositions; and a brief survey of advanced topics, including Newman-Penrose formalism, singularity theorems, and asymptotic descriptions of spacetime. (1060-761) **Class 4, Credit 4 (F)**

1060-799 AST: Independent Study
An independent study in an area of astrophysical sciences and technology not covered in the available courses. This study may be reading study of an appropriate textbook, literature review, or other appropriate work. The course requires a formal proposal, faculty sponsor, and program approval. **Credit variable (1 to 4 credits)**

1060-890 Research and Thesis
Thesis (MS) or dissertation (Ph.D.) research by the candidate for an appropriate topic as arranged between the candidate and the research adviser. **Credit variable (0-6 credits)**

Golisano Institute for Sustainability

Nabil Nasr, Assistant Provost and Institute Director
www.sustainability.rit.edu/

Programs of study

The Golisano Institute for Sustainability is a comprehensive academic, training, and technology-transfer center focusing on multidisciplinary studies in sustainability and sustainable production systems.

The institute offers expertise in the areas of sustainable development and design combining real world experience with a strong academic and research programs. Areas of expertise include:

- Asset health management
- Material aging
- Modernization through remanufacturing and conversion
- Life-cycle engineering
- Reliability engineering
- Clean technologies
- Intelligent testing and diagnostics
- Design for remanufacture/design for the life cycle
- Value engineering
- Reverse logistics
- Asset recycle management
- Green product assessment

Admission requirements

The college offering the program makes all decisions on graduate admission. Please refer to each individual program for information regarding specific admission criteria. For general graduate admission information, please refer to the Admission section of this bulletin.

Financial aid and scholarships

Please refer to the Financial Aid and Scholarship section of this bulletin for information regarding financial aid, scholarships, grants, loans, and graduate assistantships.

Research

The Golisano Institute for Sustainability is home to six different research centers and institutes, each with a highly specific mission in sustainability.

- National Center for Remanufacturing and Resource Recovery is internationally recognized as a leading center for applied research in remanufacturing;
- Center for Sustainable Production is dedicated to enhancing the environmental and economic performance of products and processes;
- Center for Sustainable Mobility assesses and evaluates the environmental and economic impact of different alternative fuel and propulsion technologies on the entire U.S. public transportation system;
- Systems Modernization and Sustainment Center develops technology for optimal life-cycle design, management, and modernization of large equipment systems;
- New York State Pollution Prevention Institute enhances the understanding of pollution prevention techniques while disseminating technologies to enhance these efforts; and
- NanoPower Research Labs is dedicated to the creation and utilization of nano devices and materials for power generation and storage.

Facilities

The institute is housed in a 170,000-square-foot facility that provides easy access to six large manufacturing bays and 21 specialized labs featuring state-of-the-art equipment. The facility also includes a 10-room, 400-seat training and conference center with smart capabilities. Labs and facilities include:

- *Reliability Lab:* Focuses on testing the durability and reliability of components with the goal of enhancing the quality and performance of the entire system;
- *Materials Engineering Lab:* Provides analysis of how the physical and mechanical properties of components meet desired design characteristics;
- *Systems Performance and Reliability Lab:* Focuses on researching the life cycles of components and systems to properly understand and predict aging and wear while utilizing this data to enhance overall performance;
- *Integrated Diagnostics and Prognostics Lab:* Used to develop components, software, and integrated systems for the evaluation and implementation of diagnostics technology for in-the-field environments;
- *Imaging Products Laboratory:* Provides state-of-the-art evaluation and research to enhance the sustainability of imaging products and systems through improved testing procedures and the utilization of sustainable design capabilities;
- *Rapid Reverse Engineering Lab:* Equipped with instruments to accurately reconstruct missing product information to enable

new production, improve design, and enhance opportunities for remanufacturing and reuse;
- *Clean Technologies Demonstration Facility:* Features a wide variety of cleaning machines utilized for alternative cleaning testing and demonstration. Engineers utilize the equipment to develop and implement technologies that will prevent pollution and reduce costs to companies; and
- *Vehicle Integration Facility:* Features equipment related to the integration of sustainable design technologies into vehicle systems and includes equipment related to life cycle engineering, material restoration, and accelerated aging.

Sustainability, Ph.D.

http://www.sustainability.rit.edu/degree_info.html

Thomas W. Smith, Interim Academic Director
(585) 475-7982, twssch@rit.edu

Program overview

The doctorate program in sustainability is the first program in the world to focus on sustainable production systems. The program seeks to advance research and education in alternative-energy development, sustainable production, sustainable mobility, and eco-IT.

The program's curriculum emphasizes sustainable production systems, which create goods and services using processes that are non-polluting; conserving of energy and natural resources; economically viable; and safe for workers, communities, and consumers. Course work and research take a systems level and interdisciplinary approach to solving seemingly intractable sustainability problems.

Students in the program will have the opportunity to work with multidisciplinary faculty and researchers in numerous research centers, including the institute's National Center for Remanufacturing and Resource Recovery, the Center for Sustainable Production, the Center for Sustainable Mobility, the Systems Modernization and Sustainment Center, the New York State Pollution Prevention Institute, and the NanoPower Research Labs.

Curriculum

Students must complete a minimum of 60 credit hours of course work and a minimum of 27 credit hours of research to total 99 credit hours.

Core courses

5001-802	Fundamentals of Sustainability Science
5001-803	Economics of Sustainability
5001-804	Industrial Ecology
5001-805	Technology, Policy, and Sustainability
5001-806	Risk Analysis
5001-808	Multicriteria Sustainable Systems Analysis

Elective courses

Elective courses are selected in consultation with the student's adviser from a wide variety of courses offered by GIS or one of RIT's 10 colleges and institutes.

This program is available on campus only.

Admission requirements

To be considered for admission to the Ph.D. program in sustainability, candidates must fulfill the following requirements:
- Hold a baccalaureate degree from an accredited institution. (Course work must include at least one year of college science and one year of college mathematics including calculus and statistics);
- Submit scores from the Graduate Record Examination (GRE);
- Submit official transcipts (in English) from all previously completed undergraduate and graduate course work;
- Submit at least two letters of academic and/or professional recommendation;
- Participate in a personal interview with the faculty committee (by teleconference when necessary), and
- Complete a graduate application.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language. Minimum scores of 250 (computer-based), 600 (paper-based) or 100 (Internet-based) are required. International English Language Testing System (IELTS) scores will be accepted in place of the TOEFL. Minimum scores will vary, however, the absolute minimum score required for unconditional acceptance is 6.5. For additional information about the IELTS, please visit www.ielts.org.

Sustainable Systems, MS

http://www.sustainability.rit.edu/ms_degree.html

Paul Stiebitz, Associate Academic Director, Golisano Institute of Sustainability
(585) 475-2602, Paul.Stiebitz@rit.edu

Program overview

The MS degree in sustainable systems focuses on sustainable production systems, which create goods and services using processes that are non-polluting; conserving of energy and natural resources; economically viable; and safe and healthful for workers, communities, and consumers. Course work and research takes a systems level and interdisciplinary approach to solving sustainability problems, as opposed to single disciplinary and locally optimized approaches destined to yield marginally positive impacts.

Graduates of this program are prepared to pursue careers in their chosen fields with an understanding of basic sustainability principles and the expertise to analyze and solve complex sustainability issues. For example, students entering the program with a degree in information systems may go on to work in the eco-IT

field while students with an economics background may work in the area of life-cycle economic analysis of alternative energy systems.

Curriculum

Students must complete a minimum of 48 credit hours of combined course work and research. This includes a minimum of 40 credit hours of course work and 8 credit hours of thesis or research. Full-time students may complete the degree in 6 to 8 quarters.

There are six required courses:

5001-802	Fundamentals of Sustainability Science
5001-804	Industrial Ecology
5001-803	Economics of Sustainability
5001-805	Technology, Policy, and Sustainability
5001-806	Risk Analysis
5001-808	Multi-criteria Sustainable Systems Analysis

Elective courses, selected in consultation with the student's adviser, may come from a wide variety of courses offered by GIS or one of RIT's other colleges or institutes.

Currently, this program is available on-campus only.

Admission requirements

To be considered for admission to the MS program in sustainable systems, candidates must fulfill the following requirements:

- Hold a baccalaureate degree from an accredited college or university,
- Have fulfilled the following curriculum requirements: one year of college science and one year of college mathematics (including calculus and statistics),
- Have a minimum grade point average of 3.0,
- Participate in an interview with the academic department,
- Submit official transcripts (in English) of all previously completed undergraduate and graduate course work,
- Submit scores from the Graduate Record Exam (GRE),
- Submit two letters of reference,
- Submit a personal statement of educational objectives,
- Submit a current resume, and
- Complete a graduate application.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language (TOEFL). Minimum scores of 600 (paper-based), 250 (computer-based), or 100 (Internet-based) are required. International English Language Testing System (IELTS) scores will be accepted in place of the TOEFL exam. The minimum acceptable score is 6.5.

Additional information

Non-matriculated students

An applicant with a bachelor's degree from an approved undergraduate institution and the background necessary for specific courses is permitted to take graduate courses as a non-matriculated student. If the student is subsequently admitted to the graduate program, courses taken for credit usually can be applied toward the master's degree. A maximum of nine credits (from courses taken at RIT as a non-matriculated student) can be transferred to the degree program. Any applicant who wishes to register for a graduate course as a non-matriculated student must obtain permission from the chair of the graduate program and the course instructor.

Architecture, M. Arch.

Alex Bitterman, Interim Graduate Director
(585) 475-5397, aebfaa@rit.edu

Program overview

At a time of significant transition for the architectural profession, the M.Arch. program allows for full incorporation of the skills and knowledge critical to the 21st century architect. The program's purpose is to produce broad-thinking architects well grounded in the principles and practices of sustainability who can apply their knowledge and talents to the architectural problems posed by the modern city.

The master of architecture program is designed for students with a broad range of interests and backgrounds who are interested in studying architecture at the graduate level, but whose undergraduate degrees were obtained in fields outside of architecture.

The program's curriculum has been shaped by the global emphasis of sustainability, factors that impact urbanism, and the hands-on application of the principles of design and technology on materials and construction.

Sustainability

With a global push for a more sustainable world, including buildings that use energy and environmental factors more efficiently to lessen an overall carbon footprint, the focus of many courses reflect the conditions of sustainable design and practice.

Urbanism

Because a degraded urban environment has grave implications for social, economic, cultural, and environmental health, the program pays particular attention to urban settings and urban principles. The complexity of the urban environment requires an interdisciplinary approach to architecture education—one that references economics, public policy, sociology, and regional culture. The program will focus on the practices and principles of preservation and adaptive reuse. The city of Rochester, New York, will serve as an active learning environment for students.

Integrated learning/Integrated practice

Like all strong design programs, the program's core education will take place in the studio. However, our studio curriculum integrates construction technologies, material science, and mechanics into design. From the outset, students will approach design problems within teams, learning to value and leverage collective

intelligence. The integrated learning model prepares students for the increasingly integrated practice of architecture, where integrated project delivery is fast becoming the dominant model, and architects are orchestrating teams of professionals from a variety of fields, including engineering, management, science, and computer science.

Curriculum

Students are required to complete 148 credit hours to successfully complete the program. Designed as a full-time program, courses will be offered on campus, primarily during the day.

The majority of the course work is studio-based, with the exception of some elective and sustainability courses. In addition to three required sustainability courses, students will take one sustainability elective. All students will prepare a thesis in their last year. Students will take three graduate electives, drawn from courses offered by the colleges of Liberal Arts, Engineering, Applied Science and Technology, Imaging Arts and Sciences, and Business.

Sample of typical course schedule

First Year

20xx-611, 612, 613	Architectural Graphics I, II and III
20xx-621, 622, 623	Architectural Design I, II and III
20xx-631, 632	Integrated Building Systems I and II
20xx-651, 652	Architectural History I and II
5001-703	Fundamentals of Sustainable Science

Second Year

20xx-721, 722, 723	Design Studio: Site, Tectonic and Adaptive
20xx-733, 734, 735	Integrated Building Systems III, IV and V
20xx-741	Urban and Regional Planning
20xx-751, 752	Architectural Theory I and II
5001-704	Industrial Ecology
5001-711	Performance Metrics and Certification of Sustainable Buildings

Third Year

20xx-724	Design Studio: Urban
20xx-726, 727	Thesis Studio I and II
20xx-736	Integrated Building Systems VI
20xx-743	Research Seminar: Social
20xx-737	Innovative Building Systems
20xx-725	Thesis Preparation
20xx-742	Research Seminar: Urban
20xx-761	Professional Practice

Admission requirements

To be considered for admission to the M.Arch. program, candidates must fulfill the following requirements:

- Hold a baccalaureate degree (other than a B.Arch.) from an accredited institution,
- Have an undergraduate cumulative GPA of B (3.0) or higher,
- Have at least one semester of previous course work in calculus and physics,
- Submit official transcripts (in English) of all previously completed undergraduate and graduate course work,
- Present a portfolio of creative work, which may include sketches, constructions, graphics, and/or photographs (While student portfolios will likely not include examples of architectural drawing/design, evidence of creative talent will be important in determining admission),
- Submit a personal statement of educational objectives,
- Submit three letters of recommendation from former instructors and/or professional employers,
- Submit the results of the Graduate Record Examination (GRE) with a minimum score of 500 (V) and 500 (Q), and
- Complete a graduate application.
- International applicants, whose native language is not English, must submit scores from the Test of English as a Foreign Language (TOEFL). Minimum scores of 600 (paper-based), 250 (computer-based), and 100 (Internet-based) are required.

Applicants who exceed the general admission requirements may be considered for conditional acceptance before GRE scores are available.

Graduate Faculty

Nabil Nasr, BS, Helwan University; M.Eng., Pennsylvania State University; MS, Ph.D., Rutgers University—Assistant Provost and Director, Golisano Institute for Sustainability

Dennis A. Andrejko, B. Arch, Arizona State University; M. Arch, Massachusetts Institute of Technology—Program Chair, Architecture; Associate Professor

Callie W. Babbitt, BS, Georgia Institute of Technology; ME, Ph.D., University of Florida—Assistant Professor

Gabrielle Gaustad, BS, Alfred University; MS, Ph.D., Massachusetts Institute of Technology—Assistant Professor

Michael Haselkorn, BS, Alfred University; MS, Ph.D., University of Illinois at Urbana—Research Associate Professor

Nenad Nenadic, BA, University of Novi Sad (Yugoslavia); MS, Ph.D., University of Rochester—Research Associate Professor

Thomas W. Smith, BS, John Carroll University; Ph.D., University of Michigan—Professor; Interim Academic Director

Paul H. Stiebitz, BS, ME, Rochester Institute of Technology; MS, State University of New York at Buffalo—Associate Professor; Associate Academic Director

Michael Thurston, BS, MS, Rochester Institute of Technology; Ph.D., State University of New York at Buffalo—Research Associate Professor and Technical Director, Systems Modernization and Sustainment Center

Thomas A. Trabold, BS, Ph.D., Clarkson University—Research Associate Professor

Anahita Williamson, BS, MS, Ph.D., Clarkson University—Research Assistant Professor

5001-700 Special Topics
A critical examination of issues in some area of sustainability not covered in other Golisano Institute for Sustainability courses. (Enrollment in Sustainability Ph.D. Program or permission of instructor) **Class 4, Credit 4 (offered occasionally)**

5001-710 Tools for Graduate Research
This class will introduce graduate students to tools and software that will be of use in conducting, analyzing, and presenting their research. An introduction, highlights of key features, and the basics of operation will be taught for software aimed at: bibliographic referencing (e.g. Endnote, Latex), statistical analysis (e.g. Excel, SPSS, SAS), analytical work (e.g. Matlab, Mathematic, Maple), advanced plotting (e.g. Deltagraph, Illustrator, Origin), equation editing (e.g. Mathtype) and search engines (e.g. setting up RSS feeds, material property databases). Assignments will be direct application to thesis/dissertation research. (Enrollment in the Sustainability Ph.D. or MS program or the permission of the instructor) **Class 4, Credit 4**

5001-711 Design for Sustainability
This transdisciplinary, problem-based studio course is a joint offering between GIS and Industrial Design, focused on the topic of integrating sustainability objectives at the conceptual product design stage. The goals of this course are to provide industrial design and sustainability students with an appreciation of cross disciplinary perspectives and to test design for sustainability principles through student-led course projects that investigate the design feasibility and the environmental impact of proposed product alternatives. Topics covered will include product design process, sustainability priorities, environmental attributes of a product life cycle, and environmentally preferable design alternatives. (Graduate standing required) **Class 4, Credit 4**

5001-800 Graduate Seminar
This is a required course for students admitted to the Sustainability Ph.D. program. Students will learn about current research in sustainable production systems from faculty and guest speakers. Topics pertaining to the development of plans of study and research proposals, and as well as teaching skills, will also be covered. (Enrollment in the Sustainability Ph.D. program) **Class 1, Credit 1 (F, W, S)**

5001-801 Independent Study
An independent project in sustainability not covered in the available courses. This project can be experimental research, literature review, or other appropriate work. This course requires a formal proposal and a faculty sponsor. (Enrollment restricted to students in the Sustainability Ph.D. program). **Credit variable**

5001-802 Fundamentals of Sustainability Science
This course prepares students to conduct original research related to sustainable production and consumption systems. Fundamental concepts of industrial ecology, ecological economics, ecosystem health, and social ecology essential to understanding the interaction of industrial and ecological systems are introduced. Students will learn multiple perspectives of sustainability such as strong and weak formulations, the importance of sustainability as an ethical concept, and a life-cycle approach to organizing research related to sustainability. (A minimum of four credits of calculus (or higher); 1016-319 Data Analysis I (or equivalent); 1016-320 Data Analysis II (or equivalent); any one of the following: physics, chemistry or biology; exceptions are by permission of instructor.) **Class 4, Credit 4 (F)**

5001-803 Economics of Sustainability
The economics of sustainability regards conceptualizing appropriate dynamic consumption and production paths and strategies for attaining such paths. This course begins by exploring how problems of sustainability can be analyzed using the neoclassical economics paradigm. We then consider how sustainability concerns arise within consumer theory and within the theory of the firm. Standard modeling tools used in economics are introduced. Environmental and resource economic policy instruments such as taxes, tradable pollution permits, liability and regulation are critically evaluated for use in various contexts in which sustainability is of concern. Consideration is given to how the economic theory of sustainability complements perspectives from other disciplines. The course concludes with a discussion of current issues in sustainability such as climate change. (0511-711 or equivalent or permission of instructor) **Class 4, Credit 4**

5001-804 Industrial Ecology
Industrial ecology is the study of the interaction between industrial and ecological systems. Students in this course learn to assess the impact and dependency of production systems on the natural environment by mastering life-cycle assessment tools, concepts in biomimicry and principles of sustainability. (A minimum of four credits in calculus (or higher); 1016-319 Data Analysis I (or equivalent); 1016-320 Data Analysis II (or equivalent); any one of the following: physics, chemistry or biology; research experience and graduate standing recommended; exceptions are by permission of instructor.) **Class 4, Credit 4 (W)**

5001-805 Technology, Policy, and Sustainability
This course introduces students to public policy and its role in building a sustainable society. The course places particular emphasis on the policy process; the relationship among technology, policy, and the environment; and policy mechanisms for addressing market and government failures that threaten sustainability. (Enrollment restricted to students in the Ph.D. in Sustainability or permission of instructor) **Class 4, Credit 4 (F)**

5001-806 Risk Analysis
This course examines the three pillars of sustainability (economy, environment, society) from a risk analytic perspective and presents an introduction to financial, toxicological and socio-political risk assessment, management and communication. Topics include utility theory, net present value analysis, benefit-cost analysis, ecotoxicology, environmental impact statements, environmental justice, risk management and risk communication. This course prepares students for further study in sustainable design, decision making and policy. (A minimum of four credits in calculus (or higher); 1016-319 Data Analysis I (or equivalent); 1016-320 Data Analysis II (or equivalent); any one of the following: Physics, chemistry or biology; research experience and graduate standing recommended; exceptions by permission of instructor) **Class 4, Credit 4 (W)**

5001-807 Research
Sustainability Ph.D. research conducted prior to passing the qualifying exam. (Enrollment restricted to students in the Sustainability Ph.D. program who have not yet passed the qualifying exam.) **Credit variable**

5001-808 Multi-Criteria Decision Analysis
This class will explore how decisions are made when confronted with multiple, often conflicting, criteria or constraints. The focus will be on the following analytical methods: linear and stochastic programming, optimization, and Monte Carlo simulation. Case studies will focus on sustainability multi-criteria problems such as energy planning, sustainable development, resource management, and recycling. Students will apply methods learned to a project involving their dissertation research. It is a core course within the Sustainability Ph.D. and MS programs. (5001-806 Risk Analysis or the permission of the instructor) **Class 4, Credit 4**

5001-810 Thermodynamics for Sustainability
This course provides an advanced understanding of thermodynamic analytics appropriate for energy and chemical systems, such as alternative energy capture and storage systems, energy conservation strategies, and chemical equilibrium systems. Successful students will understand energy, Gibbs free energy, Helmholtz energy and other analytic tools for energy analysis and apply these to solve problem in redox chemistry, chemical speciation and complexation, as well as conduct energy analyses at community, society, and life-cycle scales. This course balances conceptual understanding and mathematical problem-solving. It is appropriate for graduate students from engineering or applied sciences working in research related to alternative energy. (Graduate standing) **Credit 4**

5001-812 Sustainable Product Realization Strategies
This course draws on concepts and methods pertaining to risk, life cycle assessment, innovation, and policy introduced in various core courses to make strategic product-system decisions during the earliest stages of product development. (Permission of instructor) **Class 4, Credit 4 (offered occasionally)**

5001-814 Systems Health Management
Systems Health Management will provide systems engineering approach and tools and technologies for maintaining operational, economic and environmental performance of products throughout the life cycle. The course will focus on failure diagnosis (understanding existing failures), and failure prognosis (providing advance notice of potential failures). (Permission of instructor) **Class 4, Credit 4 (offered occasionally)**

Golisano Institute for Sustainability

5001-816 **Remanufacturing Process**
Remanufacturing is a process of bringing used products to a "like-new" functional state. It recovers a substantial proportion of the resources incorporated in a used product during its first manufacture, at low additional cost. Valuable material resources are also retained. Students in this course will learn how material aging, product design, economic, and environmental factors impact remanufacturing. (0304-344 Materials Science or equivalent; permission of instructor). **Class 4, Credit 4 (offered occasionally)**

5001-818 **Sustainable Energy Systems**
This course investigates the systemic relationships involved with energy production, distribution, and consumption. The longstanding dependence on fossil fuels and nuclear energy to supply global energy demands will be used as a basis to evaluate the potential implementation of alternative, sustainable energy sources. These technologies include solar, wind, biomass, oceanic, geothermal, hydropower and fuel cell (hydrogen). An analysis of each energy technology will be used to discuss the intended impact on political, social, economic and environmental goals. These considerations are evaluated towards developing an understanding of sustainable energy supply and consumption patterns, both domestically and internationally. (Permission of instructor) **Class 4, Credit 4 (offered occasionally)**

5001-820 **Dissertation Research**
Research fulfillment of Sustainability Ph.D. dissertation requirements. (Enrollment restricted to students in the Sustainability Ph.D. program who have successfully completed qualifying exam.) **Credit variable**

5001-822 **Material Cycling**
This class will explore the economic and environmental incentives for recycling and resource recovery. The focus will be on end-of-life fate of materials (including plastics, metals,, glass, and e-waste) while setting these within the context of overall ecosystem flows (carbon, sulfur, and nitrogen cycles, waste water, etc.). Technologies for the upgrading of secondary material streams will be studied including: physical and physico-chemical (beneficiation, electrostatic and magnetic separation), hydrometallurgical (filtration and fluxing). Production issues (product quality, remelt thermodynamics, exergy accounting, etc.) within the secondary industry will be explored with an emphasis on removing barriers to increased usage of scrap. Efforts for enhanced collection efforts and motivation of consumer and firm participation will also be covered (municipal collection fees, corporate take-back initiatives, legislation such as the WEEE directive, state deposits, etc.). (Enrollment in the Sustainability PhD or MS program or the permission of the instructor).

Online Learning

www.rit.edu/online

RIT is a recognized leader in the delivery of online asynchronous education. Since 1980, the university has offered distance learning courses and was among the first universities nationwide to utilize the Internet as a mode of delivery. In 1991, the university began offering full degrees through online learning.

The Wallace Center supports the RIT online course management system (myCourses), provides training for faculty, and assists in registering students and answering questions about myCourses. The center also reviews emerging technologies that support the critical mission of constantly improving teaching and learning.

RIT offers numerous degree and certificate programs in an online format—most of which may be earned without ever coming to campus. The university offers hundreds of graduate and undergraduate courses online annually. Each year nearly 5,000 students enroll in an online learning course. Students are encouraged to select and apply to their chosen academic program, but in some cases may enroll in courses prior to matriculation into a program.

Online learning offers students the flexibility to learn on their own time, when and where it best meets their needs. All online courses are taught using Internet and Web-based technologies. Students must have Internet access, a computer, DVD player and monitor, and a telephone to participate in courses. Not all courses use the same technologies. Some take advantage of toll-free phone or Web conferences, while others use text-based chat or CD-ROMs. Some have Web-based simulations and some require additional software to complete course requirements. All courses use asynchronous Internet/Web-based tools for the fundamental class structure.

Online students have full access to customer and technical support through phone and e-mail. Online learners also have full access to the library and its services. Other online services include registration, orientation, access to student records, and course material ordering. Registration also can be accomplished through touchtone phone and fax. Officially registered students receive an e-mail about three weeks before the quarter begins welcoming them to online learning and directing them to MyCourses. Here, students can visit the Online Learning Student Community to access information on courses, order course materials, and review any proctored exam requirements.

All courses offered online meet the same rigorous objectives set for traditional classroom experiences. Faculty members who teach online courses often teach the same class in a traditional format.

However, just as each professor establishes the learning outcomes for a traditional course, their individual choices are also reflected in the online classroom. Most classes establish either a weekly schedule for learning activities or a project-based learning approach, in which deliverables (assignments, projects, discussion participation, etc.) are due after certain learning outcomes are accomplished. Most classes also include various readings either from textbooks or electronic reserves. Students interact online with other students to exchange ideas and collaborate much as they would face-to-face.

Online learning serves students throughout the United States and in nearly 40 countries. Students living near Rochester may choose to take both online and traditional courses as a way of increasing flexibility and remaining on target to complete a degree.

Online graduate programs

Doctorate degree:

- Imaging Science

Master's degrees:

- Applied Statistics
- Environmental, Health and Safety Management
- Facility Management
- Health Systems Administration
- Human Resource Development
- Imaging Science
- Manufacturing Leadership
- Microelectronics Manufacturing Engineering
- Networking and Systems Administration
- Online Executive MBA
- Product Development
- Professional Studies
- Service Leadership and Innovation
- Telecommunications Engineering Technology

Advanced certificates:

- Elements of Healthcare Leadership
- Network Planning and Design
- Network and System Administration
- Project Management
- Senior Living Management
- Service Leadership and Innovation
- Statistical Methods for Product and Process Improvement
- Statistical Quality
- Strategic Training

Graduate Admission

The academic department offering the program makes all decisions regarding graduate admission. Correspondence between the student and the university is conducted through the Office of Graduate Enrollment Services, according to the following policies and procedures:

1. Inquiries regarding academic programs, as well as all applications for graduate study, are directed to the Office of Graduate Enrollment Services, Rochester Institute of Technology, Bausch & Lomb Center, Building 77, Room A130, 58 Lomb Memorial Drive, Rochester, NY 14623-5604.
2. The Office of Graduate Enrollment Services will acknowledge the inquiry or application, instructing the student as to the information required for admission by the school or department to which he or she is applying.
3. Once a student has submitted a formal application, the Office of Graduate Enrollment Services will prepare an applicant file. All correspondence and admission information is collected by the Office of Graduate Enrollment Services and placed in the applicant's file. The file will include an RIT application, previous college records (transcripts), applicable test scores, letters of recommendation, and other documents that may support admission of the candidate.
4. When all relevant admission data has been received, the applicant's file is sent to the appropriate school or department for review and an admission decision.
5. When the school or department has made a decision on the application, the decision and the applicant's file is returned to the Office of Graduate Enrollment Services.
6. The Office of Graduate Enrollment Services notifies candidates of admission decisions.
7. Academic departments may informally advise nonmatriculated students, but no formal program of study can be approved prior to matriculation.
8. The formal program of study will be approved by the dean's designee (department head, coordinator, program director) or other appointed person. The program must be followed by all students applying for admission or readmission.
9. The basic entry requirements for master's or doctoral degree candidates include the completion of a baccalaureate degree, the submission of support materials required by the college or department offering the program, and any other evidence that supports the applicant's potential for success. Rare exceptions to the baccalaureate requirement may be made in the case of candidates who have demonstrated unusual competence in their field of specialization. For these exceptions, the recommendation of the department chairperson/director is required in addition to the approval of the college dean and the Graduate Council.

International applicants must demonstrate English language proficiency as part of the admission process. This is normally accomplished through submission of scores from the Test of English as a Foreign Language (TOEFL). Minimum TOEFL scores vary by program, however, most programs require a minimum TOEFL score of 213 (computer-based), 550 (paper-based), or 79-80 (Internet-based). Test scores from the International English Language Testing System (IELTS) are accepted in place of the TOEFL exam. Minimum acceptable scores will vary by program, however, the absolute minimum for an unconditional acceptance is 6.5. Upon arrival at RIT, students for whom English is a second language may be required to take a number of English language exams. Upon the results, a student may be required to enroll in English instruction, which will result in additional study time and tuition cost.

In certain cases graduate students may be admitted prior to, but conditional upon, completion of the baccalaureate degree. Applicants will not be considered for admission prior to the start of the final year of undergraduate study. The student must present a final transcript covering all undergraduate study within one quarter after first registering for a graduate program.

Graduate applicants who do not fully satisfy all admission criteria (i.e.: grades, test scores, credentials), but show sufficient promise to qualify for a trial period of graduate study may be admitted to the university on probation. Such students must achieve a 3.0 (B) program cumulative grade point average by the end of their first 12 quarter credit hours of graduate study. Those students who do not meet this criterion will be suspended. Responsibility for specific requirements and maintenance of the student's appropriate status rests with the student's academic department in consultation with the Office of Graduate Enrollment Services and the Registrar. Evaluation of transfer credit is made by the academic school or department in question.

New York State immunization requirement

All students registered for four or more credits and born after January 1, 1957, must comply with New York state and RIT immunization requirements. New York State Law requires proof of immunity to measles, mumps, and rubella through either two MMR immunizations or positive blood titers for each disease. New York state also requires all students, regardless of age, to sign a meningococcal awareness form. RIT requires students age 26 and under to have the meningitis shot. Required immunizations should be obtained before arrival to avoid delay in registration or interruption of classes for which students have enrolled. Contact the Student Health Center (www.rit.edu/studentaffairs/studenthealth) with questions. Additional information and forms are available online.

Readmission

If a student has become inactive (has not completed a course in four quarters) or has withdrawn from RIT, university policy requires that he or she reapply for admission as follows:

1. Students who left a graduate program with a GPA of 3.0 or better (in good standing) and will return to the program within two years of the time their last course was completed will be readmitted to the program upon reapplication.

2. Students who left the program with a GPA of 3.0 or higher and return to the program more than two years after the last course was completed must meet current admission standards upon reapplication. The program of study is subject to review and may be rewritten. Previous waiver/transfer credit may be lost, and the student may need to make up program deficiencies.

3. Students who leave a program with a GPA below 3.0 must meet current admission standards upon reapplication. Readmission is based on all information, including previous graduate-level work. Program requirements in effect at the time of reapplication will apply. Previous waiver/transfer credit may be lost, and the student may need to make up program deficiencies.

Costs and Payment Procedures

Costs and Payment Procedures

The university reserves the right to change its tuition and fees without prior notice. Nonmatriculated students are charged graduate rates for graduate courses.

Graduate costs are listed in the table on this page. In addition, any graduate student carrying more than 18 credit hours of study will be charged the full-time tuition rate plus $963/credit hour for each hour of study exceeding 18.

Room and board for full-time students for 2011-12 will be $1,439 per quarter for a standard meal plan and $2,032 for a double occupancy room. A variety of housing options and meal plans are available, and costs may vary according to options selected.

The cost of books and supplies varies depending on the area of study and the number of courses taken by a student. The estimated cost for books and supplies ranges from $500 to $2,500 a year for full-time students and $300 to $700 a year for part-time students.

Charges for tuition, fees, and room and board are computed on a quarterly basis. University billing statements may be paid by cash, check, or electronic check (e-check). The university does not accept credit card payments for tuition, fees, and room and board that appear on the student billing statement. However, we have an arrangement for a third-party vendor to accept MasterCard and Discover Card when payment is made online. The vendor does charge a percentage fee for each credit card transaction. Billing-related payments (check) may be mailed to: Rochester Institute of Technology, Student Financial Services, P. O. Box 92878-200, Rochester, NY 14692-8978. Payment also may be made in person at the Office of Student Financial Services on the first floor of the Administrative Services Building. Credit card and e-check payments can be made at https://eservices.rit.edu/eServices/login.do

Due dates are clearly designated on the billing statement and our website. Failure to pay the amount due or arrange an optional payment by the due date will result in a late payment fee.

Fall Quarter—August 17, 2011
Winter Quarter—November 21, 2011
Spring Quarter—February 29, 2012
Summer Quarter—May 24, 2012

Students who have not participated in the early registration process for the quarter will be expected to pay the quarterly charges (tuition, fees, room and board) at the time of registration. They may pay these charges in a single payment or by the partial payment plan. Partial payments are due twice a quarter: 50 percent (plus a $25 partial payment processing fee) at the time of registration and the remaining 50 percent by the mid-quarter bill due date. A late payment fee will be assessed if the balance is not paid by the due date.

Graduate Costs

TUITION	PER QUARTER	3 QUARTERS
Full-time (12–18 credit hours)	$11,553	$34,659
Part-time (11 credit hours or less)	$963/credit hour	$963/credit hour
Student activities fee	$76	$228

If you have questions concerning payment options, please contact the Student Financial Services Office, (585) 475-6186 or asksfs@rit.edu.

Electronic Billing

The university has an electronic billing (E-Bill) program for students. Each quarter, all students receive an e-mail notification to their official university e-mail account stating that their E-Bill is available. Students have the option of selecting three additional e-mail addresses to allow for a parent, guardian, sponsor, or other authorized user to receive E-Bill notifications (https://ipay.rit.edu/eServices/).

Student Accident and Sickness Insurance

All registered students are required to maintain medical insurance while attending RIT. Insurance coverage can be through RIT, a family member's policy, or a personal policy.

A student accident and sickness insurance plan is available through RIT. There is a separate charge for this insurance. The plan provides coverage, within limits specified in the policy, for sickness and injury, outpatient services, emergency care, and prescriptions.

Enrollment in this plan is voluntary for all students except registered international undergraduate students (full- and part-time) on A, B, E, F, G, I, J, K, O, Q, R, and V visas. These students will be enrolled automatically in the basic accident and sickness policy on a semiannual basis.

There is no need to waive coverage if it is not desired. Students who want to enroll in this plan may enroll online or by mail. An open enrollment period is available at the beginning of each academic quarter. Payment can be made by check, money order, or credit card, or the premium can be added to the student's account.

The open enrollment period ends 30 days after the start of the academic quarter in which the student first registers.

For plan and enrollment information, visit the Web at www.universityhealthplans.com or call (800) 437-6448. Students are not required to obtain the student accident and sickness insurance plan to receive services at the Student Health Center.

Refund Policies

The acceptable reasons for withdrawal with full refund during the quarter are:

1. Active military service: A student called to active military service during the first eight weeks of the term may receive a full tuition refund. If called after the eighth week, he or she may elect to complete the course by making special arrangements with both the instructor and department, or may withdraw and receive a full tuition refund. If he or she withdraws, the course must be repeated at a later date.
2. Academic reasons: Students sometimes register before grades for the previous quarter are available. If such a student later finds that they are subject to academic suspension or have

failed to meet prerequisites, the student will be given a full refund upon withdrawal.
3. Part-time students: If a part-time student drops a course during the official drop/add period (first six days of classes in any quarter), they may contact the Student Financial Services Office for a full refund for the course dropped.

Full-time students must officially withdraw from all courses or take a leave of absence in order to be eligible for a partial tuition refund. Students must complete a leave of absence or withdrawal form, which can be initiated with their academic department. A partial refund will be made during a quarter if withdrawal/leave of absence is necessitated for one of the following reasons:

1. Illness, certified by the attending physician, causing excessive absence from classes,
2. Withdrawal for academic or disciplinary reasons at the request of RIT during a quarter,
3. Transfer by employer, making class attendance impossible, or
4. Withdrawal for academic, disciplinary, or personal reasons at the request of the student, approved by the student's adviser or department representative, and the Student Financial Services Office.

Partial refund schedule for tuition

Partial refunds will be made according to the following withdrawal schedule and percentage of tuition reduction:

1. During official drop/add period (first six days of classes)—100 percent tuition reduction
2. From the end of the official drop/add period through the end of the second week of classes—70 percent tuition reduction
3. During the third week of classes—60 percent tuition reduction
4. During the fourth week of classes—50 percent tuition reduction
5. During the fifth week of classes—25 percent tuition reduction
6. Sixth and subsequent weeks—no tuition reduction

Note: *Nonattendance does not constitute an official withdrawal.*

A student is not officially withdrawn until he or she receives a copy of the withdrawal form. The date on which a withdrawal form is properly completed will be the date of official withdrawal, used to determine the refundable amount.

If the student drops their course load from full-time (12 or more credits) to part-time (less than 12 credits) status during the official drop/add period, they may contact the Student Financial Services Office for a refund based on the difference between the full-time tuition charge and the total per-credit charge for the part-time course load.

No refund will be made for classes dropped after the official drop/add period unless the student is officially withdrawing from the university. Advance deposits are not refundable.

If institutional charges are reduced due to withdrawals, financial aid programs are reimbursed before a cash refund is issued to the student. The student also is responsible for any unpaid balance at the time of withdrawal. Aid programs are reimbursed in the following sequence: Federal Direct Unsubsidized Loan, Federal Direct Subsidized Loan, Graduate PLUS Loan, Parent PLUS Loan, Federal Pell Grants, Federal SEOG, other federal grants, state aid, institutional aid. If a credit balance still remains, the student is then issued a refund.

For further information or comments regarding refund policies and specific withdrawal dates, contact the Student Financial Services Office.

Appeals process

An official appeals process exists for those who feel that individual circumstances warrant exceptions from published policy. The inquiry in this process should be made to Mary Beth Nally, director of Student Financial Services.

Partial refund schedule for room and board

To complete a withdrawal from RIT, a resident student must check out with Housing Operations. All students on a meal plan should check out with the Food Service administrative office, located in the Student Alumni Union, room A520 (lower level). Refunds, when granted, are from the date of official check out. Room and board refund policies are established by the Center for Residential Life and RIT Food Service.

Room

1. During the first week of classes—90 percent of unused room charge
2. During the second week of classes—75 percent of unused room charge
3. During the third week of classes—60 percent of unused room charge
4. During the fourth week of classes—50 percent of unused room charge
5. Fifth and subsequent weeks—no refund

Board

1. Within the first four weeks—75 percent of the unused meal/debit charges
2. After the fourth week (during week five through the end of week eight)—50 percent of the unused meal/debit charges
3. During the last two weeks of classes—no refund

Any student who intentionally defrauds or attempts to defraud the university of tuition, fees, or other charges, or who gives false information in order to obtain financial aid, is subject to legal liability, prosecution, and university disciplinary action.

Financial Aid

www.rit.edu/financialaid

General Information

RIT offers a full range of financial aid programs to assist graduate students with their educational expenses. The information provided in this section is an overview of the sources of assistance available. Please consult the Office of Financial Aid and Scholarships' website for more detailed information.

Scholarships and assistantships are available in most graduate departments. In addition, some departments offer externally funded tuition remission and stipends from corporate or government sponsors. Please contact the appropriate graduate program director or the Office of Graduate Enrollment Services for additional information.

Financial aid awards are offered only once a student is accepted. Awards are generally given to full-time students, but exceptions are made for qualified part-time students.

International students (F-1 or J-1 visa holders) may generally work on campus for up to 20 hours per week. Special authorization from International Student Services and/or the INS is needed for all other employment, including co-ops and internships. Please consult International Student Services at (585) 475-6943 or www.rit.edu/studentaffairs/iss/ for employment or visa questions.

All federal student aid programs require submission of the Free Application for Federal Student Aid (FAFSA). The FAFSA may be completed online at www.fafsa.gov.

Satisfactory academic progress for federal aid recipients is evaluated at the end of spring quarter each year. Students must maintain a 3.0 grade point average and complete two-thirds of credit hours attempted each year. Students who do not meet minimum progress standards may continue to receive federal aid during a probationary period as the result of a successful petition. The dean and departmental faculty can be petitioned, in extraordinary circumstances, to review and judge the cases of individual students who believe the spirit of the above requirements have been met yet fall short of the particular requirement. If the petition is accepted and approved by the faculty, dean, and provost and vice president for academic affairs, a signed copy will be sent to the registrar for inclusion in the student's permanent record.

In addition, loan eligibility for students with full-time-equivalent status is limited to a maximum of four quarters.

Financial Aid Refund Policy

Return of federal funds

In accordance with federal regulations, the Office of Financial Aid and Scholarships recalculates quarterly federal aid eligibility for students who withdraw, drop out, are suspended, or take a leave of absence prior to completing 60 percent of a quarter. "Withdrawal date" is defined as the actual date the student initiated the withdrawal process, the student's last date of recorded attendance or the midpoint of the quarter for a student who leaves without notifying the university. Recalculation is based on the percent of earned aid using the following formula: number of days completed up to the withdrawal date/total days in the quarter. Aid returned to federal programs is then equal to 100 percent minus the percentage earned multiplied by the amount of federal aid disbursed.

Funds are returned to the federal government in the following sequence: Federal Direct Unsubsidized Loans, Federal Direct Subsidized Loans, Federal Parent Loans, Federal Perkins Loans, other federal aid.

Late disbursement

If the student is otherwise eligible, the first disbursement of Federal Direct Subsidized Loan or Federal Direct Unsubsidized Loan proceeds is allowed up to 180 days after the student has ceased to be enrolled. Subsequent disbursements are not allowed.

State scholarships

Regulations vary. Any adjustments are done in accordance with the specific requirements of the sponsoring state.

Privately funded grants and scholarships

In the absence of specific instructions from the sponsor, 100 percent of the quarterly award will be credited to the student's account.

RIT grants and scholarships

If a credit balance remains after all federal, state, and private adjustments, a percentage of the remaining credit balance is returned to the RIT scholarship account according to the following formula:

Scholarship		
Scholarship plus student payments	=	Percent returned to RIT scholarship program

Financial Aid Programs

GRANTS/SCHOLARSHIPS	ELIGIBILITY	AMOUNT	HOW TO APPLY
Graduate Assistantships	Graduate student matriculated into an RIT graduate degree program.	Amounts vary	Complete Graduate Admissions Application and check appropriate box to be considered for graduate assistantships.
Graduate Merit Scholarships	Graduate student matriculated into an RIT graduate degree program.	Amounts vary	Complete Graduate Admissions Application and check appropriate box to be considered for graduate scholarship.
Graduate Opportunity Scholarship	Limited number of scholarships to full-time matriculated graduate students who demonstrate exceptional financial need. Preference is given to students who are from underrepresented populations or those not traditionally studying in the discipline.	$500 per full-time quarter.	File the Free Application for Federal Student Aid (FAFSA). (Applicants must be U.S. citizens or permanent residents)
Vietnam Veterans Tuition Award Program	Eligible Veterans who are New York state residents.	$1,631.70 per year for full-time study; available for undergraduate or graduate study.	File the Free Application for Federal Student Aid (FAFSA) and TAP Application. Also file the Vietnam Veterans Tuition Award Supplement at www.hesc.com.
Veterans Benefits	Eligible veterans and children of deceased veterans, or service-connected disabled veterans.	Amounts vary.	Contact: Office of Veterans Affairs at (888) 442-4551, or visit their website at www.va.gov.
Bureau of Indian Affairs Graduate Fellowship Grants	Enrolled full-time and recognized by Secretary of the Interior as a member of an Indian tribe and demonstrating financial need and academic achievement.	Amounts vary	Contact American Indian Graduate Center (AIGC) at (800) 628-1920, or on the Web at www.aigc.com.

LOANS	ELIGIBILITY	AMOUNT	HOW TO APPLY
Federal Direct Loans	Matriculated students who are enrolled at least half-time and who are U.S. citizens or permanent residents.	Maximum amount: $20,500 ($8,500 of which may be subsidized, depending on financial need). The maximum amount cannot exceed the cost of education minus all other financial aid awarded.	File the Free Application for Federal Student Aid (FAFSA). (must be a U.S. citizen or Permanent Resident)
Federal Perkins Loan	Students who meet requirements established by federal government.	Up to $6,000 per year; $40,000 limit for undergraduate and graduate study.	File the Free Application for Federal Student Aid (FAFSA). (must be a U.S. citizen or Permanent Resident)
Private Alternative Loans	Enrolled student who is credit-approved by lender.	Up to the cost of education minus all other financial aid awarded.	Consult the Office of Financial Aid and Scholarships website www. rit.edu/financial aid or contact the private lender directly.

EMPLOYMENT	ELIGIBILITY	AMOUNT	HOW TO APPLY
Federal Work Study Program	Students who are U.S. citizens or permanent residents with financial need: most jobs provided are on campus, and some community service positions are available.	Varies, depending on hours and wage rate (RIT wage rates start at $7.25 per hour).	File the Free Application for Federal Student Aid (FAFSA). Contact the RIT Student Employment Office at www.rit.edu/emcs/seo.
RIT Employment Program	No financial need requirement; may be on campus or off campus.	Varies, depending on hours and wage rate (RIT wage rates start at $7.25 per hour).	Contact the RIT Student Employment Office at www.rit.edu/emcs/seo.

This chart covers the most commonly awarded financial aid programs available to full-time graduate students at RIT. Information is correct as of April 2011. Most graduate programs require satisfactory progress toward degree completion to maintain eligibility. Filing the FAFSA by April 1 will ensure priority consideration for all programs. Applications filed after this date will receive consideration as long as funds remain available. Scholarships provided by RIT will be prorated for NTID-sponsored students to reflect lower NTID tuition rates.

Registration and Degree Requirements

A graduate degree at RIT may be obtained in more than 70 programs ranging from business administration to imaging science. (Please refer to page 4 for a complete listing of graduate programs of study.)

Upon completion of the stipulated requirements, students are certified by their academic departments for their degree. After commencement, a statement verifying that a degree has been awarded will be posted to the transcript. Diplomas for fall graduates are mailed in winter quarter; for winter graduates, in spring; for spring graduates, in the summer; and for summer graduates, in the fall.

Registration

1. Student should complete the registration and payment process in accordance with university registration/billing procedures, as indicated in the current registration guide.
2. It is the responsibility of the student to update their address online through the Student Information System (SIS), or to advise the registrar of any change of address.
3. University ID cards are required for students to use many campus facilities and services (e.g., the library, Student Life Center, meal plans, check cashing). Identification cards are available at the Registrar's Office.
4. Students are expected to pursue their degree without a substantial break. Failure to enroll (register) for four successive academic terms can result in the loss of matriculated status.
5. RIT considers graduate-level students to be "full time" in every academic quarter in which they are enrolled for at least 12 credit hours. With approval of the department chair and associate provost for academic programs, additional equivalent credit can be granted for such activities as thesis work, teaching assistantships, and internships.

Matriculation

Matriculated graduate students are those who have applied to and been formally accepted into a graduate program through the Office of Graduate Enrollment Services. Such students may register for graduate-level courses (700 and above) that fit their home department-approved programs. When registering for graduate courses outside the home department, students may need to secure the approval of the department offering the course.

Nonmatriculated students will be allowed to take graduate courses on a space-available basis with the department's approval, and with the knowledge that course work completed while a nonmatriculated student will not necessarily apply to any given academic program.

Matriculated and nonmatriculated graduate students may register for undergraduate-level courses with the understanding that these courses may not apply to any RIT graduate program. In certain cases, where educationally sound programs will result, appropriate undergraduate courses, as approved by the faculty adviser and the department, may be included in a master's program. However, not more than nine undergraduate quarter credit hours (600-level or below) may be applied toward the 45-quarter-credit minimum (12 undergraduate hours for those programs requiring 48 or more quarter credit hours). Where undergraduate work is allowed, it must be well-planned and closely controlled. In the vast majority of cases, most, if not all, course work will be at the graduate level.

Degree Requirements

Credit requirements

The minimum credit requirement for a master's degree is 45 quarter credit hours. At least 36 of these quarter credit hours must be earned at the graduate level and in residence at the university.

Transfer credit

A maximum of nine quarter credit hours in a 45-credit-hour program or 12 quarter credit hours in a 48 or more credit-hour program may be awarded as transfer credit from other institutions. A request for transfer credit must be made at the time of application for graduate student status. Only a course with a grade of B (3.0) or better may be transferred.

Transfer credits are not calculated in the student's grade point average but will count toward overall credit requirements for the degree. Transfer credits do not count toward the satisfaction of residency requirements.

A graduate student who wishes to take courses at another institution and transfer them toward degree work at RIT must obtain prior permission from the appropriate departmental officer or dean.

Candidacy for an advanced degree

A graduate student must be a candidate for an advanced degree for at least one quarter prior to receipt of the degree. The position of the Graduate Council is that a student is a candidate for the master's degree when they are formally admitted to RIT as a graduate student.

Thesis requirements

Included as part of the total credit-hour requirement may be a research, dissertation, thesis, or project requirement, as specified by each department. The amount of credit the student is to receive must be determined by the time of registration for that quarter. For the purpose of verifying credit, an end-of-quarter grade of R should be submitted for each registration of research and thesis/dissertation guidance by the student's faculty adviser. Before the degree can be awarded, the acceptance of the thesis/dissertation must be recorded on the student's permanent record. Students also should note the following continuation of thesis/dissertation policy.

Students who complete a thesis or dissertation as a requirement for their master's or doctoral degree are required to submit a hard copy of the document to the Wallace Library to be placed in the Archives. Students also are required to submit an electronic copy of the thesis or dissertation to ProQuest/UMI for publication.

Continuation of thesis/project/dissertation

Once work has begun on a thesis, project or dissertation, it is seen as a continuous process until all requirements are completed. If a thesis, project, or dissertation is required, or such an option is

elected, and if the student has completed all other requirements for the degree, the student must register for the Continuation of Thesis/Project/Dissertation course each quarter (including summer quarter). This course costs the equivalent of one-quarter credit hour, although it earns no credit.

1. Registration for the Continuation of Thesis/Project/Dissertation course preserves student access to RIT services; e.g., Wallace Library, academic computing, and faculty and administrative support. With payment of appropriate user fees, access to the Student Life Center and Student Health Center also is preserved.
2. If circumstances beyond students' control preclude them from making satisfactory progress on their thesis/project/dissertation, they should consider taking a leave of absence and discuss such a leave in advance with their adviser/department head. The dean's signature of approval is required on the Leave of Absence or Institute Withdrawal form, a copy of which also must be sent to the associate provost for academic programs. If students do not register for the Continuation of Thesis/Project/Dissertation course, or take an approved leave of absence, their departments may elect to remove them from the program.
3. The length of time to complete a thesis/project/dissertation is at the discretion of the department. Be sure to read, however, the first point under "Summary of requirements for master's degree" on this page.

Note: The dissertation is required only of Ph.D. students.

Summary experience

The Graduate Council regards some form of integrative experience as necessary for graduate students. Such requirements as the comprehensive examination, a project, the oral examination of the thesis, and a summary conference are appropriate examples, provided they are designed to help the student integrate the separate parts of their total educational experience. The nature of the experience will be determined by the individual college or department.

Overlapping credit for second degree

At the discretion of the Graduate Committee in the specific degree area, nine to 12 previous master's quarter credit hours normally can be applied toward satisfying requirements for a second master's degree. The use of a given course in two different programs can be allowed only if the course that was used for credit toward the first degree is a required course for the second degree. The course must be used in both programs within five years; i.e., no more than five years between the time used for the first degree and when applied again toward the second degree.

In no case shall fewer than the minimum 36 quarter credit hours of residency be accepted for the second degree. If duplication of courses causes a student to go below the 36-hour limit in the second degree program, he or she would be exempted from these courses but required to replace the credit hours with departmentally approved courses. An RIT student will not be admitted through the Graduate Enrollment Services Office to the second degree program until the first program has been completed.

Financial standing

Tuition and fees paid to the university cover approximately 60 to 70 percent of the actual expense of a student's education. The rest of the cost is borne by the university through income on its endowment, gifts from alumni and friends, and grants from business and industry. Students, former students, and graduates are in good financial standing when their account is paid in full in the Student Financial Services Office. Any student whose account is not paid in full will not receive transcripts, degrees, or recommendations from RIT.

The university reserves the right to change its tuition and fees without prior notice.

Summary of requirements for master's degree

1. Successfully complete all required courses of the university and the college. These requirements should be met within seven years of the date of the oldest course counted toward the student's program. Extension of this rule may be granted through petition to the Graduate Council.
2. Complete a minimum of 45 quarter credit hours for the master's degree. At least 36 quarter credit hours of graduate-level course work and research (courses numbered 700 and above) must be earned in residence at RIT.
3. Achieve a program cumulative grade point average of 3.0 (B) or better.
4. Complete a thesis/project/dissertation or other appropriate research or comparable professional achievement, at the discretion of the degree-granting program.
5. Pay in full, or satisfactorily adjust, all financial obligations to the university.

Note: The dean and departmental faculty can be petitioned, in extraordinary circumstances, to review and judge the cases of individual students who believe the spirit of the above requirements have been met yet fall short of the particular requirement. If the petition is accepted and approved by the faculty, dean, and provost and vice president for academic affairs, a signed copy will be sent to the registrar for inclusion in the student's permanent record.

Definition of grades

Grades representing the students' progress in each of the courses for which they are registered are given on a grade report form at the end of each quarter of attendance. The letter grades are as follows:

- A Excellent
- B Good
- C Satisfactory
- D and F grades do not count toward the fulfillment of program requirements for a master's degree.

The grades of all courses attempted by graduate students will count in the calculation of the cumulative grade point average. This program cumulative grade point average shall average 3.0 (B) as a graduation requirement. The dean of the college or their designee must approve all applications for graduate courses a student wishes to repeat.

Quality points

Each course has a credit-hour value based on the number of hours per week in class, laboratory, or studio and the amount of outside work expected of each student. Each letter grade yields quality points per credit hour as follows:

- A Four quality points
- B Three quality points
- C Two quality points
- D One quality point
- F does not count in computing the grade point average (GPA)

The GPA is computed by the following formula: GPA = total quality points earned divided by total credit hours attempted. There are other evaluations of course work that do not affect GPA calculations. Only I and R (as described below) can be assigned by individual faculty members at the end of a quarter.

Registered (R)—This permanent grade indicates that a student has registered for a given course but has yet to meet the total requirements of the course or has continuing requirements to be met. The grade is given in graduate thesis/dissertation work. Completion of this work will be noted by having the approved/accepted thesis/dissertation title, as received by the registrar from the department, posted to the student's academic record. Full tuition is charged for these courses. Courses graded R are allowed in the calculation of the residency requirement for graduate programs.

Incomplete (I)—This notation is given when the professor observes conditions beyond the control of the student such that the student is not able to complete course requirements in the given quarter. This is a temporary grade that reverts to an F if the registrar has not received a change of grade directive from the professor by the end of the second succeeding quarter (including summer terms). Full tuition is charged.

Withdrawn (W)—This notation will be assigned in courses from which a student withdraws through the end of the eighth week of classes, or if a student withdraws from all courses in a given quarter.

Audit (Z)—This notation indicates a student has audited the course. An audit request form must be completed and approved by the department offering the course. The student need not take exams, and half tuition will be charged. A student can change from credit to audit or from audit to credit status for a course only during the first six days of classes. Audited courses do not count toward the residency requirement, do not get included in GPA calculations, and do not count toward degree requirements.

Credit by examination (X)—This notation is assigned for the successful completion of various external or university examinations, provided such examinations cover or parallel the objectives and content of the indicated course. Credit must be assigned in advance for any credit received through registration for the indicated courses. Courses graded X do not count toward the residency requirement. A maximum of 12 quarter credit hours is allowed for graduate courses. Exceptions to the maximum transfer credit or credit-by-exam for graduate programs can be granted by the associate provost for academic programs in unusual circumstances, upon appeal from the dean of the college involved.

Waived—Waived courses are those courses eliminated from the list of requirements that a student must take to graduate. For graduate students, required courses may be waived because of previously completed academic work, but in no case shall the resulting graduate program requirements be reduced below 45 quarter credit hours.

In addition, waiver credit for graduate courses can be applied only toward required, not elective, courses. The process of waiving courses and thereby reducing graduate program requirements is not to be confused with the process of exempting certain requirements that are then replaced by an equal number of credit hours in the specified program.

Changing grades

Once a grade has been reported by a faculty member, it is not within the right of any person to change this unless an actual error has been made in computing or recording it. If an error has been made, the faculty member must complete the appropriate form. The completed form must be approved by the head of the department in which the faculty member teaches. When approved, the form is then sent to the registrar. There is, however, an appeal procedure for disputed grades through the Academic Conduct Committee of the college in which the course is offered. A final appeal can be sent to the university's Hearing and Appeals Board.

Academic probation and suspension

Any matriculated graduate student whose program cumulative GPA falls below a 3.0 after 12 quarter credit hours will be placed on probation and counseled by the departmental adviser concerning continuation in the graduate program.

Those students placed on probation must raise their program cumulative GPA to the 3.0 level within 12 quarter credit hours or be suspended from the graduate program.

Should it be necessary to suspend a graduate student for academic reasons, the student may apply for readmission to the dean of the college or his designee upon demonstration of adequate reason for readmission.

Standards for student conduct

The RIT community intends that campus life will provide opportunities for students to exercise individual responsibility and places high priority on self-regulation by its members. All members of the community are responsible for encouraging positive behavior by others, as well as preventing or correcting conduct by others that is detrimental to RIT's educational mission and values.

As an educational community, RIT strives for a campus environment that is free from coercive or exploitative behavior by its members. Moreover, it sets high standards that challenge students to develop values that enhance their lives professionally and will enable them to contribute constructively to society.

RIT enjoys a diversity of backgrounds, lifestyles, and personal value systems among those who compose the academic community. Students, however, are expected to observe and respect the policies and standards of the university and the right of individuals to hold values that differ from their own and those expressed

by RIT. Students are encouraged to review the *Student Rights and Responsibilities Handbook* for information regarding campus policies and expectations of student conduct.

Students must recognize that they are members of the local, state, and federal communities, and that they are obliged to live in accord with the law without special privilege because of their status as students or temporary residents.

RIT offers a number of services for graduate students. Those described in the following pages are among the most frequently used.

Student Services

Academic Support Center

www.rit.edu/asc
(585) 475-6682
The Academic Support Center provides academic assistance to students, faculty, and staff. The center offers drop-in services for mathematics/physics and writing support for all levels of students, from freshmen to graduates. In addition to skill development, the center offers workshops that teach students how to improve their study techniques and make the most of their individual learning abilities. Individualized appointments are available as well as assessment of learning challenges. Academic Support Center services are free to RIT students (structured monitoring services are fee-based).

Academic Assessment Program: The goal of the Academic Assessment Program is to help students determine why their academic performance is not what they, or others, would like it to be. The variety of factors that may interfere with academic performance includes learning style, content background, study habits and approaches, unclear choice of major, and/or disabilities. The AAP uses interviews, surveys, screening instruments, and diagnostic testing to explore potential sources of difficulty; helps students identify the source of academic problems; and assists them in overcoming these obstacles by referring them to resources both on and off campus.

Institute Testing Services: Institute Testing Services is dedicated to providing design, implementation, and administration of group testing programs for students and community groups. The department is responsible for RIT's role as a National Testing Center and supervises the administration of the Graduate Record Examination (GRE) subject exams, Scholastic Achievement Test (SAT), Law School Admission Test (LSAT), National Certified Counselors (NCC) certification examination, and DANTES examination. Institute Testing Services also serves as a paper and pencil proctoring site for distance learners.

Structured Monitoring Program: This program is committed to helping individuals recognize and access their natural learning abilities and offers academic coaching designed for students who anticipate difficulties navigating the complexities of the academic environment. Structured Monitoring recognizes that each student is unique and responds by offering three levels of check-ins: biweekly, weekly, or daily. Students may select their level of participation on a quarterly basis. This is a fee-based service.

Mathematics services: The center's math program supports students' progress in learning mathematics. Tutors are located in the Bates Study Center in the Gosnell Building. This is a drop-in tutoring center staffed with peer tutors and ASC faculty. Tutors can help students with math and physics homework, lecture notes, textbook reading, practice quizzes, and practice tests. Math review packets cover topics in algebra, trigonometry, and calculus. Students encountering difficulties in their math courses may schedule an appointment with an ASC math instructor for a math assessment. Individualized math is a non-credit, self-paced math review course offered to students who have completed a math assessment. Students follow a unique program of study based on their math background and future math needs.

Reading services: ASC provides reading strategies for students who are having difficulty deciphering their textbooks. Services provided include standardized reading testing and evaluation, informal reading assessment, textbook strategies, ways to improve vocabulary, and information about speedreading.

Supplemental instruction: Supplemental Instruction offers a series of weekly study Sessons open to all students enrolled in supported sections of historically difficult courses. During SI, students meet to compare notes, discuss important concepts and develop study strategies. These voluntary study sessions are planned and facilitated by an undergraduate student leader, who has recently completed the course. To view a list of SI supported course sections or to learn more about how to become an SI Leader, please visit si.rit.edu.

Study skills: Students have the opportunity to meet with faculty who will assist in the development of study strategies to promote academic success. Individual instruction, coaching, and evaluation are available. Students will find a series of one-hour workshops offered each quarter that includes topics such as time management, listening and notetaking, text reading and marking, test taking, and test preparation. Student groups may request workshops and presentations from study skills faculty. Additionally, students will find materials on the ASC website.

Tutor training: A comprehensive and up-to-date website lists all available tutorial services on campus. In addition, tutor training workshops are offered for peer tutors who have been hired in any of the learning centers or academic departments. The tutor training program does not offer content training. For more information visit www.rit.edu/tutoring.

Writing Center: The Writing Center provides individualized instruction designed to improve students' ability to complete college writing assignments. Writing instructors work with students at every stage of the writing process. Instruction can be provided to develop students' editing and proofreading skills. This is a drop-in center with no appointments necessary.

Study centers:

- Bates Study Center (1200 Gosnell) provides support in mathematics and physics.
- ASC Writing Center (1180 SAU) provides instruction on becoming a more effective writer.
- Sol Study Center (1016 Sol Heumann Residence Hall) provides support in mathematics/physics and writing during weekday evening hours.
- Global Village Study Center (Study Abroad Conference room) provides support in mathematics and physics during weekday evening hours.

Campus Stores

rit.bncollege.com

Barnes & Noble@RIT—The official college bookstore is located at Park Point. The 40,000-square-foot store features educational textbooks for all courses, 60,000 titles, and RIT-related merchandise. The store offers wireless access, a Starbucks Café, and regular shuttle service to and from campus.

Digital Den—Located in the Student Alumni Union, the Digital Den offers a wide array of merchandise including computer equipment, hardware and software, iPods, and photography equipment and accessories. The store is staffed with knowledgeable personnel who can offer guidance on equipment and purchases.

Cooperative Education and Career Services

www.rit.edu/emcs/oce/
(585) 475-2301

The Office of Cooperative Education and Career Services offers a wide range of programs and services to support the career development and employment needs of all RIT students. The office offers one-on-one advising as well as job search seminars and presentations. It also provides online access to employment opportunities. Working relationships with thousands of employing organizations can help graduate students develop their individual job search plans. Graduate students are encouraged to meet with their assigned program coordinator in the Office of Cooperative Education and Career Services early to begin their career planning. Information is available through the website, by visiting the office on the first floor of the Bausch and Lomb Building, or by making an appointment.

Counseling Center

www.rit.edu/counseling
(585) 475-2261

University life can be one of excitement and self-discovery. At the same time, it can generate academic, emotional, personal, social, and even financial concerns. At times these concerns can make it difficult to succeed or function while at school. Counseling is an excellent way to address such issues, to learn more about yourself and others, and to develop new life skills.

The center's staff of professional counselors and psychologists is committed to supporting your academic and personal success. Counselors work with students whose concerns range from the everyday challenges of university life to more disruptive psychological issues. All services provided by the center are free to eligible students. Counselors fluent in American Sign Language are available for deaf and hard-of-hearing students.

Common concerns shared by students include:

- Academic performance
- Choice of major or careers
- Anxiety or stress
- Depression
- Feeling overwhelmed
- Self-esteem
- Family, friend, and partner relationships
- Eating and body image concerns
- Loss of an important relationship
- Illness or death of a loved one
- Out-of-control feelings
- Sexual orientation
- Sexual assault and violence
- Race, ethnicity, nationality, or other cultural identity
- Gender identity
- Suicidal feelings

Location: The Counseling Center is located in the August Center, immediately above the Student Health Service.

Hours:
Monday – Friday: 8:30 a.m. - 4:30 p.m.
Wednesday evenings – by appointment only

Mental health emergencies: If the emergency is life threatening, call 911 or go to the nearest emergency room. For emergencies during business hours (8:30 a.m. – 4:30 p.m.), call (585) 475-2261 or come to the center and identify the situation as an emergency. If you or someone else is in physical danger, call Public Safety at (585) 475-3333. Do not use e-mail in an emergency situation. For after-hours emergencies, contact Public Safety or Life Line (585) 275-5151, a confidential Rochester hotline.

Career exploration counseling: Counselors can assist students in making thorough appraisals of their interests, abilities, and personality traits so they can use this information in developing educational and vocational plans. Aptitude, interest, and personality tests may be used in this assessment process.

Career exploration resources: Located in the reception area of the center, career exploration resources include occupational information on a variety of careers, as well as vocational and educational reference books. The center and its resources are available on a walk-in basis.

Confidentiality: All counseling services are confidential. The center will not release information about students without a student's written permission except where required by law, as required to protect the student or others from physical danger, or upon court order (an extremely rare occurrence).

Making an initial appointment: Schedule an intake appointment by calling (585) 475-2261 or by visiting the center. During the initial visit, which lasts approximately 90 minutes, students will be asked to complete a confidential questionnaire and to briefly speak with an intake counselor about their immediate concerns.

Upon reviewing the student's intake information, a counselor will briefly explain options that may be appropriate. These might include: scheduling a follow-up appointment with a counselor, getting the student into a support or therapy group, or referring the student to another RIT office for services.

If the intake counselor recommends counseling at the center, students will be assigned a counselor and scheduled for a subsequent

appointment. On occasion, students are referred to community resources for specialized or continued counseling. In such instances, the center will assist them in locating a suitable resource.

Disability Services

www.rit.edu/dso
(585) 475-2023
RIT is committed to providing students with disabilities equal access to programs, services and physical facilities, and to fostering an environment where all community members are welcomed, valued, and respected.

Students who would like to request accommodation due to a disability should submit a "Request for Accommodations" form and appropriate documentation of the disability to the Disability Services Office. The request form can be found online or requested from Disability Services.

The director will review a student's request for accommodation and supporting documentation and recommend appropriate and reasonable accommodations as needed.

Diversity at RIT

Office for Diversity and Inclusion

www.diversity.rit.edu
(585) 475-6546
The Office for Diversity and Inclusion serves as a vital resource to develop and implement campus-wide initiatives and programs to promote diversity and inclusive excellence to students, faculty, and staff. Through various programs and special projects, the office fosters relationships between RIT and the greater Rochester community. The office is committed to the development of diversity education and monitors areas that target diverse populations across the university.

Multicultural Center for Academic Success

www.rit.edu/mcas
(585) 475-4704
The Multicultural Center for Academic Success serves all students regardless of their ethnic background. Our mission is to aid in the retention and graduation of African American, Latin American, and Native American students. MCAS offers programs that focus on academic excellence, mentoring, community development, leadership, and professional success. MCAS also offers a variety of professional development events, cultural heritage months, celebrations of diversity, and partnerships with student clubs and organizations to help students connect with the RIT community and establish a positive sense of campus life that celebrates RIT's cultural diversity.

McNair Scholars Program

www.rit.edu/mcnair
(585) 475-7611
The Ronald E. McNair Post-baccalaureate Achievement Program serves a diverse group of talented second- and third-year students who are interested in pursuing post-baccalaureate education. The program provides enriching scholastic experience that prepares eligible scholars for graduate education, with an emphasis on doctoral studies. This preparation includes research experience, the presentation of research at local and regional symposiums, and graduate school seminars and workshops.

Future Stewards Program

www.rit.edu/futurestewards
(585) 475-4982
The Future Stewards Program was established to increase the success rate and number of Native scholars (Native American, Alaska Native, and First Nations) in science, technology, engineering, and math disciplines, along with other areas of need in Indian society. The program partners with students and Tribal nations, organizations, and corporations to create opportunities for Native scholars to develop professionally, personally, and culturally. The program is dedicated to helping Native scholars succeed by recruiting, retaining, and returning scholars to the Tribal community upon graduation.

English Language Center

www.rit.edu/studentaffairs/elc/
(585) 475-6684 (voice/TTY)
The English Language Center offers both full- and part-time study of English to non-native speakers. Class offerings include conversation, grammar, writing, vocabulary, reading, pronunciation, presentation skills, business communication, and TOEFL preparation.

Full-time program: The intensive English language program consists of 20 hours of class instruction each week at beginning, intermediate, and advanced levels. There is also a learning lab where students may work on specific language skills and obtain extra assistance with their writing. There is a fee for English language services. This intensive study program meets the immigration requirements for the Certificate of Eligibility I-20 for F-1 student status.

Before a course of study can be selected, students are tested to determine their levels of English proficiency and diagnose their specific language needs.

Part-time program and individualized instruction: In addition to the full-time program, students may register for one or more English language courses. The center also offers private English classes tailored to individual needs. Pronunciation and conversation, as well as grammar, writing, reading, and vocabulary, may be studied in this manner. There is a fee for instruction.

Foreign language instruction: The center offers a fee-based program in which international students give lessons in their native languages. A trained language instructor supervises all student instructors. In addition to language, the international student can give lessons on the culture and customs of his or her country. Some of the languages offered have included Chinese, Japanese, Spanish, Portuguese, Hindi, Tagalog, Korean, French, and German.

ETC Production Services

http://www.rit.edu/academicaffairs/etc/
(585) 475-7703
ETC Production Services provides non-classroom production and event support. Individual services include:

Video production services: A full range of digital standard or high definition video services, including recording guest speakers in auditoriums, creating public relations marketing videos, producing RIT's SportsZone and SportsZone Live shows, videotaping in television studios, and editing in state-of-the-art digital post-production facilities as well as 2D and 3D animation. Finished projects can be captioned and delivered a variety of formats, including DVD, CD, Blu-ray, podcast, web or videotape.

Web/IT services: Multimedia and Web production services include website design and development, website updates, online registration systems, multimedia presentations, database development, and video streaming.

Event support services: Production and management of large and small venue video and multimedia productions, media projection, location shooting, multi-camera support, live video streaming, and real-time captioning.

Photography services: A range of digital photographic services in studio or on location, creating visual resources for slide presentations, class documentation, portfolios, websites and, publications.

Housing Operations

housing.rit.edu
(585) 475-2572
Serving nearly 7,000 students, campus housing offers many living options to meet the diverse needs, interests, and backgrounds of RIT students.

RIT Inn and Conference Center

The RIT Inn and Conference Center, located near campus, offers a student living environment combined with the perks of a first-rate hotel including fully furnished double rooms with private baths, TV with free cable service, phone with free local service, free high-speed Ethernet, free housekeeping, free reserved parking pass, and air conditioning. Students also have access to a heated indoor/outdoor pool, sauna whirlpool, fitness center, three on-site dining facilities, free laundry service, and free express shuttle service.

Apartments, University Commons Suites, Global Village

Five apartment and suite complexes with 950 apartment, suite, and townhouse units, ranging from one to four bedrooms, make up RIT's apartment and suite offerings. Additionally, Global Village offers 70 furnished suites with single and double bedroom options, as well as suites with and without kitchens. Although the majority of apartment, suite, and Global Village residents are undergraduates, each complex features a mixture of graduate and undergraduate, single and married students. Each complex offers the privacy of a small community and numerous amenities including free standard cable, free laundry service, utilities included, and much more.

The Housing Connection

Housing Connection is an online roommate and apartment referral service that provides an opportunity for upperclass students to post openings within the on-campus apartment complexes. Students use this site to look for housing within the apartments (roommate available), or to fill a vacancy in an apartment (roommate wanted).

Information and Technology Services

www.rit.edu/its/
(585) 475-4357
Campus computing and network services are provided by Information and Technology Services (ITS).

Wireless, Google Apps at RIT, and more

The campus-wide network includes high-speed wireless capabilities in all buildings on campus (except for the Riverknoll apartments and the RIT Inn & Conference Center). All RIT students are provided access to Google Apps at RIT, which includes RIT Gmail, the home for student e-mail accounts.

A campus-wide online portal is available at http://my.rit.edu. Users can customize their own site on the portal with personal Web links in addition to standard features as access to student government and RIT sporting events, University News, and the Student Information System, where individual student course information and grades are posted.

ITS, in conjunction with the Educational Technology Center, manages numerous computer labs and smart classrooms containing Windows and Macintosh workstations and printers. Most of these facilities are available to students for general computing use and to faculty for reserved class work. Lab assistants help people use the hardware and software available in the labs.

RIT computer accounts

Computer accounts are issued to students, faculty, and staff so that they can perform activities supporting educational goals and internal RIT functions. Incoming students will receive instructions for setting up their computer account upon payment of their tuition deposit. This allows students to use their accounts, get familiar with campus online systems, and feel more a part of the RIT community before they arrive.

Computer security and safeguards

RIT's Code of Conduct for Computer and Network Use guides campus-wide use of all computers and networks. This document, found online at www.rit.edu/computerconduct, outlines RIT's official policy related to ethical use of computing and network resources. ITS put into place multiple safeguards to protect RIT's network environment and the integrity of individual user ac-

counts. Additionally, ITS provides all students, faculty, and staff with anti-virus software free of charge.

Computer-based training

ITS, along with the Center for Professional Development, provides computer-based training modules that cover a wide variety of topics. Students, faculty, and staff can access numerous online courses in the areas of technology, e-business, and business/interpersonal skills. For more information on computer-based training, visit www.rit.edu/eLearningZone.

Student employment information

ITS employs more than 250 students and is one of the largest student employers at RIT. Student employment opportunities are available at the ITS HelpDesk, in Desktop Support, at colleges through Distributed Support Services, and within Technical Support and Administrative Support services. More specific information about job opportunities within ITS is available at www.rit.edu/its/about/student_employment. Additional information about student employment opportunities can be found at the Student Employment Office site at www.rit.edu/seo.

Residential Networking (Resnet)

Residential Networking provides computer support to students living in residential housing at RIT. The Resnet team can assist students with connecting their computers to the RIT network, accessing campus computing resources, and troubleshooting computer software and hardware. Contact Resnet at (585) 475-2600 (voice), (585) 475-4927 (TTY), or resnet@rit.edu, or visit http://resnet.rit.edu.

Contacting the HelpDesk

The ITS HelpDesk is located in room 1113 of the Gannett Building. Contact HelpDesk staff via telephone/TTY, e-mail, or the Internet:

(585) 475-HELP (4357)
(585) 475-2810 (TTY)
E-mail: helpdesk@rit.edu
Online: www.rit.edu/its/help

Service hours

Fall, winter, and spring quarter hours:
Monday-Thursday: 7:30 a.m. to 9 p.m.
Friday: 7:30 a.m. to 5 p.m.
Saturday-Sunday: Noon to 5 p.m.
Summer quarter, holidays, and quarter breaks:
Monday-Friday: 7:30 a.m. to 5 p.m.
Saturday-Sunday: Closed

International Student Services

http://www.rit.edu/studentaffairs/iss/
(585) 475-6943 (voice/TTY)

International Student Services is the primary resource for more than 1,600 hearing and deaf international students from 100 countries, as well as for members of the campus community seeking cross-cultural information. The office provides assistance with immigration regulations and travel documents, helps international students adjust to academic and cultural expectations in the United States, and provides cross-cultural programming for international students and the campus at large. The staff works closely with Global Union, international student clubs, and International House (the special-interest house in the residence halls for both international and American students). Off-campus programs are regularly coordinated with the Rochester International Council.

Libraries

library.rit.edu

The RIT Libraries includes the Wallace Library, the Cary Collection, the RIT Archive Collections, and the RIT Museum. The Lawson Center, home to the RIT Cary Graphic Arts Press and the RIT Press, can also be found within the Wallace Library.

Wallace Library is a high technology, multimedia resource center. It offers hundreds of databases and thousands of electronic books and journals, as well as traditional printed resources. Online resources can be accessed onsite, or around the clock from any location. Online course reading assignments and laptops are among the many other resources available.

If the library does not have what you need, it can be ordered through Information Delivery Services (IDS). Millions of additional books are available via ConnectNY, a service that provides access to the collections of 14 academic libraries in New York state. The Rochester Regional Library Council's Access program allows patrons to obtain a library card that offers access to other area libraries, including the University of Rochester and the state university colleges at Geneseo and Brockport.

Each college has a subject expert in the library to help with research. These subject experts are available seven days a week for individual assistance, while in-depth assistance is also available by appointment. You can connect with the subject experts by phone, email, or instant messaging. The Scholarly Publishing Studio provides one-stop service for advice and assistance in preparing research, articles, books, and other documents for publication.

Quiet study spaces for individuals and groups are available throughout the library. Students can reserve group study rooms online. Java Wally's café is also a favorite spot for relaxing, studying, or meeting in an informal setting.

The Cary Library is a unique collection of more than 14,000 volumes of rare books illustrating fine printing and other materials detailing the history of printing, book design and illustration, papermaking, and other aspects of the graphic arts. The RIT Archive Collections acquires, organizes, preserves, and displays materials from the university's past. The archives are the primary resource for studying the history of the university.

Wallace Library is open more than 100 hours a week, with extended hours before and during finals.

Leadership Institute and Community Service Center

www.rit.edu/lead
(585) 475-6974
The Leadership Institute and Community Service Center provides a variety of experiences for students to engage in and learn about leadership and community service. Some examples of our opportunities include: a weekend leadership adventure with ropes course, a leadership certificate program, four different leadership courses, a corporate and an RIT leadership conference, a public speaking series, an alternative spring-break program, participation in the American Heart Walk and Hillside's Special Santa drive, and volunteer connections with more than 260 agencies in the Rochester area.

Margaret's House

www.rit.edu/studentaffairs/margaretshouse
(585) 475-5176 (voice/TTY)

Childcare Programs

Margaret's House is a state-licensed childcare center offering full-day quality care and education for children 8 weeks to 8 years of age. It includes a district-approved full-day kindergarten as well as after-school, vacation, and summer programs. The center is open to children of RIT students, faculty, and staff and to members of the greater Rochester community. Margaret's House is located on campus and is open year-round. Call for information and registration material.

- Infant and toddler programs: 8 weeks to 36 months
- Preschool programs: 3- and 4-year-olds
- Full-day kindergarten/after-school programs: 5- to 8-year-olds
- Lil' Kids on Campus summer program for children entering grades 1 through 4

Parking and Transportation Services

http://facilities.rit.edu/pats
(585) 475-2074
To maintain order and safety, the Parking and Transportation Services department maintains parking policies that require all vehicles operated on campus by students, faculty, and staff to be registered within 10 days of arrival on campus. Students are not required to own the vehicle to register it, however, the address used to register the vehicle must be the same address where students reside while attending classes or working at RIT.

Transportation services are provided free of charge for all RIT housing residents, Park Point residents, and The Province residents via a shuttle service, which makes regularly scheduled stops to and from the academic areas on campus, housing areas, and other pertinent campus locations.

The Parking and Transportation Services office is located in Grace Watson Hall and is open Monday through Friday from 8 a.m. until 5 p.m. during the academic year. Summer hours may vary.

Bus and shuttle services: Transportation Services operates a van service for those with impaired mobility. The service runs Monday through Friday, 7 a.m. to 6 p.m., during fall, winter, and spring quarters. The transportation division also provides vans for use by student groups, clubs, and organizations.

Parking permits and vehicle registration: All vehicles operated on campus must be registered with the parking office annually. Vehicle registration decals must be properly displayed on each vehicle. Fines are imposed for those in violation of RIT parking and traffic regulations. We encourage everyone to become fully familiar with RIT parking policies and procedures, including online registration.

Handicap parking permits: RIT honors ADA-approved handicap parking permits from every state. Handicap parking permits can be obtained at local municipalities. Resident students can apply for a New York state permit at the Town of Henrietta. The RIT parking office does issue a one-week temporary handicap permit.

Part-time Enrollment Services

www.rit.edu/parttime
(585) 475-2229
The Office of Part-time Enrollment Services provides central information and counseling services for students interested in enrolling in part-time and online studies offered through RIT's various schools and colleges. Contact the office if you need assistance with selecting an academic program, exploring financial aid opportunities, registering for classes, or receiving information about any aspect of part-time study.

Staff members are available from 8:30 a.m. to 5 p.m., Monday through Thursday, and from 8:30 a.m. to 4:30 p.m. on Friday.

Public Safety

http://finweb.rit.edu/publicsafety/
(585) 475-2853
(585) 475-3333 (Emergency Line)
The Public Safety Department is open 24-hours-a-day and is located in Grace Watson Hall. To report an emergency call (585) 475-3333 or instant message staff at IM:ritpublicsafety. The department encourages the RIT community to take responsibility for their safety by staying informed of these services and reporting suspicious activity. Although each individual is ultimately responsible for their own personal safety, learning and practicing basic safety precautions can enhance one's well being.

The department provides the following services:

Blue light call boxes: Campus courtesy call boxes, identified by a blue light, are located across campus. These call boxes provide a direct line to Public Safety 24-hours-a-day. The location of the call is automatically recorded at the Public Safety Communications Center, making it possible for hard-of-hearing individuals to also use the call boxes. The call boxes may be used to request an

escort, assist a motorist, report suspicious individuals or activity, or request access to a locked building or room.

Mobile escort service: Public Safety strongly encourages students to use the mobile escort service. The service is available to anyone, seven-days-a-week, on a timed schedule between 11 p.m. and 3 a.m. Call the Public Safety Department at (585) 475-2853 (IM: ritpublicsafety) or use one of the blue light courtesy call boxes located across campus.

Lost and found: All items lost and found on campus are stored by the Public Safety Department. To report an item lost, please visit https://finweb.rit.edu/publicsafety/safety/lostitems.html to submit information related to lost property. Public Safety will contact you if the item is found on campus.

Emergency notification: If a family member needs to make an emergency notification to a student, he or she should contact Public Safety at (585) 475-2853 or (585) 475-6654 (TTY). Public safety will locate the student and relay the message.

Presentation programs: Throughout the year, public safety hosts a variety of prevention awareness programs and services on various topics including crime prevention, personal safety, and alcohol awareness. Quarterly newsletters are distributed via e-mail to all students to bolster safety awareness on campus.

Annual Safety and Security Report: Public safety's security report is available online and offers a description of security practices and information on reported occurrences of crime. Access the report at http://finweb.rit.edu/publicsafety/ritsaftey2010.pdf

Confidential tip line: The goal in providing this service is to obtain information that is unattainable through conventional methods and to alert public safety to endangering behavior that might go otherwise unreported. Individuals who utilize the tip line are encouraged to leave their names and contact information; however, they will not be contacted. http://finweb.rit.edu/publicsafety/forms/tipline/

The Advisory Committee on Public Safety will provide, upon request, all campus crime statistics as reported to the Department of Education. RIT crime statistics can be found at the Department of Education website (http://ope.ed.gov/security/) or by contacting the Public Safety Department. A hard copy of reported crime statistics required to be ascertained under Title 20 of the U. S. Code Section 1092(f) will be mailed to you within 10 days of the request.

Sexual assault information hotline: Confidential counseling services are available to anyone in need by calling (585) 546-2777 (voice/TTY).

Emergency Preparedness: RIT's emergency responses are based on a national model that is very flexible and can be applied to any scenario. RIT regularly communicates, prepares, and practices emergency management with public safety personnel and campus managers from various departments. If necessary, we will provide updated information through broadcast email, mass notification system (RIT ALERT), voicemail, and the university's website at http://www.rit.edu/.

Religious Life

www.rit.edu/studentaffairs/religion/
(585) 475-2135

The Center for Religious Life is unique in the RIT community. Recognizing the balance of mind and spirit, the chaplain staff, housed in the Schmitt Interfaith Center, provide worship and observances within diverse religious and cultural traditions. Nondenominational Christian, Southern Baptist, Catholic, Muslim, Jewish, Hindu, Lutheran, and Orthodox Christian are among the many communities serving campus needs and interests. Several religious clubs, including InterVaristy Christian Fellowship and Campus Crusade for Christ, also gather each week on campus. In a time of intellectual and spiritual growth, the center establishes an affirming environment for students, faculty, and staff to explore and discuss values informed by religious beliefs.

The Kilian J. and Caroline F. Schmitt Interfaith Center

The Interfaith Center, a gift of Kilian and Caroline Schmitt and other generous donors, is located on the east side of the Student Alumni Union. It is a focal point for the diverse religious traditions within the university, housing two chapels, meeting rooms, and offices for the campus ministry staff.

Student Financial Services

http://finweb.rit.edu/sfs/
(585)475-6186

Student Financial Services offers a variety of financial services for students, including billing, payment options, and loan repayment. The university has an electronic billing (eServices) program for students. eBills have replaced paper bill statements. Each quarter, all students are sent an e-mail notification to their university e-mail account stating that their eBill is available. Students have the option of selecting three additional e-mail addresses to allow for a parent, guardian, sponsor or other authorized user to receive eBill notifications. This facilitates online, real-time account inquiry and electronic payment.

Student Health Center

www.rit.edu/studentaffairs/studenthealth/
(585) 475-2255 (v), (585) 475-5515(tty)

The Student Health Center provides primary medical care on an outpatient basis. The staff includes physicians, nurse practitioners, physician assistants, registered nurses, health educators, an alcohol/drug counselor, and an interpreter for the deaf. Services are available by appointment. Health education programs also are provided.

The Student Health Center is located along the walkway linking the academic and residence hall areas of the campus. Students are seen Monday through Thursday, 8:30 a.m. to 6:30 p.m., and Friday, 8:30 a.m. to 4:30 p.m., by appointment. Emergencies are seen as need requires. Hours are subject to change and are posted.

The university requires students to maintain health insurance coverage—which they may purchase either on their own or through RIT—as long as they are enrolled at the university.

The quarterly student health fee is mandatory for all full-time undergraduate students. All other students may pay either the quarterly fee or a fee for service. Some laboratory work ordered through the Student Health Center is not covered by this fee; there is an additional charge for this service. Prescription medicines may be purchased from local pharmacies or, for some specific prescriptions, from the Student Health Center. The health fee does not include prescription medications.

Questions about the Student Health Center should be directed to the office. Questions regarding health insurance available through RIT should be directed to University Health Plans at (800) 437-6448.

RIT ambulance

(585) 475-3333 (voice)/(585) 475-6654 (TTY)

RIT ambulance is a New York state certified volunteer ambulance service that serves the campus community, including its adjoining apartment complexes. The organization, an auxiliary of the Student Health Center, is governed by RIT students and staff and is staffed by emergency medical technicians. Ambulance service is available 24-hours-a-day, seven-days-a-week. If, for some reason, RIT ambulance is not available, there may be a charge for services provided by another corps.

Health records

Medical records are confidential. Information will not be released without the written consent of the student. Exceptions to this rule are made only when required by the public health laws of New York state or a court-ordered subpoena or in a life-threatening situation.

New York state and RIT immunization requirements

New York state public law requires that all students enrolled for more than four quarter credit hours in a quarter and born after January 1, 1957, must provide proof of having received the appropriate immunizations against measles, rubella, and mumps or of having immunity to each disease validated by laboratory results from blood titers. Immunization requirements include two measles vaccinations, at least one month apart, after the first birthday; and one vaccination each against mumps and rubella and after the first birthday. RIT requires that these immunizations be given in two doses of combined MMR vaccine at least 30 days apart. New York State requires students to sign the meningitis awareness form. RIT requires all students age 26 and under to be immunized against meningitis. Failure to comply with the NY State immunization law may lead to exclusion from classes and the RIT community until compliance is obtained.

Other immunization requirements include Hepatitis B, TD booster, and PPD (for students from high-risk areas). Additional information concerning these requirements, the necessary documentation, and where documentation must be sent is included with the Admissions Office acceptance packet and also available on the center's website.

Veteran Enrollment Services

www.rit.edu/emcs/ptgrad/veterans.php3

(585) 475-6641

If you have questions regarding VA Benefits, NYS War Veteran Scholarships, TA, or the RIT Active Duty Service Member Scholarship, contact Veteran Enrollment Services.

All RIT courses and programs are approved for the education of members of the U.S. Armed Forces, veterans, and eligible dependents under the Veterans Readjustment Benefits Act, the Rehabilitation Act, and the War Orphans Act.

To receive information or apply for benefits, contact the office. Eligible students must submit an application for the VA Certificate of Eligibility. This application can be submitted online through the VA's website. All VA educational benefits paid to RIT students are the responsibility of the VA Regional Office in Buffalo, N.Y. We can send most enrollment information well in advance of the beginning of the starting quarter, thus eliminating long delays in payments. Applications for all benefits are available online, at local VA offices, or on campus in the Office of Veteran Enrollment Services. To ensure a smooth transition and successful academic program completion, start benefits paperwork early.

The Center For Women and Gender

www.rit.edu/studentaffairs/womenscenter/

(585) 475-7464

The Center for Women and Gender promotes a campus community that is safe, equitable, and respectful of all members by fostering an educational environment in which the entire RIT community can be personally, academically, and professionally successful without regard to gender, racial/ethnic origins, sexual orientation, gender identity, socio-economic status, or spiritual beliefs.

The center provides programs and services that serve women, men, deaf, hearing, and the LGBT communities, and that address relationship and sexuality issues, pregnancy, body image issues, harassment and discrimination, assertiveness, and sexual assault.

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*0105 Marketing
*0106 Decision Sciences/ Production and Operations Management
*0112 Management Information Systems

Kate Gleason College of Engineering

*0301 Electrical Engineering
0302 General Engineering
*0303 Industrial and Systems Engineering
*0304 Mechanical Engineering
*0305 Microelectronic Engineering
*0306 Computer Engineering
*0307 Quality and Applied Statistics
0308 Microsystems Engineering

College of Liberal Arts

0501 Criminal Justice
0502 Language
0503 Foreign Languages
0504 Literature
*0505 Fine Arts
0507 History
0508 Science, Technology and Society
*0509 Philosophy
0510 Anthropology
0511 Economics
0513 Political Science
*0514 Psychology
*0515 Sociology
0516 Social Work
0520 Interdisciplinary—Liberal Arts
*0521 Public Policy
0522 Women's Studies
0523 American Studies
*0535 Professional and Technical Communication

College of Applied Science and Technology

0606 Electrical/Mechanical Engineering Technology
*0607 Packaging Science
0608 Civil Engineering Technology
0609 Electrical Engineering Technology
*0610 Mechanical Engineering Technology
*0614 Telecommunications Engineering Technology
*0617 Manufacturing Engineering Technology
0618 Computer Engineering Technology
0619 Hospitality Service Management
0620 Nutrition Management
0621 Food Management
0622 Hotel and Resort Management
0623 Travel Management
*0624 Hospitality/Tourism Management
*0625 Service Management
*0626 Human Resource Development
*0627 Instructional Technology
*0630 Environmental Management Technology
*0633 Safety Technology
0634 Emergency Management
*0635 Health Systems Administration
0640 Reserve Officer Training-Corps—Air Force
0650 Reserve Officer Training Corps—Army
0680 Accounting and Business Systems
0681 Business and Management
0682 International Business
0684 Quality Management
0686 Humanities and Social Science
*0688 Technical Communication
0692 Math and Science
0694 Emergency Management
*0699 Cross-Disciplinary Professional Studies

National Technical Institute for the Deaf

0801 Accounting Technology
0804 Business Technology/ Administrative Support Technology
0805 Applied Computer Technology
0806 Interdisciplinary Studies
0812 Computer Integrated Machining Technology
0813 Computer Integrated Machining Technology
0820 Healthcare Billing and Coding Technology
0825 Art and Computer Design
0827 Applied Optical Technology
*0835 Graduate Secondary Education
0853 Prebaccalaureate Studies
0860 Speech and Language
0875 ASL/English Interpretation
0876 Deaf Studies Certificate
0878 Digital Imaging and Publishing Technology
0879 Laboratory Science Technology
0880 Communication Studies
0880 Humanities
0881 Performing Arts
0882 Social Science
0883 English
0884 Mathematics
0885 Science
0886 American Sign Language
0890 Computer Aided Drafting Technology
0891 Automation Technologies

College of Science

1001 Biology
1004 General Biology
1005 Field Biology
*1006 Environmental Science
*1008 Analytical Chemistry
*1009 Biochemistry
*1010 Chemistry
1011 General Chemistry
*1012 Inorganic Chemistry
*1013 Organic Chemistry
*1014 Physical Chemistry
*1015 Environmental Chemistry
*1016 Mathematics and Statistics
1017 Physics
1018 Contemporary Science—General
1024 Medical Lab Technology
1025 Nuclear Medicine Technology
1026 Clinical Science—General
1027 Biomedical Computing
1028 Materials Science and Engineering
*1029 Polymer Chemistry
1030 Diagnostic Medical Sonography
1032 Physician Assistant
1050 Color Science
*1051 Imaging Science
1055 Honors Courses

College of Imaging Arts and Sciences

*2001 Interdisciplinary Imaging Arts
2009 New Media Design
*2010 Graphic Design
2011 Art Education
2012 Art and Design Extended Studies
2013 Foundation Courses
2015 Interior Design
*2019 Illustration
*2020 Medical Illustration
*2021 Fine Arts Studio
*2035 Industrial Design
2039 Art History
*2040 Ceramics
*2041 Glass
*2042 Metals
*2043 Textiles
*2044 Wood
2045 General Crafts Studies
2046 Crafts Extended Studies
2060 Fine Art Photography
2061 Biomedical Photo
*2065 Film and Animation
2067 Photographic Arts
2068 Imaging Systems Management
2076 Imaging and Photo Technology
*2080 Printing Management
*2081 Printing Technology
2082 Graphic Media
2083 New Media Publishing

B. Thomas Golisano College of Computing and Information Sciences

*4002 Information Technology
4003 Computer Science
4004 Information Technology Graduate Web and Multimedia
4005 Computer Science
4010 Software Engineering

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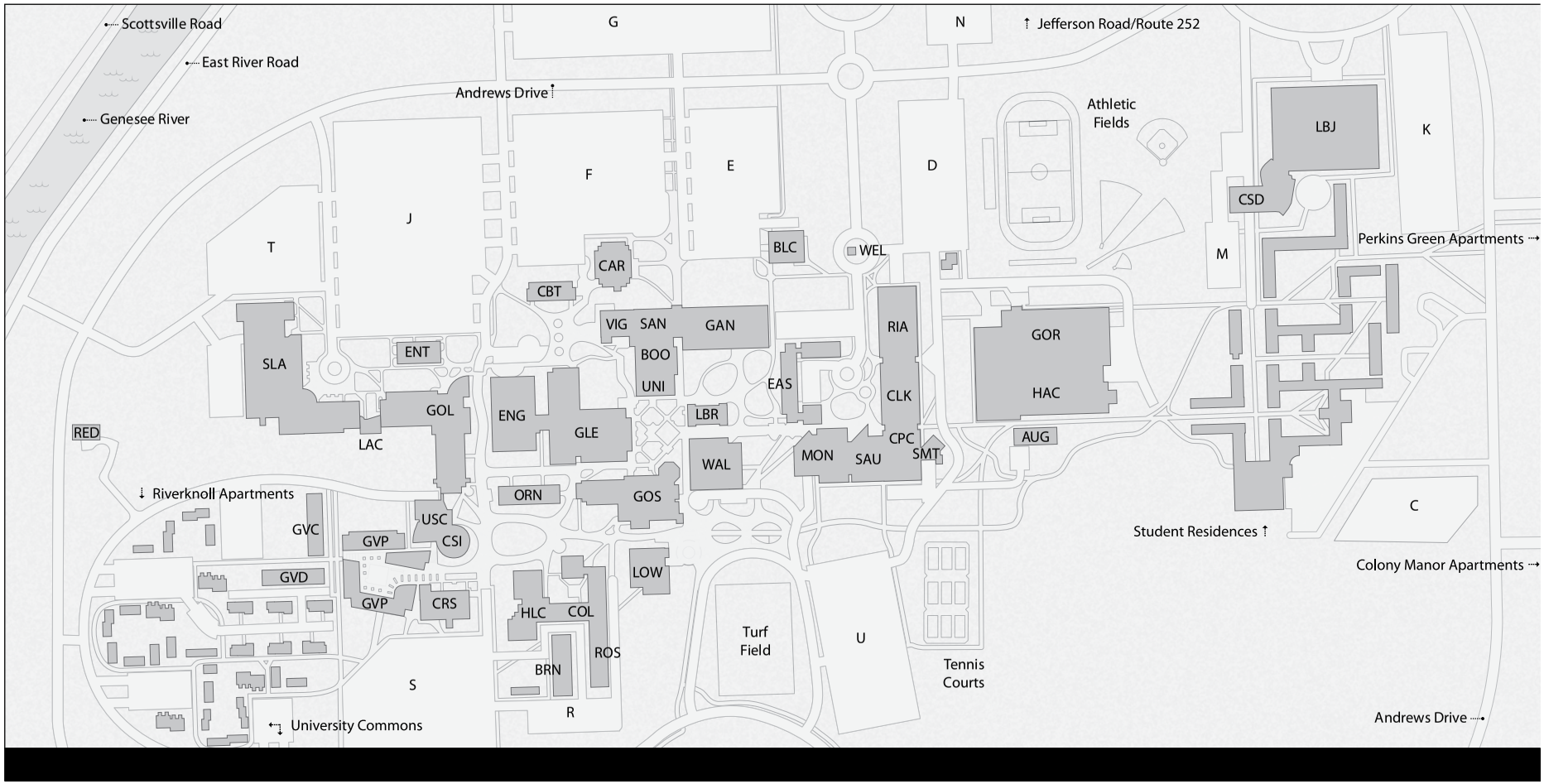

RIT CAMPUS MAP

AUG	August Center
BLC	Bausch & Lomb Center
BOO	James E. Booth Hall
BRN	Brown Hall
CAR	Chester F. Carlson Center for Imaging Science
CBT	Center for Bioscience Education & Technology
CLK	George H. Clark Gymnasium
COL	Color Science Hall
CPC	Campus Center
CRS	Crossroads
CSD	CSD Student Development Center
CSI	Center for Student Innovation
EAS	George Eastman Hall
ENG	Engineering Hall
ENT	Engineering Technology Hall
GAN	Frank E. Gannett Hall
GLE	James E. Gleason Hall
GOL	Golisano Hall
GOR	Gordon Field House and Activities Center
GOS	Thomas Gosnell Hall
GVC	Global Village Way C
GVD	Global Village Way D
GVP	Global Village Plaza
HAC	Hale-Andrews Student Life Center
HLC	Hugh L. Carey Hall
LAC	Laboratory for Applied Computing
LBJ	Lyndon Baines Johnson Hall
LBR	Liberal Arts Hall
LOW	Max Lowenthal Hall
MON	Monroe Hall
ORN	Orange Hall
RED	Red Barn
RIA	Frank Ritter Ice Arena
ROS	Lewis P. Ross Hall
SAN	Sands Family Studios
SAU	Student Alumni Union
SLA	Louise Slaughter Hall
SMT	Schmitt Interfaith Center
UNI	University Gallery
USC	University Services Center
VIG	Vignelli Center for Design Studies
WAL	Wallace Library
WEL	Welcome Center

R·I·T

Rochester Institute of Technology

Periodicals