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2022-2023 Graduate Course Descriptions

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**outstanding
educational
experience**



**Graduate Bulletin
2022-23**

Rochester Institute of Technology 2022–23 Academic Calendar

† The Add/Drop period is the first seven class days of the fall, spring, and full summer terms, excluding Sundays and holidays.

* Tentative spring semester and summer term schedule. RIT reserves the right to update the spring and summer schedule.

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Fall Semester (2221)

August 22

Day, evening, and online classes begin
First day of Add/Drop period †

August 27

Saturday classes begin

August 29

Last day of Add/Drop period †

August 30

First day to drop from classes with a grade of “W”

September 5

Labor Day—No Classes

October 10–11

Fall Break—No Classes

November 4

Last day to drop from classes with a grade of “W”

November 23

No Classes
University closes at 2pm

November 24–25

Thanksgiving Holiday
University closed

December 5

Last day, evening, and online classes

December 6

Reading Day

Dec. 7, 8, 9, 12, 13, 14

Final exams

December 16

Final grades due

December 15–January 16

Break between fall and spring semesters

Spring Semester (2225)

January 16

Martin Luther King Jr. Day (no classes)

January 17

Day, evening, and online classes begin
First day of Add/Drop period †

January 21

Saturday classes begin

January 24

Last day of Add/Drop period †

January 25

First day to drop from classes with a grade of “W”

March 12–19

Spring Break (no classes)

April 7

Last day to drop from classes with a grade of “W”

May 1

Last day, evening, and online classes

May 2

Reading Day

May 3, 4, 5, 8, 9, 10

Final exams

May 12

Final grades due

May 12–13

Convocation and
Commencement Ceremonies

May 15–17

Break between spring semester
and summer term

12-week Summer Term (2228)

May 18

Day, evening, and online classes begin
First day of Add/Drop period †

May 20

Saturday classes begin

May 25

Last day to Add/Drop classes †

May 26

First day to drop from classes with a grade of “W”

May 29

Memorial Day (no classes)
University closed

July 4

Independence Day observed
University closed

July 27

Last day to drop from classes with a grade of “W”

August 9

Last day, evening, and online classes

August 10

Reading Day

August 11, 14, 15

Final exams

August 17

Final grades due

August 18–27

Break between summer term and fall semester

Short Session 1 Summer Term (2228)

May 18

Day, evening, and online classes begin
First day of Add/Drop period †

May 22

Last day to Add/Drop classes †

May 23

First day to drop from classes with a grade of “W”

May 29

Memorial Day (no classes)
University closed

June 21

Last day to drop from classes with a grade of “W”

June 28

Last day of classes

June 29, 30

Final exams

July 3

Final grades due

Short Session 2 Summer Term (2218)

July 3

Day, evening, and online classes begin
First day of Add/Drop period †

July 4

Independence Day observed (no classes)
University closed

July 6

Last day to Add/Drop classes †

July 7

First day to drop from classes with a grade of “W”

August 2

Last day to drop from classes with a grade of “W”

August 9

Last day, evening, and online classes

August 10

Reading Day

August 11, 14, 15

Final exams

August 17

Final grades due

College of Art and Design

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Course numbering: RIT courses are generally referred to by their alphanumeric registration label. The four alpha characters indicate the discipline within the college. The final three digits are unique to each course and identify whether the course is noncredit (less than 099), lower division (100-299), upper division (300-599), or graduate level (600 and above).

Unless otherwise noted, the following courses are offered annually. Specific times and dates can be found in each semester's schedule of courses. Prerequisites/corequisites are noted in parentheses near the end of the course description.

Interdisciplinary Art and Design

IDEA-621 Experiential Urban Landscapes

This course focuses on learning a variety of assessment, problem-solving, and representational approaches; merging and developing new approaches and solutions through the medium of a complex urban design problem; and evolving a modus operandi for transdisciplinary creative activity for more resilient urban design interventions. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 2, Credits 3 (Fall)**

IDEA-621 Experiential Urban Landscapes

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IDEA-650 Experimental Workshop

This course will focus on implementing and developing interdisciplinary design projects. The specific topics for this course will vary each time it is taught but may be limited to repeatability. The topic is determined by the instructor. Technical, cultural, and human-centered aspects will be covered through a series of projects. Students will participate in extended group projects with a range of design problems, goals, tools, and procedures. Activities include branding, physical prototyping, fabrication, and digital product design. The specific topic varies and is determined by the instructor. This course can be taken multiple times but individual topics must be different. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall, Spring)**

IDEA-690 TravelSem: Topic

This course will provide students with an intensive seminar experience in art, craft, design, photography, film, or animation while traveling internationally. Topics will vary depending on the faculty member or members leading the study abroad program associated with the course. A description will be published for each iteration of the course. This course can be taken multiple times but individual topics must be different. **Lecture 3, Credits 3 (Fall, Spring, Summer)**

IDEA-691

Travel Studio: Topic

This course will provide students with an intensive studio experience in art, craft, design, photography, film, or animation while traveling internationally. Topics will vary depending on the faculty member or members leading the study abroad program associated with the course. A description will be published for each iteration of the course. This course can be taken multiple times but individual topics must be different. Admission to the course is based on application through RIT Global and instructor permission. Students may not enroll in or withdraw from the course independently. Additional fees are required for this course. **Studio 6, Credits 3 (Fall, Spring, Summer)**

IDEA-705

Thinking About Making: the Practice of Art in a Global Society

The course seeks to bridge the gap between studio practice and contemporary art history. Course content will explore 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. **Lecture 3, Credits 3 (Fall, Spring)**

IDEA-708

Inside the Artist's Studio

This course will provide students with the opportunity to visit with professional working artists from various disciplines in the arts and design. Through in-person and virtual studio visits students will engage in live discussions relating to each artist's studio practice. Topics discussed will include the development of creative inspiration and source materials, work methods, techniques and process for studio practice, and professional and business practice. Introductions and discussions with a range of creative artists and designers will lead to a broader understanding of creative problem solving, contemporary issues in art and design, and the development of a business acumen in art and design. (his course is restricted to Graduate College of Art and Design students.) **Lecture 3, Credits 3 (Spring)**

IDEA-713

Art in Person

This course will engage students in aesthetic research through field trips to museums, galleries and other locations of significance to the art and design fields. Through in person examinations of art, architecture and design, students will gain an awareness of the historical and cultural context of a range of significant creative work. Participants in this immersive course will be expected to gather visual references and source material in support of a personal aesthetic, design philosophy and studio practice. Location(s) of field trip excursions will be determined by the instructor. (his course is restricted to Graduate College of Art and Design students.) **Lecture 3, Credits 3 (Fall)**

IDEA-776

College Teaching and Learning

This course will provide students with an introduction to the scholarship of teaching and learning in the university environment. Students will explore a range of perspectives on pedagogical practice, curriculum development and the assessment of learning in a studio, lab and seminar based classroom. Additionally, students will focus on ways that students learn, how learning can be improved, and different methods of conducting research into teaching and learning. Students are expected to write critical papers and essays, develop curriculum resources, and to participate in weekly small and large format discussion groups. Online technology is utilized in addition to lectures, videos, and other forms of media. **Lecture 3, Credits 3 (Fall)**

School for American Crafts

Ceramics

CCER-601

Ceramic Practice

This course will explore advanced aesthetics and techniques of ceramics. Course content is structured on the basis of the individual student's needs, interests, and background preparation. There will be a strengthening of ceramics techniques, design fundamentals, and encouragement of personal expression. The student will be encouraged to evaluate new techniques, materials, and concepts. **Fee: A materials fee is required for this course, and an additional course fee applied via student account** **Studio 6, Credits 3 (Fall or Spring)**

CCER-611

Ceramic Processes

Students will build upon their experience to further advance the technical, aesthetic and conceptual understanding of ceramic form and surface. This course will work from a set of prompts which will provide parameters for building individual bodies of work in a variety of different forming processes. Students will work from conceptual and contextual prompts to gain insight and build skills with advanced forming processes, surface investigation, idea development, and documentation. **Fee: A materials fee is required for this course, and an additional course fee applied via student account** **Studio 6, Credits 3 (Fall or Spring)**

CCER-630

Ceramics Elective III

This is a class specifically designed for non-majors covering the fundamental techniques and aesthetics of working with clay. Topics covered include the forming techniques, clay mixing, basic properties of clay, glazing and firing techniques and fundamental understanding of historical and contemporary practices and applications. The course includes prescribed projects. **Fee: There is a lab fee required for this course** (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Studio 5, Credits 3 (Fall, Spring)**

CCER-698

Ceramics Internship

The Ceramics Internship will provide students with the option to work in the ceramics field. Students may apply for internships to businesses based on the availability of positions and business job needs. Students must obtain permission of an instructor and complete the Internship Permission Form to enroll. (Prerequisites: This class is restricted to students in CCER-MFA with department permission.) **Internship, Credits 1 - 6 (Fall, Spring)**

CCER-699

Ceramics Co-op

Cooperative Education will provide Ceramic students with hands-on experience in their field, directly related to a student's major with an established studio or related business. Students will need to apply for co-ops, and interview as part of the selection process, based on available positions posted by the Co-op and Career Services Office, or found through the students' own research. In programs where co-op is a degree requirement, students must obtain permission of their program or graduate director prior to enrollment. Co-ops are typically paid work experience, and can be part-time (150-479 total hours within the term), or full-time (480+ hours within the term). Co-ops may be one or two consecutive terms - fall, spring, or summer - with department permission. (Prerequisites: This class is restricted to students in CCER-MFA with department permission.) **CO OP, Credits 0 (Fall, Spring, Summer)**

CCER-790

Ceramics Thesis Initiation

Ceramics Thesis Initiation is the third of a four-semester sequential class covering the advanced aesthetics and techniques of ceramics and culminating in the Master's of Fine Art thesis. Students will develop a topic of investigation for the Master's of Fine Arts thesis, select a graduate thesis committee, and begin the planning, research, and development of a body of creative work. This program is structured on the basis of the individual student's needs, interests and background preparation determined through research and faculty consultation. There will be a strengthening of ceramics techniques, design fundamentals and encouragement of personal expression. Student will be encouraged to evaluate new techniques, materials and concepts. This course is the prequel to the Master's of Fine Arts thesis, proposed by the student and approved by the faculty. **Fee: There is a lab fee required for this course** (Prerequisites: CCER-702 or equivalent course and student standing in the CCER-MFA program.) **Studio 12, Credits 6 (Fall)**

CCER-799

Ceramics Independent Study

Ceramics Independent Study will provide students with the ability to study in a specialized area with an individual faculty member. Students, with the assistance of a faculty adviser will propose a course of study. Ceramics Independent Study students must obtain permission of an instructor and complete the Independent Study Permission Form to enroll. **NOTE: Student must have a minimum 3.0 GPA ** (This course requires permission of the Instructor to enroll.) **Ind Study, Credits 1 - 6 (Fall, Spring)**

CCER-887

Ceramics Part-Time Co-op

Cooperative Education will provide Ceramic students with hands-on experience in their field, directly related to a student's major with an established studio or related business. Students will need to apply for co-ops, and interview as part of the selection process, based on available positions posted by the Co-op and Career Services Office, or found through the students' own research. In programs where co-op is a degree requirement, students must obtain permission of their program or graduate director prior to enrollment. Co-ops are typically paid work experience, and can be part-time (150-479 total hours within the term), or full-time (480+ hours within the term). Co-ops may be one or two consecutive terms - fall, spring, or summer - with department permission. (Prerequisites: This class is restricted to students in CCER-MFA with department permission.) **CO OP, Credits 0 (Fall, Spring, Summer)**

CCER-890

Ceramics Thesis Resolution

Ceramics Thesis Resolution is final course covering the advanced aesthetics and techniques of ceramics. Working from an approved topic of investigation for the Master's Thesis, students work independently and create a body of work supported by a written Thesis paper. In consultation with a selected graduate Thesis Committee, students plan, research, and develop a body of creative work for exhibition and review. This program is structured on the basis of the individual student's needs, interests and background preparation determined through research and faculty consultation. There will be a strengthening of ceramic techniques, design fundamentals and encouragement of personal expression. Student will be encouraged to evaluate new techniques, materials and concepts. **Fee: There is a lab fee required for this course** (Enrollment in this course requires permission from the department offering the course.) **Thesis 12, Credits 9 (Spring)**

General Crafts Studies

Glass

CGLS-601

Glass Graduate Studio: Concepts

This course is designed to deepen the individual's understanding and connection to concepts in contemporary glass and art. Course content will include a chosen thematic focus relevant to issues in the contemporary art conversation that will influence student development and the course's conversation through various assignments and group activities. Readings, group discussion, written responses, and material research will culminate in self-directed projects based on a proposed topic of student investigation. Students will explore research themes through conversation, presentation, and workshops. Additionally, this course will host visiting artists who will contribute through lectures, studio visits and activities pertinent to their practices. This course may be retaken for credit. **Fee: There is a materials fee required for this course and an additional course fee applied via student account. ** **Studio 6, Credits 3 (Fall, Spring)**

CGLS-602

Glass Graduate Studio: Practice

This course is designed to challenge the individual student's interests, background and capabilities to support a reinvigorated approach to their thinking and making in relation to glass. Course content will include exploration of technique and experimentation through student designed and implemented skill exchanges. Glass studios will be investigated in four-week blocks. Each block will tackle a different studio/technique/material question and will be supported by studio visits, discussions, and punctuated by critique. This course will be retaken for credit and leads to the master's thesis, proposed by the student and approved by the faculty. **Fee: There is a materials fee required for this course and an additional course fee applied via student account. ** **Studio 6, Credits 3 (Fall, Spring)**

CGLS-630

Glass Processes

This course is designed for non-majors and covers fundamental techniques and aesthetics of working with glass. Topics will include glass forming, hot and cold-working techniques, basic properties of glass, fundamental understanding of historical and contemporary practices and applications. There is required out-of-class lab time in the glass studio for a minimum of 3 hours per week. ** Fee: There is a course fee applied via student account** (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Studio 6, Credits 3 (Fall, Spring)**

CGLS-698

Glass Graduate Internship

Glass graduate internship is a course that offers students the chance to take advantage of professional opportunities as they arise during their graduate studies. This course is structured on the basis of the individual student's needs, interests and background preparation as they may be determined through faculty counseling. This course leads to the master's thesis, proposed by the student and approved by the faculty. (Prerequisites: This class is restricted to students in GLASS-MFA who have at least a 3.0 GPA and instructor permission to enroll.) **Internship, Credits 1 - 6 (Fall, Spring, Summer)**

CGLS-699

Glass Co-op

Cooperative Education will provide Glass students with hands-on experience in their field, directly related to a student's major with an established studio or related business. Students will need to apply for co-ops, and interview as part of the selection process, based on available positions posted by the Co-op and Career Services Office, or found through the students' own research. In programs where co-op is a degree requirement, students must obtain permission of their program or graduate director prior to enrollment. Co-ops are typically paid work experience, and can be part-time (150-479 total hours within the term), or full-time (480+ hours within the term). Co-ops may be one or two consecutive terms - fall, spring, or summer - with department permission. (Prerequisites: This class is restricted to students in GLASS-MFA with department permission.) **CO OP, Credits 0 (Fall, Spring, Summer)**

CGLS-799

Glass Grad Independent Study

Glass Graduate Independent Study will provide students with the ability to study in a specialized area with an individual faculty member. Students, with the assistance of a faculty adviser, will propose a course of study. Students will produce projects specific to their proposal. **NOTE: Student must have a minimum 3.0 GPA ** (Prerequisites: This class is restricted to students in MFA programs with instructor permission to enroll.) **Ind Study, Credits 1 - 6 (Fall, Spring)**

CGLS-887**Glass Part-Time Co-op**

Cooperative Education will provide Glass students with hands-on experience in their field, directly related to a student's major with an established studio or related business. Students will need to apply for co-ops, and interview as part of the selection process, based on available positions posted by the Co-op and Career Services Office, or found through the students' own research. In programs where co-op is a degree requirement, students must obtain permission of their program or graduate director prior to enrollment. Co-ops are typically paid work experience, and can be part-time (150-479 total hours within the term), or full-time (480+ hours within the term). Co-ops may be one or two consecutive terms - fall, spring, or summer - with department permission. (Prerequisites: This class is restricted to students in GLASS-MFA with department permission.) **CO OP, Credits 0 (Fall, Spring, Summer)**

Metals and Jewelry Design

CMTJ-601**Metals and Jewelry Design Graduate Studio**

This course covers the advanced aesthetics and techniques in metals and culminating in the Master's of Fine Arts Thesis. The course is structured on the individual student's needs, interests and background preparation as they may be determined through faculty counseling. There will be a strengthening of metals techniques, design fundamentals and encouragement of personal expression. The student will be encouraged to evaluate new techniques, materials and concepts. This course is repeatable and leads to the master's thesis, proposed by the student and approved by the faculty. Lab fee is required. (This class is restricted to students in the METAL-MFA program.) **Studio 12, Credits 6 (Fall, Spring)**

CMTJ-630**Form and Fabrication: Metals and Jewelry Design**

This is an elective course providing graduate-level students an opportunity for introductory study in metals: either hollowware or jewelry. Students will gain an understanding of the history of metals. Development of metals techniques, design fundamentals and encouragement of personal expression are encouraged. The student will learn to evaluate new techniques, materials and concepts. Slide lectures, technical demonstrations, field trips, hands-on experience and critiques used. **Fee: There is a lab fee required for this course** (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Studio 6, Credits 3 (Fall, Spring, Summer)**

CMTJ-698**Metals and Jewelry Design Graduate Internship**

This course is open to all Metals graduate students with a minimum of a 3.0 GPA. Metals and Jewelry Design students should first procure an internship opportunity within our industry. Students must submit a completed permission form identifying the firm and what they have been told will be their duties and responsibilities. Metals and Jewelry Design Internships must be approved by the student's Graduate Director or School Director. Students are required to submit a minimum 10-page paper about their experience and obtain a letter of review from their job site supervisor. 90 hours of work earns 1 semester credit. (Prerequisites: This class is restricted to students in METAL-MFA with department permission.) **Internship, Credits 1 - 6 (Fall, Spring, Summer)**

CMTJ-699**Metals and Jewelry Design Co-op**

Cooperative Education will provide Metals and Jewelry Design students with hands-on experience in their field, directly related to a student's major with an established studio or related business. Students will need to apply for co-ops, and interview as part of the selection process, based on available positions posted by the Co-op and Career Services Office, or found through the students' own research. In programs where co-op is a degree requirement, students must obtain permission of their program or graduate director prior to enrollment. Co-ops are typically paid work experience, and can be part-time (150-479 total hours within the term), or full-time (480+ hours within the term). Co-ops may be one or two consecutive terms - fall, spring, or summer - with department permission. (Prerequisites: This class is restricted to students in METAL-MFA with department permission.) **CO OP, Credits 0 (Fall, Spring, Summer)**

CMTJ-790**Metals and Jewelry Design Thesis Initiation**

This is the first of a two-semester thesis course sequence covering the advanced aesthetics and techniques in metals. This is a 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 may be 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. **Fee: There is a lab fee required for this course** (Prerequisites: CMTJ-702 or equivalent course and student standing in the METAL-MFA program.) **Studio 12, Credits 6 (Fall)**

CMTJ-799**Metals and Jewelry Design Independent Study**

Metals and Jewelry Independent Study will provide students with the ability to study in a specialized area with an individual faculty member. Students, with the assistance of a faculty adviser will propose a course of study to pursue over the course of the semester. Goals and objectives will be outlined by the student in conjunction with their faculty adviser. Metals and Jewelry Independent Study students must obtain permission of an instructor and complete the Independent Study Permission Form to enroll. **NOTE: Student must have a minimum 3.0 GPA ** (Prerequisites: This class is restricted to students in CCER-MFA, GLASS-MFA, METAL-MFA or WOOD-MFA with instructor permission.) **Ind Study, Credits 1 - 6 (Fall, Spring)**

CMTJ-887**Metals and Jewelry Design Part-Time Co-op**

Cooperative Education will provide Metals and Jewelry Design students with hands-on experience in their field, directly related to a student's major with an established studio or related business. Students will need to apply for co-ops, and interview as part of the selection process, based on available positions posted by the Co-op and Career Services Office, or found through the students' own research. In programs where co-op is a degree requirement, students must obtain permission of their program or graduate director prior to enrollment. Co-ops are typically paid work experience, and can be part-time (150-479 total hours within the term), or full-time (480+ hours within the term). Co-ops may be one or two consecutive terms - fall, spring, or summer - with department permission. (Prerequisites: This class is restricted to students in METAL-MFA with department permission.) **CO OP, Credits 0 (Fall, Spring, Summer)**

CMTJ-890**Metals and Jewelry Design Thesis Resolution**

This course will focus on 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. **There is a lab fee required for this course** (Enrollment in this course requires permission from the department offering the course.) **Studio 12, Credits 9 (Spring)**

Furniture Design

CWFD-601**Furniture Design Graduate Studio**

Furniture Design Graduate Studio covers the advanced aesthetics and techniques of wood-working and culminating in the master's thesis. 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 woodworking techniques, design fundamentals and encouragement of personal expression. The student will be encouraged to evaluate new techniques, materials and concepts. This repeatable course leads to the master's thesis, proposed by the student and approved by the faculty. Lab fee is required. (This course is restricted to students in the WOOD-MFA program.) **Studio 12, Credits 6 (Fall, Spring)**

CWFD-606**Design and Fabrication I**

This course will cover fundamental woodworking techniques associated with furniture design and construction. Through ideation and conceptual development, students will investigate the functional and aesthetic considerations of table design. Topics covered will include wood as a material and its basic properties, design development through drawing and modelmaking, the safe use and care of hand tools such as chisels and saws, and stationary power tools. Students will be introduced to wood joinery best suited for table construction including halved and bridle joints, and simple mortise and tenon construction. **Fee: There is a materials fee required for this course and an additional course fee applied via student account. See course notes for course fee information** **Studio 6, Credits 3 (Fall)**

CWFD-607**Design Methods and Practice I**

This course will provide students with fundamental techniques necessary to design and fabricate refined hand carved vessels and other wooden objects. Participants in this course will gain an understanding of the inherent properties of wood, identifying assets and limitations of the material as they design and build. Students will develop skills to formalize individual design ideas for presentation, planning and construction. Topics will include lumber selection, the safe and proper use of machinery and portable power tools, the care and use of gouges, spokeshaves and other sharp-edged hand tools, as well as sanding and wood finishing. Demonstrations, presentations, discussions, critiques, as well as individual meetings with students, will support the focus on craftsmanship, technical knowledge and design development. **Fee: There is a materials fee required for this course and an additional course fee applied via student account. See course notes for course fee information** **Studio 6, Credits 3 (Fall)**

CWFD-611

Design and Fabrication II

This course will cover intermediate woodworking techniques associated with furniture design and construction. With a focus on aesthetics, structure, and functionality, students will design and construct furniture for seating such as a stools and benches. Topics covered will include intermediate joinery techniques, lathe turning, hand and power shaping, and the safe use of the multi-router, router table and rotary carving tools. Demonstrations, presentations, discussions, critiques, as well as individual meetings with students, will support the focus on craftsmanship, technical knowledge and design development. **Fee: There is a materials fee required for this course and an additional course fee applied via student account. See course notes for course fee information** **Studio 6, Credits 3 (Spring)**

CWFD-612

Design Methods and Practice II

This course will cover the fundamental techniques associated with the design and construction of wooden boxes. Students will design and build a series of functional containers giving careful consideration to the inherent properties of the material. Course topics will include lumber selection and processing, joinery layout and corner joint construction, as well as the safe use of hand and power tools. Lid and hinging options, as well as intermediate hand finishing techniques will also be introduced. Demonstrations, presentations, discussions, critiques, as well as individual meetings with students, will support the focus on craftsmanship, technical knowledge and design development. **Fee: There is a materials fee required for this course and an additional course fee applied via student account. See course notes for course fee information** **Studio 6, Credits 3 (Spring)**

CWFD-630

Furniture Design Elective III

This is a class designed for non-majors, covering a fundamental introduction to techniques and aesthetics of woodworking. Topics covered include the use of select hand tools and woodworking power tools, wood as a material, its basic properties and fundamental processes of wood fabrication. The course includes a prescribed project based on five in-class contact hours. **Fee: There is a lab fee required for this course** (his course is restricted to Graduate College of Art and Design students.) **Studio 5, Credits 3 (Fall, Spring)**

CWFD-698

Furniture Design Internship

The Furniture Design Internship will provide students with the option to work in the furniture design or furniture manufacturing field. Students may apply for internships to businesses based on the availability of positions and business job needs. Students must obtain permission of an instructor and complete the Internship Permission Form to enroll. Registration with co-op and placement office also required. (Prerequisites: This class is restricted to students in WOOD-MFA with department permission.) **Internship, Credits 1 - 6 (Fall, Spring, Summer)**

CWFD-699

Furniture Design Co-op

Cooperative Education will provide Furniture Design students with hands-on experience in their field, directly related to a student's major with an established studio or related business. Students will need to apply for co-ops, and interview as part of the selection process, based on available positions posted by the Co-op and Career Services Office, or found through the students' own research. In programs where co-op is a degree requirement, students must obtain permission of their program or graduate director prior to enrollment. Co-ops are typically paid work experience, and can be part-time (150-479 total hours within the term), or full-time (480+ hours within the term). Co-ops may be one or two consecutive terms - fall, spring, or summer - with department permission. (Prerequisites: This class is restricted to students in WOOD-MFA with department permission.) **CO OP, Credits 0 (Fall, Spring, Summer)**

CWFD-790

Furniture Design Thesis Initiation

Initiation is the first of a two-semester sequential class covering creation of the master's thesis exhibition. Students will develop a topic of investigation for the master's thesis, select a graduate thesis committee, and begin the planning, research, and development of a body of creative work. There will be a strengthening of woodworking techniques, design fundamentals and encouragement of personal expression. Student will be encouraged to evaluate new techniques, materials and concepts. **Fee: There is a lab fee required for this course** (Prerequisites: CWFD-702 or equivalent course and student standing in the WOOD-MFA program.) **Studio 12, Credits 6 (Fall)**

CWFD-799

Furniture Design Independent Study

Furniture Design Independent Study will provide students with the ability to study in a specialized area with an individual faculty member. Students, with the assistance of a faculty adviser will propose a course of study. Furniture Design students must obtain permission of an instructor and complete the Independent Study Form to enroll. **NOTE: Student must have a minimum 3.0 GPA ** (Prerequisites: This class is restricted to students in WOOD-MFA with instructor permission.) **Ind Study, Credits 1 - 6 (Fall, Spring)**

CWFD-887

Furniture Design Part-Time Co-op

Cooperative Education will provide Furniture Design students with hands-on experience in their field, directly related to a student's major with an established studio or related business. Students will need to apply for co-ops, and interview as part of the selection process, based on available positions posted by the Co-op and Career Services Office, or found through the students' own research. In programs where co-op is a degree requirement, students must obtain permission of their program or graduate director prior to enrollment. Co-ops are typically paid work experience, and can be part-time (150-479 total hours within the term), or full-time (480+ hours within the term). Co-ops may be one or two consecutive terms - fall, spring, or summer - with department permission. (Prerequisites: This class is restricted to students in WOOD-MFA with department permission.) **CO OP, Credits 0 (Fall, Spring, Summer)**

CWFD-890

Furniture Design Thesis Resolution

Furniture Design Thesis Resolution is final course covering the completion of the Masters Thesis exhibition. Working from an approved topic of investigation for the Master's Thesis, students work independently and create a body of work supported by a written thesis paper. In consultation with a selected graduate thesis committee, students plan, research, and develop a body of creative work for exhibition and review. There will be a strengthening of woodworking techniques, design fundamentals and encouragement of personal expression. **Fee: There is a lab fee required for this course** (Enrollment in this course requires permission from the department offering the course.) **Studio 12, Credits 9 (Spring)**

Sculpture

SCUL-601

Sculpture

This course allows students to explore concepts, materials, processes, and techniques to develop a personal, cohesive three-dimensional body of work. Theories and history of sculpture will be discussed as relevant to individual directions. Course may be retaken. ** Fee: A materials fee is required for this course** (his course is restricted to Graduate College of Art and Design students.) **Studio 6, Credits 3 (Fall, Spring)**

SCUL-611

Expanded Forms

This course focuses on the diverse forms of expression that have emerged in contemporary fine art, including installation, performance art, video, and digital art among the many other possibilities. Students will research some of these expanded forms and produce artwork in at least one of these forms. Course may be retaken. *** Fee: A materials fee is required for this course** (his course is restricted to Graduate College of Art and Design students.) **Studio 6, Credits 3 (Fall, Spring)**

SCUL-643

Foundry Practices

This course will introduce and develop students' skills in casting metals with an emphasis on cast iron and the use of cupola. Course content will cover advanced pattern-making, mold-making, spruing, patination, and casting techniques will be introduced. Students will create several cast metal pieces using different mold-making materials and alloys. At the completion of this course students will be able to develop their concepts through cast metal sculpture. **Fee: There is a materials fee required for this course and an additional course fee applied via student account. See course notes for course fee information** (This course is available to RIT degree-seeking graduate students.) **Studio 6, Credits 3 (Fall or Spring)**

SCUL-673

Figure Sculpture

This course will focus on the creation of three-dimensional figurative work. Course content will cover sculpting directly from live models and creating multiple armatures with a focus on both anatomical correctness and individual interpretation. Students will use this knowledge to create several oil clay maquettes. At the completion of this course students will produce finished figurative sculptures translating chosen maquettes into a permanent material **Fee: There is a materials fee required for this course and an additional course fee applied via student account. See course notes for course fee information** (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Studio 6, Credits 3 (Fall or Spring)**

SCUL-683

Welding and Fabrication

This course will introduce develop skills in metal fabrication. Course content will cover several different types of equipment utilized in the welding and cutting processes. Students will learn to effectively use equipment to fabricate mild steel. At the completion of this course students will complete a body of work consisting of finished fabricated steel sculptures in addition to understanding the rationale for working in an additive fashion. The course will be taught off-campus at Rochester Arc and Flame Center, 115 Fedex Way, Rochester, NY. **Fee: There is a materials fee required for this course and an additional course fee applied via student account. See course notes for course fee information** (This course is restricted to CAD Graduate students.) **Studio 6, Credits 3 (Fall or Spring)**

Textiles

CWTD-630

Quilting Graduate Elective

This course will introduce the beginner to the textile studio and to textiles as a creative material. Particularly the art of quilting. The students will acquire the ability to sew by hand and by machine. Lectures will include topics such as quilt design, fabric surface design, the history of quilting and techniques of quilting. **Fee: A course fee applied via student account.** (his course is restricted to Graduate College of Art and Design students.) **Studio 6, Credits 3 (Fall, Spring)**

CWTD-799

Grad Textiles Ind Study

Graduate Textiles Independent Study will provide students with the ability to study in a specialized area with an individual faculty member. Students, with the assistance of a faculty adviser will propose a course of study. (Enrollment in this course requires permission from the department offering the course.) **Ind Study, Credits 1 - 6 (Fall, Spring)**

School of Art

Art Education

ARED-701

Child Development in Art

In this course students will investigate and study the topic of child development in art and education. Students will explore a range of perspectives on developmental theories; the creation, and understanding of children's art and meaning making; and approaches to teaching art to children in a Birth-12 setting. Resources from the areas of art, psychology, sociology and art education will be investigated. Projects will include the development of a case study, relevant readings, research and studio activities, and collaborative research. Students will be expected to complete weekly reading, writing assignments, conduct research and field experience, and to participate in weekly discussions. This course has a field experience component of 20 hours. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall)**

ARED-702

Inclusive

Art Education: Teaching Students with Disabilities in the K-12 Art Classroom
Art Educators are expected to be able to understand the diverse learning needs of all students. Students in this course will discover how to adapt their own curricula and collaborate with special needs teachers to help students succeed in the art classroom. Through course work and field experience students will build a foundation of knowledge for working with children and youth with special needs. Students will develop new instructional strategies for making visual art more accessible for students with exceptionalities and a plan to incorporate accessibility strategies into their daily teachings. In a seminar format, the students realize the course objectives through participatory means. Students are expected to write critical essays, conduct research and field experience, and to participate in weekly small and large format discussion groups. Online technology is utilized in addition to lectures, videos, and other forms of media. This course has a field experience component of 20 hours. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall)**

ARED-703

Multicultural Issues in Art and Education

This course will explore a range of perspectives on multicultural issues in the visual arts and education fields. Course content will cover making connections with contemporary multicultural art, the implementation of lesson plans based on multicultural issues for the art education classroom, and an examination of curriculum and policy issues. Students are expected to write critical papers and essays, develop curriculum resources, and to participate in weekly discussions. This course has a field component of 20 hours. **Fee: A course fee applied via student account** (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall)**

ARED-704

Methods in Teaching and Learning

This course will explore the process of teaching art in the public school classroom at the Elementary level. Theories and practices relevant to teaching and learning in visual art will be addressed. Projects will include: lesson-planning, unit planning, classroom management, investigating new technologies, urban education, and action research. In addition, students will focus on human development, teaching students with disabilities and multiple intelligences, and assessment processes. This course has a field experience component of 20 hours. (This course is restricted to VISART-MST students.) **Lecture 3, Credits 3 (Fall)**

ARED-705

Methods II: Studio Thinking

This course explores the relationship between curriculum, instruction, and the assessment of learning. Students are introduced to process and procedures for developing curriculum, and assessing student learning in the art classroom, specifically at the secondary level. An emphasis is placed on a studio-thinking approach to teaching and learning. Students will explore innovative and creative approaches to curriculum design. Pedagogical knowledge is developed and extended through artistic practice and meaning making in lesson and unit development. This course compliments the course: Methods in Teaching and Learning. This course has a field experience component of 20 hours. (This course is restricted to VISART-MST students.) **Lecture 3, Credits 3 (Fall)**

ARED-711

Professional Practices in Art Education

This course will focus on the development of professional practices for entry-level art educators who are involved in their student teaching practicum. Projects will include presentations, relevant readings, assessment practices, mock interviews, case studies, visiting speakers, and preparing materials for applications in the field of art education. Students will be expected to complete weekly assignments. Goals for excellence in teaching and State and National standards are investigated and addressed. (Prerequisite: ARED-704 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

ARED-761

Survey of Methods and Materials for 6th – 12th Grade Art Education

This course will examine four topics in media and methods: Drawing, Painting, Printmaking and Ceramic Hand building, in relation to a student's individual art practices and interest in teaching art education 6th -12th grades. Course content will include examining the elements of art and principles of design. Media and technique exploration will include graphite, charcoal, colored pencils, watercolor paint, tempera and acrylic paint, low fire clay and low fire glazes in relation to pedagogy. Historical and contemporary perspectives will be introduced for each of the four media topics covered. At the completion of this course, students will apply media, methods and perspectives taught in art education programs. Note: Students will need purchase materials to complete this course. The instructor will provide information on the materials required. **Fee: A course fee applied via student account** (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 2, Credits 3 (Fall)**

ARED-761

Survey of Methods and Materials for 6th – 12th Grade Art Education

This course will examine four topics in media and methods: Drawing, Painting, Printmaking and Ceramic Hand building, in relation to a student's individual art practices and interest in teaching art education 6th -12th grades. Course content will include examining the elements of art and principles of design. Media and technique exploration will include graphite, charcoal, colored pencils, watercolor paint, tempera and acrylic paint, low fire clay and low fire glazes in relation to pedagogy. Historical and contemporary perspectives will be introduced for each of the four media topics covered. At the completion of this course, students will apply media, methods and perspectives taught in art education programs. Note: Students will need purchase materials to complete this course. The instructor will provide information on the materials required. **Fee: A course fee applied via student account** (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Studio 3, Credits 3 (Fall)**

ARED-790

Student Teaching

The student teaching practicum is designed to provide the student teacher with in depth pedagogical experiences, real world challenges, and rich learning opportunities. Two student teaching placements are arranged for each student for the duration of 6-7 weeks each. Full-time involvement at the school site is required. The Student Teacher will be under the guidance of experienced mentor teachers and college supervisors. This experience includes observation, full-responsibility planning and teaching, and involvement in the culture of the school setting. Students are assigned a cooperating teacher and a college supervisor for each setting. A Student Teaching Handbook is provided. Students are required to meet state and national standards when teaching. Unit and work sample preparation, instruction and assessment are required. Online technology is utilized in addition to lectures, video and other forms of media. (Prerequisites: ARED-702 and ARED-704 and ARED-705 or equivalent courses. Co-requisites: ARED-890 or equivalent course.) **Studio 28, Credits 9 (Spring)**

ARED-890

Graduate Seminar in Art Education

This course will explore a range of perspectives on contemporary theories in art and education, making connections with theory, meeting state and national standards, and reflecting on pedagogical experiences to address the overall goals of the program. Students focus on the following areas to meet New York State Education Department requirements and Council for the Accreditation of Educator Programs standards: 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 capstone project and exhibition. This course requires the student to complete 20 field experience hours, which will complete their required 100 hours. (Co-requisite: ARED-790 or equivalent course.) **Studio 6, Credits 6 (Spring)**

Art History

ARTH-600

Postmodernism and After: Contemporary Aesthetics

This course explores the history of contemporary art and visual culture from postmodernism to the present. We will focus on major artistic movements such as Pop Art, Minimalism, Conceptualism, Performance Art, and Relational Aesthetics. Along with and inseparable from aesthetics and media, we will chart the ways in which class, gender, race, and sexual inequality have figured into the major aesthetic movements of our time. By reading theory and criticism, discussing artworks across media forms, and researching artistic movements in context, students will examine art since the 1960s and its connections to cultural history. Graduate students will complete a research project and class presentation in addition to the writing assignments and discussion expected in the undergraduate section. **Lecture 3, Credits 3 (Spring)**

ARTH-601

Forms of Inquiry

Forms of Inquiry aims to expose students to a broad range of critical issues related to conception and production, to inspire and provoke critical reflection, and to facilitate the development of a preliminary thesis topic. Presentations, discussions, and written assignments will examine concerns from aesthetics, psychology, anthropology, philosophy, and critical theory as they relate to contemporary art, crafts, design and image making. (This course is restricted to CAD Graduate students.) **Lecture 3, Credits 3 (Fall, Spring)**

ARTH-611

Extreme Abstraction

Although we can trace the roots of abstraction to non-modern times and find its beginning as a concept in the visual arts in the late 18th and through-out the 19th century, it is a predominantly 20th century phenomenon. During the beginning of the 20th century there were many artists who turned to nonfigural practices for reasons that were mostly cultural and political. The world was changing and the artists wanted art to change as well. Although these reasons were about creating new ways of seeing and representing the world the sources for these visions varied from artist to artist. Scientific discoveries dealing with concepts of evolution, bacteria, atomic theory and astronomy contributed to those artists theorizing and producing abstract works of art. And although the work took on a look that may have been associated with decoration, most artists denied this connection for fearing that their work would not be taken seriously. Merely decorative! Abstraction since then has gone through many manifestations. The artists of today are no longer just going through the process of abstracting but are now producing abstract work that has its own history, rules and grammar. Issues of science, spirituality, primitivism and the decorative still resonate in the work of late 20th and early 21st century artists. But what is different? (This course is restricted to CAD Graduate students.) **Lecture 3, Credits 3 (Spring)**

ARTH-621

The Image

This course will examine recent scholarship devoted to the image – a ubiquitous controversial, ambiguous and deeply problematic issue in contemporary critical discourse -- 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, the totem, and effigy, the mental image, the limits of visuality, the moving and projected image, the virtual image, dialectical images, image fetishism, the valence of the image, semiotics and the image, as well as criteria by which to assess their success or failure (their intelligibility) and their alleged redemptive and poetic power. Students will explore the theoretical framework of the concept of the image, and critically evaluate these theories within their broader intellectual and historical contexts. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall, Spring)**

ARTH-624

Scandinavian Modernism

Students will examine 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, Iittala, 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. (This course is restricted to CAD Graduate students.) **Lecture 3, Credits 3 (Fall, Spring)**

ARTH-638

Symbols and Symbol Making: Psychoanalytic Perspectives on Art

This course explores the links between psychoanalytic theory and art history with special focus on the work of Sigmund Freud, Carl Jung, and their followers. 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 and 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 studied include: Albrecht Dürer, Leonardo da Vinci, Michelangelo, Edvard Munch, Max Ernst, Jackson Pollock, Louise Bourgeois, Mary Kelly and Victor Burgin; in addition to examples from film (Maya Deren, Luis Buñuel and Salvador Dalí, as well as Stan Brakhage). (This course is restricted to CIAS Graduate students.) **Lecture 3, Credits 3 (Fall, Spring)**

ARTH-644

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. (his course is restricted to Graduate College of Art and Design students.) **Lecture 3, Credits 3 (Fall, Spring)**

ARTH-649

Topics in Global Art and Architecture:

This course will focus on a critical examination of a select theme within art and architecture beyond the traditions of Europe or modern North America. A topic description will be posted each term the course is offered. This course can be taken multiple times but individual topics must be different. **Lecture 3, Credits 3 (Fall, Spring, Summer)**

ARTH-650

Topics in Art History

This course is focused on the critical examination and analysis of a selected topic in art history varying according to faculty teaching the course. A subtopic course description will be published each term course is offered. This course can be retaken, topics may not. (This course is restricted to CAD Graduate students.) **Lecture 3, Credits 3 (Fall, Spring)**

ARTH-655

Topics in Medieval Art and Architecture

A critical examination of a select theme within the field of medieval art and architecture. A subtopic description will be posted each term the course is offered. This course may be repeated for credit, but students may not repeat a topic. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall, Spring)**

ARTH-663

Modern Architecture

In this course, we will explore the history of world architecture from the late nineteenth century to the present. Issues to be considered include the definition of modern as it applies to the built environment; new building types; historicism; stylistic movements; urban development; housing; modern materials; critical theory and its impact on design; and architectural representation. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Spring)**

ARTH-666

Modernism Realism Expressionism

This course is an inquiry into one of the major debates of modern art. This debate had a seemingly clear victor. The idea that the artist expresses his or her individuality and then communicates that self to the rest of humanity through a higher, transcendental, language has dominated the discourse and practice of modernist art. In retrospect, the art that dominated most of the first half of the 20th century was of an Expressive nature. On the other hand art that in any way addressed direct and specific social issues was banished by art's major institutions. Realism was dead. In this course students will look at the circumstances of how Realism became subordinated to Expressionism. Students will also address the question of what exactly constituted the practice of realist art. Students will look at the roots of both movements, taking us at times into 18th and 19th centuries, but will concentrate on how institutions like the Museum of Modern Art helped define how we see the history of 20th century art as being determined. Students will also explore how Modernism's other, Realism, survived and gained new currency in practices of late 20th and early 21st century art. (This course is restricted to CAD Graduate students.) **Lecture 3, Credits 3 (Fall)**

ARTH-668 Art and Technology: From the Machine Aesthetic to the Cyborg Age

Students will explore the link between art and technology in the 20th century with special focus on the historical, theoretical, and ideological implications. Topics will include the body in the industrial revolution, utopian, dystopian, and fascist appropriations of the machine, engineering the mechanical body and machine-eroticism, humanism, the principles of scientific management, and the paranoid machine, multiples, mass production, and the art factory, industrial design, and machines for living, the technological sublime, cyborgs, cyberpunk and the posthuman. Key theorists to be discussed include: Karl Marx, Norbert Weiner, Reyner Banham, Siegfried Gideon, Michel Foucault, Deleuze and Guattari, Donna Haraway, and Martin Heidegger, as well as examples from film (Modern Times, Metropolis, Man with the Movie Camera and Blade Runner) and literature (Shelley's *Frankenstein*, Zamyatin's *We*). Artists covered include: Tatlin, Rodchenko, Malevich, Moholy-Nagy, Léger, Sheeler, Picabia, Duchamp, Calder, Ernst, Le Corbusier, Klee, Tinguely, Oldenburg, Rauschenberg, Warhol, Beuys, Kiefer, Lewitt, Fischli and Weiss, Acconci, Nam June Paik, Survival Research Laboratories, Bureau of Inverse Technology, Stelarc, Orlan, Dara Birnbaum, Roxy Paine, Marina Abramovic, Eduardo Kac and Bill Viola. (This course is restricted to CAD Graduate students.) **Lecture 3, Credits 3 (Fall)**

ARTH-671 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, and power; 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. (This course is restricted to CAD Graduate students.) **Lecture 3, Credits 3 (Fall)**

ARTH-672 Art of the Americas

This is a survey course of native north and South American visual arts within an historical and anthropological framework. Included will be an examination of the development of principal styles of Ancient American architecture, sculpture, painting, and ceramics up to the sixteenth century when the Spanish conquistadores defeated the Aztec and Inca empires and imposed colonial rule. Consideration is also given to materials used, techniques of construction, individual and tribal styles, as well as to the meaning and function of various art forms within Native American societies. (This course is restricted to CAD Graduate students.) **Lecture 3, Credits 3 (Fall)**

ARTH-673 Conceptual Art

This course examines the widely influential mid-1960s art movement that questioned the fundamental nature of art itself by renouncing 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. (This course is restricted to CAD Graduate students.) **Lecture 3, Credits 3 (Fall)**

ARTH-674 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, as well as broader literary and ideological contexts (e.g., Freud, Breton, Lautréamont, Leiris and Bataille). A wide 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 (Höchst, Heartfield, Schwitters, Duchamp, Picabia, Picasso, Dalí, Ernst, Giacometti, Man Ray, Bellmer, Cahun, Cornell, Magritte, Miro, Oppenheim, Toyen and Picasso) will be analyzed in depth. (This course is restricted to CAD Graduate students.) **Lecture 3, Credits 3 (Fall, Spring)**

ARTH-677 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. (This course is restricted to CAD Graduate students.) **Lecture 3, Credits 3 (Spring)**

ARTH-678

The Norwegian artist Edvard Munch (1863-1944) continues to generate a great deal of popular interest, critical scholarship, and reflection. The 4-volume catalogue raisonné of his paintings was published in 2009, and the graphic work appeared in 2001. 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-siècle. 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 beginning with the famous 1913 Armory Show. In this course students 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. (This course is restricted to CIAS Graduate students.) **Lecture 3, Credits 3 (Fall, Spring)**

ARTH-681

Students will explore 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. (This course is restricted to CAD Graduate students.) **Lecture 3, Credits 3 (Spring)**

ARTH-683

This course will introduce students to historic, contemporary, and critical issues surrounding installation art. There will be an introduction to the development of installation art as a genre. We will examine the changes, which have developed over the past three decades, of object sculpture to non-object. There will be an emphasis on the development of the concept of an installation project and its relationship to site and/or audience. Both public and gallery spaces will be discussed. (This course is restricted to CAD Graduate students.) **Lecture 3, Credits 3 (Fall)**

ARTH-686

Students will examine techniques and materials together with a historical overview of the artistic achievements of craftsmen and women in the past, with particular emphasis on ceramics and metalsmithing. It will include the study of Renaissance and early modern earthenware and stoneware as a prelude to the consideration of the history of porcelain and explores creative thinking and designing in other traditional craft areas such as fiber, glass, and wood. (This course is restricted to CAD Graduate students.) **Lecture 3, Credits 3 (Fall)**

ARTH-688

This class covers the Gothic Revival of the 18th, 19th, 20th, and 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 18th-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. (This course is restricted to CAD Graduate students.) **Lecture 3, Credits 3 (Fall, Spring)**

ARTH-711

Representation is the fundamental practice underlying the visual arts. In this graduate course, students will explore theoretical concepts, processes, meanings, and functions of visual representation across different cultures, eras, and media, analyzing how, why, and to whom representation communicates meaning. This course will be reading intensive, and group discussion will be the primary pedagogical method. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall)**

Fine Arts Studio**FNAS-890**

After creating a body of artwork derived from the student's thesis proposal, the student must exhibit this work in a gallery. In the exhibition space, during this show, the student will meet with the thesis committee to examine the success of the artwork in relation to the proposal. The student will be expected to orally present and defend the ideas explored through the artwork. The student will conclude the thesis process by explaining the work and putting it into both a personal and artistic context in a written and published document. (Enrollment in this course requires permission from the department offering the course.) **Thesis, Credits 1 - 10 (Fall, Spring)**

Edvard Munch**Latin American Art****Installation Art****History of Things: Studies in Material Culture****The Gothic Revival****Theories of Representation****Research and Thesis**

ILLS-659

Illustrative Design

Illustrative Design 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. Illustrative Design I 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 that will demand the use of traditional illustration methods as well as computer-based production media. Assignments will stress solutions that are typically managed by art directors and designers. The course will emphasize the language of visualization and the relationship and coordination of concept, illustration and word. (This course is restricted to CIAS Graduate students.) **Studio 6, Credits 3 (Fall)**

ILLS-662

Journalistic Illus Grad

This course will familiarize students with the requirements of researching and visually reporting a specific happening or event. Assignments will be longer in duration and will consist of several major works, many drawings, sketches, notes, and photo references. This journalistic approach to illustration demands that students attend an event and selectively record important aspects that will best communicate the atmosphere and action of the scene. Extensive research, both informational and visual is expected. A personal, editorial viewpoint is desired. This course will familiarize students with methods and issues involving creating a series of images for the single purpose of representing a story or illustrated sequence. Emphasis will be placed on choosing important content and planning effective image sequences. Students will learn to share their observations to clarify and embellish what might be commonplace for the non-visual observer. (This course is restricted to CIAS Graduate students.) **Studio 5, Credits 3 (Spring)**

ILLS-663

Zoological and Botanical Illustration

This course utilizes subjects found in nature as resources for fine and applied art applications. Working from live and preserved subjects, students will accurately depict plant and animal images which may be used in print and electronic media. (This course is restricted to students in the FNAS-MFA, IDDE-MFA, GRDE-MFA, CMGD-MFA, VISCOM-MFA and ILLM-MFA programs.) **Studio 6, Credits 3 (Fall, Spring)**

ILLS-668

Pop-Up Books

This course will deal with constructing, illustrating, and developing stories for pop-up and mechanical books. Students will study planning, preparation, engineering and illustration for production of pop-ups. The course will be divided into a preliminary section of learning basic mechanisms of pop-up books and a second section, which allows students to apply knowledge learned in the first section to the illustration and production of their own book. (This course is restricted to CIAS Graduate students.) **Studio 6, Credits 3 (Spring)**

ILLS-669

Advertising Illustration Graduate

This course will deal with creating illustrations used to advertise products, services and events. Assigned projects will give students a better understanding of the wide range of assignments that advertising illustrators produce for advertising agencies and corporate accounts. Students will experience the fast-paced working conditions inherent in the advertising industry. (This course is restricted to CIAS Graduate students.) **Studio 5, Credits 3 (Fall)**

ILLS-679

Digital Editorial Graduate

Digital Editorial will introduce students to editorial illustration. Importance will be placed on interpretation of editorial subject matter for illustration series, and preparation of digital imagery for print reproduction. Students will apply approaches to creative illustration while creatively interpreting editorial text and visual narratives. 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. (This course is restricted to CIAS Graduate students.) **Studio 5, Credits 3 (Spring)**

ILLS-799

Illustration Graduate Independent Study

Illustration Graduate Independent Study will provide students with the ability to study in a specialized area with an individual faculty member. Students, with the assistance of a faculty adviser will propose a course of study. Students must obtain permission of an instructor and complete the Independent Study Form to enroll. (Enrollment in this course requires permission from the department offering the course.) **Ind Study, Credits 1 - 6 (Fall, Spring)**

Painting

PAIT-601

Painting

This course engages students in a personal exploration of techniques in painting to advance their understanding and practice of visual art. Individual approaches to painting from the representational through the abstract present a cross-section of current art issues which students must address as they build their portfolio. Course may be retaken. ** Fee: A materials fee is required for this course**. (his course is restricted to Graduate College of Art and Design students.) **Studio 6, Credits 3 (Fall, Spring)**

PAIT-661

Painting the Natural World

This class will examine the natural world in our current culture in combination with technical aspects of oil paint. Course content will cover the transition from direct observation to conceptual work. Students will create a body of artwork referencing assigned readings and personally driven research relating to contemporary themes such as identity, the body, time, memory, place, language, science, spirituality, and how they connect to nature. At the completion of this course, students will be able to use the skills from a technical overview of observational painting to create a body of work exploring developed ideas based on individual research. **Course fee via student account** (his course is restricted to Graduate College of Art and Design students.) **Studio 6, Credits 3 (Fall)**

PAIT-671

Painting the Figure

This course will explore materials and techniques used in painting the human form. Theory and practice of color and drawing will be used to develop an understanding of how to portray the figure. Traditional and contemporary approaches to figurative painting will be explored. There is a lab fee required for this course. (his course is restricted to Graduate College of Art and Design students.) **Studio 6, Credits 3 (Fall)**

PAIT-760

Watercolor

This course focuses on the exploration of watercolor techniques and concepts to enhance skills and personal expression of the individual student. (his course is restricted to Graduate College of Art and Design students.) **Studio 6, Credits 3 (Fall, Spring, Summer)**

Printmaking

PRNT-601

Printmaking

This course is designed to introduce advanced printmaking technical concepts and techniques. The focus will be on intaglio printmaking research and how to creatively apply techniques that will result in sophisticated works of art. Course may be retaken. ** Fee: A materials fee is required for this course**. (his course is restricted to Graduate College of Art and Design students.) **Studio 6, Credits 3 (Fall, Spring)**

PRNT-602

Photo Print Processes

This course explores photographic printmaking techniques, including screenprinting on paper and glass surfaces. Course content and discussions will focus on the relationship and relevancy of printmaking processes to photographic imagery. At the completion of this course, students will understand the formal and conceptual implications of media, process and form. **Fee: A materials fee is required for this course, and an additional course fee applied via student account** **Studio 6, Credits 3 (Fall or Spring)**

PRNT-607

Printmaking I

This is part one of a two-part advanced certificate in non-toxic printmaking for highly motivated students who are able to sustain their work independently. This course is designed to introduce basic non-toxic printmaking technical concepts that may also include techniques such as Intaglio-Type, A.R.E., screen, relief, monoprint, digital transfer, halftone, photo, and the art of the master printer. The focus will be on non-toxic intaglio printmaking research and how to creatively apply techniques that will result in works of art. (This course is restricted to NTIPRT-ACT Major students.) **Lecture 2, Credits 6 (Fall)**

PRNT-607

Printmaking I

This is part one of a two-part advanced certificate in non-toxic printmaking for highly motivated students who are able to sustain their work independently. This course is designed to introduce basic non-toxic printmaking technical concepts that may also include techniques such as Intaglio-Type, A.R.E., screen, relief, monoprint, digital transfer, halftone, photo, and the art of the master printer. The focus will be on non-toxic intaglio printmaking research and how to creatively apply techniques that will result in works of art. (This course is restricted to NTIPRT-ACT Major students.) **Studio 4, Credits 6 (Fall)**

PRNT-608

Printmaking II

This is part two of a two-part advanced certificate in non-toxic printmaking for highly motivated students who are able to sustain their work independently. This course is designed to introduce advanced level non-toxic printmaking technical concepts that may also include one or more of the following techniques; Intaglio-Type, A.R.E., screen, relief, monoprint, digital transfer, halftone, polyester plate litho, photo, and the art of the master printer. The focus will be on non-toxic intaglio printmaking research and how to creatively apply techniques that will result in more sophisticated works of art. (This course is restricted to NTIPRT-ACT Major students.) **Lecture 2, Credits 6 (Spring)**

PRNT-608**Printmaking II**

This is part two of a two-part advanced certificate in non-toxic printmaking for highly motivated students who are able to sustain their work independently. This course is designed to introduce advanced level non-toxic printmaking technical concepts that may also include one or more of the following techniques: Intaglio-Type, A.R.E., screen, relief, monoprint, digital transfer, halftone, polyester plate litho, photo, and the art of the master printer. The focus will be on non-toxic intaglio printmaking research and how to creatively apply techniques that will result in more sophisticated works of art. (This course is restricted to NTIPRT-ACT Major students.) **Studio 4, Credits 6 (Spring)**

Studio Arts

STAR-603**CAD Drawing**

This class covers basic CAD (computer-aided design) drawing for both design and presentation. Topics covered will include a broad range of drawing types, three-dimensional modeling, and presentation techniques. The course includes demonstrations, lectures, group-discussions, projects, and presentations. At the completion of this course, students will use skills obtained in CAD orthographic drawing and 3-dimensional modeling to refine and present ideas and projects. **Lec/Lab 5, Credits 3 (Fall or Spring)**

STAR-605**Figure Drawing**

This course will focus on building figure drawing skills in a traditional life drawing class format with emphasis on dynamic line quality, visual perception and contemporary approaches to figure drawing. Students will work directly from the model in a variety of media. At the completion of this course, students will gain an understanding of diverse representations and applications of the human figure using various drawing materials and processes. **Studio 6, Credits 3 (Fall or Spring)**

STAR-635**Curating and Managing Art Spaces**

This course explores the roles of contemporary, traditional, and alternative art spaces through curatorial studies, exhibition evaluation and criticism. Student will consider gallery administration roles and supporting operations, and undertake site visitations and gallery research. Students will organize and install a final exhibition project in an approved exhibition venue. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall)**

STAR-645**Art Exhibition Critique**

This course will explore the role of the art exhibition and its effect on the discourse and practice of art. Course content will focus on: contemporary and historical exhibition studies, individual and group projects. Student will also conduct site visitations and evaluation, and critique work in the context of exhibition. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall)**

STAR-649**Topics in Contemporary Issues**

This course will focus selected contemporary issues in the field of fine arts and crafts including specific artists, trends, practices, theory, or criticism. A topic course description will be published each term the course is offered. This course can be retaken but individual topics may not. **Lecture 3, Credits 3 (Fa/sp/su)**

STAR-650**Topics in Studio Arts**

This course will focus on traditional or contemporary process, techniques, media or material used in the creation of artwork. Topic will be determined by faculty teaching the course. A topic course description will be published each term the course is offered. This course can be retaken but individual topics may not. (his course is restricted to Graduate College of Art and Design students.) **Studio 6, Credits 3 (Fall, Spring)**

STAR-651**Topics in Fine Art Contemporary Issues**

This course will focus selected contemporary issues in the field of fine arts including specific artists, trends, theory, or criticism. A topic course description will be published each term the course is offered. This course can be retaken but individual topics may not. (his course is restricted to Graduate College of Art and Design students.) **Lecture 3, Credits 3 (Fall, Spring)**

STAR-663**Contemporary Drawing**

This course places an emphasis on drawing and the development of form, space, and expression from a variety of sources. Course content will include traditional drawing mediums and practices for exploration of unusual materials, concepts, and mark-making. Students will develop an individual mode of expression through drawing and surface exploration as well as an understanding of contemporary practices. At the completion of this course, students will create a body of work exploring developed ideas based on individual research with drawing as a practice. **Materials fee is required for this course** (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Studio 6, Credits 3 (Fall, Spring)**

STAR-678**Screenprinting**

This course will be a comprehensive introduction to non-toxic silkscreen printing concepts and techniques. Organized to create a broad introductory experience, the course will focus on the expansion of problem solving and skill building within the context of screenprinting. The course will address a wide variety of media, tools, techniques both traditional and technological and the theoretical concepts to facilitate skill development and experimentation with process. Accumulative aspects of the curriculum will include the exploration of historical and cultural concepts of materiality and the multiple, intertwined aspects of personal interpretation and experience. **Fee: There is a lab fee required for this course** **Studio 6, Credits 3 (Fall, Spring)**

STAR-698**Studio Arts Internship**

Studio Arts Internship will provide students with the option to work with established artists or in fine art related businesses. Students may apply for internships to businesses based on the availability of positions and business job needs. Students must obtain permission of an instructor and complete the Internship Permission Form to enroll. (Prerequisites: This class is restricted to students in FNAS-MFA with department permission.) **Internship, Credits 1 - 6 (Fall, Spring)**

STAR-699**Studio Arts Co-op**

Cooperative Education will provide Studio Arts students with hands-on experience in their field, directly related to a student's major with an established studio or related business. Students will need to apply for co-ops, and interview as part of the selection process, based on available positions posted by the Co-op and Career Services Office, or found through the students' own research. In programs where co-op is a degree requirement, students must obtain permission of their program or graduate director prior to enrollment. Co-ops are typically paid work experience, and can be part-time (150-479 total hours within the term), or full-time (480+ hours within the term). Co-ops may be one or two consecutive terms - fall, spring, or summer - with department permission. (Prerequisites: This class is restricted to students in FNAS-MFA with department permission.) **CO OP, Credits 0 (Fall, Spring, Summer)**

STAR-701**Technology in the Studio**

This course will introduce a contemporary technology used by the course instructor in their studio practice. Students will be encouraged to investigate how this technology may be applied in their making process. The subjects offered in the course will vary according to the faculty teaching the class. The course can be taken multiple times with faculty permission. **Studio 6, Credits 3 (Fall or Spring)**

STAR-702**Studio Art Research**

This course will prepare graduate students for the written component of the thesis. Course content will cover defining research in the arts, arts based research, research through practice, critical judgment, writing strategically and critically for reflective thinking and scholarly dissemination. At the completion of this course students will be able to write a thesis proposal addressing a research question or direction along with objectives, context, and methods. (Prerequisites: STAR-701 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

STAR-706**Business Practices for Studio Artists**

This class is devoted to business issues that artists must address including portfolio management, pricing and marketing strategies, and public relations for pursuit of a professional career as studio artists. Financial and communication skills are highlighted as are networking skills for the advancement of an artist's work. (Prerequisites: This course is restricted to students in the FNAS-MFA or GLASS-MFA or METAL-MFA or CCER-MFA or WOOD-MFA programs.) **Lecture 3, Credits 3 (Spring)**

STAR-714**Ideation and Series**

Creative flow, having an endless stream of ideas, alternatives, and choices for solutions, helps creative work evolve and reach more advanced levels. In this course students develop appropriate skills and strategies to generate ideas and develop them effectively into a cohesive body of work. (Prerequisites: This course is restricted to students in the FNAS-MFA or GLASS-MFA or METAL-MFA or CCER-MFA or WOOD-MFA programs.) **Studio 6, Credits 3 (Fall)**

STAR-718**Research Methods and Publication**

Students will conduct research appropriate for individual thesis directions, incorporate that research into writing, analyze and review their thesis body of work then produce and publish their written thesis document. (Prerequisites: STAR-702 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

STAR-730**Developing an Online Brand**

This course will provide a comprehensive exploration of the planning, building, and managing website and social media. The course will include instruction on creating, publishing and managing content for internet self-promotion as well as ways to use social media to create new opportunities. Students will be encouraged to explore and develop effective approaches to documenting their processes of making and portfolios for online publishing. (This course is restricted to CAD Graduate students.) **Studio 6, Credits 3 (Fall, Spring)**

STAR-758

Studio Art Critique

Students will explore the process of critical analysis of studio work. Content will focus on the structure and form of the critique process. They will discuss, defend, and interpret existing studio work as they work towards their thesis. Faculty led critiques will include studio visits for in depth analysis of works in progress. (Prerequisites: This course is restricted to students in the FNAS-MFA or GLASS-MFA or METAL-MFA or CCER-MFA or WOOD-MFA programs.) **Lecture 3, Credits 3 (Fall, Spring)**

STAR-790

Research and Thesis

This is the first of two courses designed to advance a student towards completion of their thesis. Students will work independently on their approved proposal while meeting on a regular basis with their committee chair. Students are required to meet at least twice with their full committee during the semester. (Prerequisites: STAR-702 or equivalent course.) **Thesis, Credits 3 (Fall)**

STAR-799

Studio Arts Independent Study

Studio Arts Independent Study will provide students with the ability to study in a specialized area with an individual faculty member. Students, with the assistance of a faculty advisor, will propose and conduct a course of study. An approved Independent Study Permission Form must be submitted to Student Services to enroll. (Prerequisites: This class is restricted to students in FNAS-MFA with instructor permission.) **Ind Study, Credits 1 - 6 (Fall, Spring)**

STAR-887

Studio Arts Part-Time Co-op

Cooperative Education will provide Studio Arts students with hands-on experience in their field, directly related to a student's major with an established studio or related business. Students will need to apply for co-ops, and interview as part of the selection process, based on available positions posted by the Co-op and Career Services Office, or found through the students' own research. In programs where co-op is a degree requirement, students must obtain permission of their program or graduate director prior to enrollment. Co-ops are typically paid work experience, and can be part-time (150-479 total hours within the term), or full-time (480+ hours within the term). Co-ops may be one or two consecutive terms - fall, spring, or summer - with department permission. (Prerequisites: This class is restricted to students in FNAS-MFA with department permission.) **CO OP, Credits 0 (Fall, Spring, Summer)**

STAR-890

Thesis

For this final thesis course students continue working with their committee to evaluate work produced, and select the work to be exhibited. In addition, students will work with gallery coordinators and curators to install and exhibit their final body of work. Students are expected to defend their work to the committee through an oral defense and a written document. (Prerequisite: STAR-790 or equivalent course.) **Thesis, Credits 6 (Spring)**

STAR-892

Continuation of Thesis Studio Arts

The Studio Arts Continuation of Thesis course provides student additional semester(s) to complete their thesis research, project, and thesis document. (Prerequisites: This course is restricted to students in the FNAS-MFA or GLASS-MFA or METAL-MFA or CCER-MFA or WOOD-MFA programs.) **Cont, Credits 0 (Fall, Spring, Summer)**

School of Design

Industrial Design

IDDE-607

Technology Studio

This course explores the use of computer-aided design (CAD) and other related technologies as tools for designing, modeling, visualizing, simulating and fabricating design solutions. Emphasis is given to the combination of digital and analog technologies, and the workflows for using them effectively in design process. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Studio 6, Credits 3 (Fall, Spring)**

IDDE-620

The Studio 2.0

This course will focus on developing ideas in art, design and craft. The specific topics for this course will vary each time it is taught. Potential topics may include the creation of public spaces, products, analog and digital fabrication, furniture, inter-disciplinary collaborations, etc. This course can be taken multiple times but individual topics must be different. (This course is restricted to students in FNAS-MFA, CCER-MFA, GLASS-MFA, WOOD-MFA, METAL-MFA, VISCOM-MFA and CMGD-MFA.) **Studio 6, Credits 3 (Fall, Spring)**

IDDE-665

Experimental Studio

The course focuses on implementing advanced, newly developing ideas in industrial design. The specific sub-topic for this course will vary. As a result this course may be repeated. The subtopic is determined by the instructor. Potential topics may include the creation of exhibits, consumer products, sustainable design, analog and digital fabrication, furniture, interior landscapes, vehicle design, medical and healthcare design, inter-disciplinary design, etc. (This course is restricted to students in IDDE-MFA.) **Lecture 2, Credits 3 (Fall, Spring)**

IDDE-665

Experimental Studio

The course focuses on implementing advanced, newly developing ideas in industrial design. The specific sub-topic for this course will vary. As a result this course may be repeated. The subtopic is determined by the instructor. Potential topics may include the creation of exhibits, consumer products, sustainable design, analog and digital fabrication, furniture, interior landscapes, vehicle design, medical and healthcare design, inter-disciplinary design, etc. (This course is restricted to students in IDDE-MFA.) **Studio 3, Credits 3 (Fall, Spring)**

IDDE-667

Industry, Technology and Design

This lecture-based course explores how historical events, technology and culture connect with and influence the current state and future direction of design. Special attention is given to the sequence of the technical skills and innovations that have been necessary to drive progress. Students will make relevant connections between the role of design, manufacturing, business and other disciplines, all involved in the development of new products, graphics, interfaces, systems and experiences. This analysis is done from a diverse and inclusive range of geographies, cultures and societies beyond euro-centric design. Activities include readings and discussions, guest lectures, participation in design events, and written assignments. Additional tools may include mind mapping, and strategic foresight. **Lecture 3, Credits 3 (Fall or Spring)**

IDDE-669

Master Seminar

The Master Seminar course is a forum for cross-disciplinary presentations and discussions of methods, techniques, processes, and interpretations. Luminaries discuss conceptual and practical studio activities, their current and past endeavors, and the contextualization of their work. Assignments may range from ideation exercises, charrettes, studio visits, research papers, and presentations. (This course is restricted to students in IDDE-MFA.) **Lecture 3, Credits 3 (Fall, Spring)**

IDDE-671

Graduate ID Studio I

This is the first part of a two-course series that provides opportunities for fine-tuning of design process and development of meaningful solutions across multiple scenarios. Projects and assignments will explore the application of design methods and skills. Projects will also address large-community and global problems requiring team-based, trans-disciplinary collaborations. (This course is restricted to students in IDDE-MFA.) **Studio 6, Credits 3 (Fall)**

IDDE-672

Graduate ID Studio II

This is the second part of a two-course series that provides opportunities for fine tuning of design process and development of meaningful solutions across multiple scenarios. Projects and assignments will expand on the application of design methods and collaboration. Course content will integrate current and emerging technologies that influence design practice as well as society and culture. A strong focus will be on the testing and implementation of design solutions in effective ways. (This course is restricted to students in IDDE-MFA.) **Studio 6, Credits 3 (Spring)**

IDDE-673

ID Sketching Studio

A studio styled course in freehand sketching and visualization techniques using a combination of orthogonal, perspective and empathic and any other two-dimensional methods of developing and communicating design concepts. (This course is restricted to students in IDDE-MFA.) **Lecture 2, Credits 3 (Fall, Spring)**

IDDE-673

ID Sketching Studio

A studio styled course in freehand sketching and visualization techniques using a combination of orthogonal, perspective and empathic and any other two-dimensional methods of developing and communicating design concepts. (This course is restricted to students in IDDE-MFA.) **Studio 3, Credits 3 (Fall, Spring)**

IDDE-698

Industrial Design Internship

The Industrial Design Internship provides students the option to work in the industrial design field. Students must obtain permission of an instructor and complete the Internship Permission Form to enroll. (Prerequisites: This class is restricted to students in IDDE-MFA with department permission.) **Internship, Credits 1 - 6 (Fall, Spring, Summer)**

IDDE-699

Industrial Design Co-op

Cooperative Education will provide Industrial Design students with hands-on experience in their field, directly related to a student's major with an established studio or related business. Students will need to apply for co-ops, and interview as part of the selection process, based on available positions posted by the Co-op and Career Services Office, or found through the students' own research. In programs where co-op is a degree requirement, students must obtain permission of their program or graduate director prior to enrollment. Co-ops are typically paid work experience, and can be part-time (150-479 total hours within the term), or full-time (480+ hours within the term). Co-ops may be one or two consecutive terms - fall, spring, or summer - with department permission. (Prerequisites: This class is restricted to students in IDDE-MFA with department permission.) **CO OP, Credits 0 (Fall, Spring, Summer)**

IDDE-701**Design Laboratory I**

Design Laboratory I is part one of a studio sequence that provides a forum for discourse and experimentation in design. Critical analysis, contextual relevance and research methodologies are developed and used as a means to define the role of design and the designer in creating consequential solutions for the social, economical and environmental betterment of the global communities. Projects will extend these ideas into the practice of industrial design as a mode of understanding the relationships that exist between the user, the community and the designed artifacts. Opportunities for inter and trans-disciplinary collaborations will broaden the scope of the projects. We will design through a process of iteration and reiteration, empathic exploration, and the development of the physical artifacts. Categories of products may include: consumer goods, equipment, transportation, furniture, or packaging. (This course is restricted to students in IDDE-MFA.) **Lab 3, Credits 3 (Fall)**

IDDE-701**Design Laboratory I**

Design Laboratory I is part one of a studio sequence that provides a forum for discourse and experimentation in design. Critical analysis, contextual relevance and research methodologies are developed and used as a means to define the role of design and the designer in creating consequential solutions for the social, economical and environmental betterment of the global communities. Projects will extend these ideas into the practice of industrial design as a mode of understanding the relationships that exist between the user, the community and the designed artifacts. Opportunities for inter and trans-disciplinary collaborations will broaden the scope of the projects. We will design through a process of iteration and reiteration, empathic exploration, and the development of the physical artifacts. Categories of products may include: consumer goods, equipment, transportation, furniture, or packaging. (This course is restricted to students in IDDE-MFA.) **Lecture 2, Credits 3 (Fall)**

IDDE-702**Design Laboratory II**

This course is the second of a two-course studio sequence that provides a forum for discourse and experimentation in design. Course continues the methodology established in Design Laboratory I, and extends the scope to human-centered concepts, artifacts and systems at both local and global levels. Assignments will include topics such as: responsible design practices, universal design, environmental sensibility, project management and fabrication. (Prerequisites: IDDE-701 or equivalent course and a student in the IDDE-MFA program.) **Lab 3, Credits 3 (Spring)**

IDDE-702**Design Laboratory II**

This course is the second of a two-course studio sequence that provides a forum for discourse and experimentation in design. Course continues the methodology established in Design Laboratory I, and extends the scope to human-centered concepts, artifacts and systems at both local and global levels. Assignments will include topics such as: responsible design practices, universal design, environmental sensibility, project management and fabrication. (Prerequisites: IDDE-701 or equivalent course and a student in the IDDE-MFA program.) **Lecture 2, Credits 3 (Spring)**

IDDE-703**Function of Form**

The first of a two-semester sequence, this course emphasizes the experience of seeing, developing, and manipulating three-dimensional forms and compositions. Projects focus on developing the ability to see, organize, and understand the ambiguity inherent in the design process through the study of three-dimension design elements, the analysis of their relationships and the subsequent sensory responses. (This course is restricted to students in IDDE-MFA.) **Studio 6, Credits 3 (Fall)**

IDDE-704**Form of Function**

The second of a two-semester sequence, this course emphasizes the technical skills necessary to manipulate material and data for the accurate three-dimensional communication of design intent. Projects focus on understanding the relationship of materials, manufacturing processes, products and the user. (Prerequisites: IDDE-703 or equivalent course and a student in the IDDE-MFA program.) **Studio 6, Credits 3 (Spring)**

IDDE-705**2D Ideation and Visualization**

The first of a two-semester visualization sequence, this course focuses on developing the skills and methods necessary to generate, visualize and define design concepts in two-dimensions, in both analog and digital formats. Assignments may include orthogonal views, perspective drawings and descriptive illustrations, as means to develop and communicate design solutions. (This course is restricted to students in IDDE-MFA.) **Studio 6, Credits 3 (Fall)**

IDDE-706**Integrated Design Visualization**

The second of a two-semester visualization sequence, this course further develops analog and digital visualization techniques, while expanding on graphic and three-dimensional components needed to create effective presentations and the workflows to achieve them. Assignments will also include crafting visual and verbal presentations that synthesize the concepts developed. (Prerequisite: IDDE-705 or equivalent course.) **Studio 6, Credits 3 (Spring)**

IDDE-710**Industrial Design History, Theory, and Culture**

This course explores key moments in industrial design's evolution from multiple angles: historical, theoretical, technological and cultural. While the emphasis is on industrial design, other integral design disciplines (i.e. visual communication, UX, systems, service, etc.) will be discussed. This combination of perspectives provides deeper understanding of how design addresses needs and wants of society, commerce, and environment beyond euro-centric contexts. Students are expected to read seminal design articles, write critical essays and questions and to participate in discussion groups. **Lecture 3, Credits 3 (Fall or Spring)**

IDDE-711**Design Research and Proposals**

This course focuses on developing research skills in the field of design. Emphasis is placed on an exposure to a wide range of methods, research sources, data collection, and evaluation. Students will select and plan a design research topic, conduct a search for background material, construct a proposal, and defend their research topic. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA, CMGD-MFA and IDDE-MFA majors and other CIAS and RIT graduate students with permission of instructor.) **Lecture 3, Credits 3 (Spring)**

IDDE-790**Thesis: Research and Planning**

The first of a two-course thesis sequence, the focus of this course is on establishing content, planning, scheduling, and research seeking innovative solutions through the process of concept development, ideation, and in-process evaluation. Final articulation of the project is approved by a faculty committee, presented in a graduate thesis show and accompanied by a written document that addresses how the theories and methods used in the project impact the current and future state of design in society. (Enrollment in this course requires permission from the department offering the course.) **Thesis, Credits 6 (Fall)**

IDDE-799**Industrial Design Independent Study**

Industrial Design Independent Study provides students the means to study in a specialized area with an individual faculty member. With the assistance of their faculty advisers, students will propose a course of study. Students must obtain permission of an instructor and complete the Independent Study Permission Form to enroll. **NOTE: Student must have a minimum 3.0 GPA ** (Prerequisites: This class is restricted to students in IDDE-MFA or VISCOM-MFA with instructor permission.) **Ind Study, Credits 1 - 6 (Fall, Spring)**

IDDE-887**Industrial Design Part-Time Co-op**

Cooperative Education will provide Industrial Design students with hands-on experience in their field, directly related to a student's major with an established studio or related business. Students will need to apply for co-ops, and interview as part of the selection process, based on available positions posted by the Co-op and Career Services Office, or found through the students' own research. In programs where co-op is a degree requirement, students must obtain permission of their program or graduate director prior to enrollment. Co-ops are typically paid work experience, and can be part-time (150-479 total hours within the term), or full-time (480+ hours within the term). Co-ops may be one or two consecutive terms - fall, spring, or summer - with department permission. (Prerequisites: This class is restricted to students in IDDE-MFA with department permission.) **CO OP, Credits 0 (Fall, Spring, Summer)**

IDDE-890**Thesis: Implementation and Evaluation**

The second of a two-course thesis sequence, this course focuses on continued concept development of a thesis, concluding with the implementation and retrospective evaluation of chosen design problem. Solution is presented in a public exhibition, complemented by a written articulation of how the theories and methods employed in the project impact the current and future state of design in society. (Prerequisite: IDDE-790 or equivalent course.) **Thesis 9, Credits 6 (Spring)**

IDDE-892**Continuation of Thesis Industrial Design**

The Industrial Design Continuation of Thesis course provides student additional semester(s) to complete their thesis research, project, and thesis document. (Prerequisite: IDDE-890 or equivalent course and student standing in the IDDE-MFA program.) **Cont, Credits 0 (Fall, Spring)**

Interior Design

IDDE-799**Interior Design Graduate Independent Study**

Interior Design Graduate Independent Study will provide students with the ability to study in a specialized area with an individual faculty member. Students, with the assistance of a faculty adviser will propose a course of study. Students must maintain a GPA of 3.0 or higher. Students must obtain permission of an instructor and complete the Independent Study Form to enroll. **Ind Study 2, Credits 1 - 6 (Fall, Spring, Summer)**

Visual Communication Design

VCDE-617 **Experimental Workshop**
The course focuses on implementing advanced, newly developing ideas in visual communication design. The specific subtopic for this course varies each time it is taught. As a result it may be repeated with a different subtopic. The subtopic is determined by the instructor. Potential topics include the creation of interactive installations, adaptive/responsive interface design, tangible media design, digital performances, cyber fashion, network art, locative media, scientific visualization, information visualization, event design, projection design, or any new area in digital design. Students can take more than one Experimental Workshop in a term, as long as the subtopic is not repeated. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) **Lecture 2, Credits 3 (Fall, Spring)**

VCDE-617 **Experimental Workshop**
The course focuses on implementing advanced, newly developing ideas in visual communication design. The specific subtopic for this course varies each time it is taught. As a result it may be repeated with a different subtopic. The subtopic is determined by the instructor. Potential topics include the creation of interactive installations, adaptive/responsive interface design, tangible media design, digital performances, cyber fashion, network art, locative media, scientific visualization, information visualization, event design, projection design, or any new area in digital design. Students can take more than one Experimental Workshop in a term, as long as the subtopic is not repeated. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) **Studio 3, Credits 3 (Fall, Spring)**

VCDE-621 **Character Design and Rigging**
This course covers first the design of characters and then the creation of them using three-dimensional software, inverse kinematics, parent and rigid binding, bones, and deformers. Students design characters using techniques like interpretant matrices, model sheets, sketches, and maquettes followed by development of the actual character in software. Characters are designed for incorporation into motion graphics, games, real time applications, performance, or visualization. (Prerequisites: VCDE-706 or equivalent course.) **Lecture 2, Credits 3 (Fall)**

VCDE-621 **Character Design and Rigging**
This course covers first the design of characters and then the creation of them using three-dimensional software, inverse kinematics, parent and rigid binding, bones, and deformers. Students design characters using techniques like interpretant matrices, model sheets, sketches, and maquettes followed by development of the actual character in software. Characters are designed for incorporation into motion graphics, games, real time applications, performance, or visualization. (Prerequisites: VCDE-706 or equivalent course.) **Studio 2, Credits 3 (Fall)**

VCDE-622 **3D Environment Design**
This course covers advanced modeling techniques useful in developing environments, both interior and exterior. The content of the course covers proportions appropriate to a variety of environments, lighting for spaces, surface design to replicate real world materials, and building to an appropriate level of detail for the circumstance. (Prerequisites: VCDE-706 or equivalent course.) **Lecture 2, Credits 3 (Fall)**

VCDE-622 **3D Environment Design**
This course covers advanced modeling techniques useful in developing environments, both interior and exterior. The content of the course covers proportions appropriate to a variety of environments, lighting for spaces, surface design to replicate real world materials, and building to an appropriate level of detail for the circumstance. (Prerequisites: VCDE-706 or equivalent course.) **Studio 2, Credits 3 (Fall)**

VCDE-626 **Physical Interface Design**
This course covers the use of basic electronics so that students can develop embedded systems or controllers for games, design environments with ambient intelligence, design interactive museum exhibits and point of purchase installations, or embed electronics in clothing. Students use micro controllers, sensors, switches, lights, and motors to implement their designs. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) **Lecture 2, Credits 3 (Spring)**

VCDE-626 **Physical Interface Design**
This course covers the use of basic electronics so that students can develop embedded systems or controllers for games, design environments with ambient intelligence, design interactive museum exhibits and point of purchase installations, or embed electronics in clothing. Students use micro controllers, sensors, switches, lights, and motors to implement their designs. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) **Studio 2, Credits 3 (Spring)**

VCDE-627 **Real Time Design**
In this course, students design levels for games or virtual worlds for a variety of applications. Once the design is complete, the design is implemented using high-end three-dimensional software. In many cases the projects will be large and will be executed by teams of students. Versioning systems will be used to keep track of the most recently developed assets. Models are imported into real time software engines for manipulation. (Prerequisites: VCDE-706 or equivalent course.) **Lecture 2, Credits 3 (Fall, Spring)**

VCDE-627 **Real Time Design**
In this course, students design levels for games or virtual worlds for a variety of applications. Once the design is complete, the design is implemented using high-end three-dimensional software. In many cases the projects will be large and will be executed by teams of students. Versioning systems will be used to keep track of the most recently developed assets. Models are imported into real time software engines for manipulation. (Prerequisites: VCDE-706 or equivalent course.) **Studio 2, Credits 3 (Fall, Spring)**

VCDE-628 **3D Particles and Dynamics**
This course focuses on three-dimensional special effects using 3D software in combination with other techniques. Course content addresses particle systems and dynamic simulations in a 3D environment. Physical reality concepts such as water flow, air movement, smoke, clouds, fire, and gravitational effects are explored in relation to their effects on cloth, hair, and fluids. Students will incorporate these dynamic simulations in practical design contexts for film, broadcast, and online. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) **Lecture 2, Credits 3 (Spring)**

VCDE-628 **3D Particles and Dynamics**
This course focuses on three-dimensional special effects using 3D software in combination with other techniques. Course content addresses particle systems and dynamic simulations in a 3D environment. Physical reality concepts such as water flow, air movement, smoke, clouds, fire, and gravitational effects are explored in relation to their effects on cloth, hair, and fluids. Students will incorporate these dynamic simulations in practical design contexts for film, broadcast, and online. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) **Studio 3, Credits 3 (Spring)**

VCDE-633 **Hard Surface Modeling**
The course focuses on designing and constructing hard surface models including machinery, furniture, vehicles, electronics, and robots. Students explore the use of different modeling techniques in the process and are particularly interested in the flow of the topology within the geometry. Some attention is given to creating controls for moving the hard surface models. (Prerequisites: VCDE-706 or equivalent course.) **Lecture 2, Credits 3 (Fall)**

VCDE-633 **Hard Surface Modeling**
The course focuses on designing and constructing hard surface models including machinery, furniture, vehicles, electronics, and robots. Students explore the use of different modeling techniques in the process and are particularly interested in the flow of the topology within the geometry. Some attention is given to creating controls for moving the hard surface models. (Prerequisites: VCDE-706 or equivalent course.) **Studio 2, Credits 3 (Fall)**

VCDE-636 **3D Motion Design**
Students will learn the general production workflow of creating and integrating three-dimensional rendered elements into a two-dimensional motion graphics setting. The production process will include an overview of modeling, lighting, shading and rendering techniques in a 3D application. Then the course will also explore how to integrate these assets into a 2D animation setting and techniques of creating a professional, polished result quickly and efficiently. (Prerequisites: VCDE-706 or equivalent course.) **Lecture 2, Credits 3 (Fall)**

VCDE-636 **3D Motion Design**
Students will learn the general production workflow of creating and integrating three-dimensional rendered elements into a two-dimensional motion graphics setting. The production process will include an overview of modeling, lighting, shading and rendering techniques in a 3D application. Then the course will also explore how to integrate these assets into a 2D animation setting and techniques of creating a professional, polished result quickly and efficiently. (Prerequisites: VCDE-706 or equivalent course.) **Studio 3, Credits 3 (Fall)**

VCDE-666**Design History Colloquium**

This course is about scholarly issues such as critical thinking, analysis, expression, rigorous questioning, discussion, and dialogue. The course seeks to stimulate a deeper interest in scholarly approaches for graduate students who share an intellectual curiosity about the history of design and seek to expand their knowledge in the emerging field of design studies through a dynamic interplay of design history, design theory and design criticism as these central elements are focused on design objects or artifacts. The Vignelli Center for Design Studies and the Cary Graphic Design Archive offer unique archival resources to support research and interpretive course objectives. The aspect of a colloquium is a gathering of graduate students who share an intellectual curiosity about the history of design and seek to expand their knowledge in the emerging field of design studies. The course objectives are realized through lectures, field trips, guest speakers, archive visits and required research and writing projects. Using a case study format, the course content will focus primarily on the seminal people, places and products of the modern design movement. (This course is restricted to CAD Graduate students.) **Lecture 3, Credits 3 (Fall, Spring)**

VCDE-698**Visual Communication Design Internship**

The Visual Communication Design Internship will provide students with the option to work in the visual communication design field. Students may apply for internships to businesses based on the availability of positions and business job needs. Students must obtain permission of an instructor and complete the Internship Permission Form to enroll. (Prerequisites: This class is restricted to students in VISCOM-MFA with department permission.) **Internship, Credits 1 - 6 (Fall, Spring)**

VCDE-699**Visual Communication Design Co-op**

Cooperative Education will provide Visual Communication Design students with hands-on experience in their field, directly related to a student's major with an established studio or related business. Students will need to apply for co-ops, and interview as part of the selection process, based on available positions posted by the Co-op and Career Services Office, or found through the students' own research. In programs where co-op is a degree requirement, students must obtain permission of their program or graduate director prior to enrollment. Co-ops are typically paid work experience, and can be part-time (150-479 total hours within the term), or full-time (480+ hours within the term). Co-ops may be one or two consecutive terms - fall, spring, or summer - with department permission. (Prerequisites: This class is restricted to students in VISCOM-MFA, CMGD-MFA or GRDE-MFA with department permission.) **CO OP, Credits 0 (Fall, Spring, Summer)**

VCDE-701**Design History Seminar**

This seminar focuses on a basis in the history of design, which complements the overall graduate studies in the School of Design. Interdisciplinary in nature, the course is thematic and emphasizes performance on the part of the student in dynamic dialogue on course topics. The course content focuses on subjects relative to the history and theory of design (people, processes, products, environment, culture and places), critical thinking and contextual historical issues. Students are expected to read seminal design articles, write critical essays and questions and to participate in weekly discussion groups. On-line technology is utilized in addition to slide lectures. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA, CMGD-MFA and IDDE-MFA majors and other CIAS and RIT graduate students with permission of instructor.) **Lecture 2, Credits 3 (Fall)**

VCDE-701**Design History Seminar**

This seminar focuses on a basis in the history of design, which complements the overall graduate studies in the School of Design. Interdisciplinary in nature, the course is thematic and emphasizes performance on the part of the student in dynamic dialogue on course topics. The course content focuses on subjects relative to the history and theory of design (people, processes, products, environment, culture and places), critical thinking and contextual historical issues. Students are expected to read seminal design articles, write critical essays and questions and to participate in weekly discussion groups. On-line technology is utilized in addition to slide lectures. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA, CMGD-MFA and IDDE-MFA majors and other CIAS and RIT graduate students with permission of instructor.) **Seminar 2, Credits 3 (Fall)**

VCDE-702**Materials and Methods for Advanced Graphics**

This course will examine methods of synthesizing analog and digital tools to create visual works that communicate complex information through compelling visual interactions. Projects will prompt students to remix materials, techniques, and design elements in unexpected ways to create new hybrid forms. Course content will cover analog and digital image-making techniques, 2D and 3D design, photography, coding, experimental visual manipulation, and unconventional design tools. Students will research, design, and implement their own unique processes that capitalize on a variety of form-making tools, and move fluidly in and out of the computer. At the completion of this course, students will have developed a vast library of interdisciplinary ideas and techniques for visualizing design that integrate a wide range of materials, forms, and methods. (Prerequisites: VCDE-708 or equivalent course.) **Lec/Lab 5, Credits 3 (Fall or Spring)**

VCDE-706**3D Modeling and Motion**

This course is an introduction to digital three-dimensional visualization. Students learn all aspects of 3D design, from modeling all the way through rendering the final images to setting keyframes for animation. Once familiar with the basics of production, students are encouraged to focus on specific topics such as lighting and texturing and the creation of visual effects for gaming, broadcast, visualization and education. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) **Lecture 2, Credits 3 (Fall)**

VCDE-706**3D Modeling and Motion**

This course is an introduction to digital three-dimensional visualization. Students learn all aspects of 3D design, from modeling all the way through rendering the final images to setting keyframes for animation. Once familiar with the basics of production, students are encouraged to focus on specific topics such as lighting and texturing and the creation of visual effects for gaming, broadcast, visualization and education. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) **Studio 3, Credits 3 (Fall)**

VCDE-707**Web and UI Design**

This course provides an in-depth look at human-centered interface design. Students develop interactive web pages with functional design and usability for e-commerce, education, and the communication of visual communication. Emphasis is placed on the integration and application of design skills applied to information architecture, user navigation and orientation. Projects are focused on designing alternative navigational solutions for online Web applications and touch-screen devices such as mobile phones and touch-pads. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) **Lecture 2, Credits 3 (Fall)**

VCDE-707**Web and UI Design**

This course provides an in-depth look at human-centered interface design. Students develop interactive web pages with functional design and usability for e-commerce, education, and the communication of visual communication. Emphasis is placed on the integration and application of design skills applied to information architecture, user navigation and orientation. Projects are focused on designing alternative navigational solutions for online Web applications and touch-screen devices such as mobile phones and touch-pads. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) **Studio 3, Credits 3 (Fall)**

VCDE-708**Typography**

This course examines the historical, theoretical, and perceptual aspects of typography for print and screen use. Grid structure, composition, hierarchy, message conveyance, and formal aspects of typographic design are explored with an emphasis on developing harmonious type and image integration into cohesive, sequential design applications. How temporal structural elements such as rhythm and pacing affect visual communication in a dynamic medium is also investigated and applied. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) **Lecture 2, Credits 3 (Fall)**

VCDE-708**Typography**

This course examines the historical, theoretical, and perceptual aspects of typography for print and screen use. Grid structure, composition, hierarchy, message conveyance, and formal aspects of typographic design are explored with an emphasis on developing harmonious type and image integration into cohesive, sequential design applications. How temporal structural elements such as rhythm and pacing affect visual communication in a dynamic medium is also investigated and applied. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) **Studio 3, Credits 3 (Fall)**

VCDE-709**Digital Design in Motion**

This course focuses on motion design from story reels to the final project. Course content focuses on visual components, and assignments translate production techniques used in traditional filmmaking into the online environment. This includes the use of line, space (two and three-dimensional), composition and framing, simulated camera movements, color, and sound. Using a time-based application as the authoring tool and the techniques outlined in this course, a student will be able to produce interactive stories, such as online graphic novels and webisodes. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) **Lecture 2, Credits 3 (Fall)**

VCDE-709**Digital Design in Motion**

This course focuses on motion design from story reels to the final project. Course content focuses on visual components, and assignments translate production techniques used in traditional filmmaking into the online environment. This includes the use of line, space (two and three-dimensional), composition and framing, simulated camera movements, color, and sound. Using a time-based application as the authoring tool and the techniques outlined in this course, a student will be able to produce interactive stories, such as online graphic novels and webisodes. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) **Studio 3, Credits 3 (Fall)**

VCDE-711

Design Methodology

This seminar explores cross-disciplinary principles, theories and methods that can be used by designers. Through selected readings from current periodicals, critical writing, hands-on involvement, presentations and guest lectures, students will broaden their awareness of topics such as systems thinking, human factors, semiotic theory, and visual rhetoric, and become familiar with brainstorming, problem solving and evaluation methods in order to sharpen their understanding of the design process. Information will be directed toward meaningful concept development and the selection and use of appropriate methodologies for design problem solving. (This course is restricted to CAD Graduate students.) **Lecture 3, Credits 3 (Spring)**

VCDE-712

Design Studies Seminar

As an introduction to the field, this course will present the many complex roles of design—as process, product, function, symbol and use. This seminar will approach critical views of design studies from an interdisciplinary perspective. Faculty colleagues representing diverse campus expertise and beyond will contribute from their respective knowledge bases. The course will require readings, discussion, critical thinking, and writings as we examine the impact of history, theory and critical analysis as related to the interpretation and understanding of design. **Lecture 2, Credits 3 (Spring)**

VCDE-712

Design Studies Seminar

As an introduction to the field, this course will present the many complex roles of design—as process, product, function, symbol and use. This seminar will approach critical views of design studies from an interdisciplinary perspective. Faculty colleagues representing diverse campus expertise and beyond will contribute from their respective knowledge bases. The course will require readings, discussion, critical thinking, and writings as we examine the impact of history, theory and critical analysis as related to the interpretation and understanding of design. **Seminar 2, Credits 3 (Spring)**

VCDE-717

Design Systems

This course investigates a systems thinking approach for the purpose of clear, unified communication. The complexity of multiple components are integrated into a common framework to solve graphic design problems. Conceptual mapping, design process strategies, user-centric goals, visual symbolism, the balance of design with cultural, environmental and technological factors, design writing, and design evaluation are integrated into the course. Both theoretical and applied problems will be developed. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) **Studio 5, Credits 3 (Spring)**

VCDE-718

Project Design and Implementation

This course provides students with the necessary skills to further develop a research plan into a specific design inquiry with an application component. Emphasis is placed on identifying connections and integrating content between this course and the culminating first-year experience in the MFA Visual Communication Design program. Students will chose a topic, write a design proposal, and design and implement a project from inception to conclusion. This involves research, development, evaluation, refinement, completion of a finished creative project, and documentation of the process. The project can be produced independently or collaborative with advice from the instructor. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) **Lab 3, Credits 3 (Spring)**

VCDE-718

Project Design and Implementation

This course provides students with the necessary skills to further develop a research plan into a specific design inquiry with an application component. Emphasis is placed on identifying connections and integrating content between this course and the culminating first-year experience in the MFA Visual Communication Design program. Students will chose a topic, write a design proposal, and design and implement a project from inception to conclusion. This involves research, development, evaluation, refinement, completion of a finished creative project, and documentation of the process. The project can be produced independently or collaborative with advice from the instructor. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) **Lecture 2, Credits 3 (Spring)**

VCDE-722

Design Praxis I

This course involves the research, writing, and production of printed applications based on content developed from RIT's unique archival resources (Vignelli Center, Cary Graphic Design Archive, Cary Collection and Wallace Library) and others. Typography and imagery are used to interpret topics such as design history, theory and criticism with formal visual language. **Lecture 2, Credits 3 (Spring)**

VCDE-722

Design Praxis I

This course involves the research, writing, and production of printed applications based on content developed from RIT's unique archival resources (Vignelli Center, Cary Graphic Design Archive, Cary Collection and Wallace Library) and others. Typography and imagery are used to interpret topics such as design history, theory and criticism with formal visual language. **Studio 3, Credits 3 (Spring)**

VCDE-723

Interaction Design

This course applies design methodologies to multimedia applications. Students communicate ideas and information to specific audiences through interactive, instructional applications. Course work will integrate content research, developing measurable objectives, and information architecture with interactivity. At the completion of this course students will be able to design site maps and flowcharts, implement an effective graphical user interface, communicate layered information through a hierarchical structure, control user navigation and feedback using interactivity, and design cross-platform projects for entertainment, games, information systems, and education. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) **Lecture 2, Credits 3 (Spring)**

VCDE-723

Interaction Design

This course applies design methodologies to multimedia applications. Students communicate ideas and information to specific audiences through interactive, instructional applications. Course work will integrate content research, developing measurable objectives, and information architecture with interactivity. At the completion of this course students will be able to design site maps and flowcharts, implement an effective graphical user interface, communicate layered information through a hierarchical structure, control user navigation and feedback using interactivity, and design cross-platform projects for entertainment, games, information systems, and education. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) **Studio 3, Credits 3 (Spring)**

VCDE-726

Design Praxis II

The development of digital deliverables and experiences is the central focus of this course. Interpretive projects will be composed of a sequence of text and images applying formal visual principles. The course is intended to center on the interrelationship of themes such as design history, theory and criticism using RIT's unique communications resources (Vignelli Center, Cary Graphic Design Archive, Cary Collection and Wallace Library) and others. (Prerequisites: VCDE-722 or equivalent course.) **Lecture 2, Credits 3 (Fall)**

VCDE-726

Design Praxis II

The development of digital deliverables and experiences is the central focus of this course. Interpretive projects will be composed of a sequence of text and images applying formal visual principles. The course is intended to center on the interrelationship of themes such as design history, theory and criticism using RIT's unique communications resources (Vignelli Center, Cary Graphic Design Archive, Cary Collection and Wallace Library) and others. (Prerequisites: VCDE-722 or equivalent course.) **Studio 3, Credits 3 (Fall)**

VCDE-728

Motion Graphics

This course focuses on motion graphics as an extension of traditional design that incorporates a temporal or time-based element into the message. Students are exposed to video compositing software and learn the craft, practice, and theory of what it takes to make it in the fast-paced, competitive world of motion graphics design. Computer software is used to composite visual effects in both animation and live video. Sequencing, storyboarding, digital audio, titling, and animation are integrated to produce time-based projects for film, broadcast, and the web. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) **Lecture 2, Credits 3 (Spring)**

VCDE-728

Motion Graphics

This course focuses on motion graphics as an extension of traditional design that incorporates a temporal or time-based element into the message. Students are exposed to video compositing software and learn the craft, practice, and theory of what it takes to make it in the fast-paced, competitive world of motion graphics design. Computer software is used to composite visual effects in both animation and live video. Sequencing, storyboarding, digital audio, titling, and animation are integrated to produce time-based projects for film, broadcast, and the web. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) **Studio 3, Credits 3 (Spring)**

VCDE-731

3D Visual Design

This course focuses on the visual look of a three-dimensional model. Students apply lighting methods to illuminate 3D models and spaces. The interaction of light and pigment, use of light in painting, photography, and film are used as examples. Techniques in using shading networks are incorporated into the projects. Displacement textures are used to create detail in models. This course also covers a contrast and comparison of various methods and resolutions of rendering and outputting information from 3D software. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) **Lecture 2, Credits 3 (Fall)**

VCDE-731

3D Visual Design

This course focuses on the visual look of a three-dimensional model. Students apply lighting methods to illuminate 3D models and spaces. The interaction of light and pigment, use of light in painting, photography, and film are used as examples. Techniques in using shading networks are incorporated into the projects. Displacement textures are used to create detail in models. This course also covers a contrast and comparison of various methods and resolutions of rendering and outputting information from 3D software. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) **Studio 3, Credits 3 (Fall)**

VCDE-732**Branding and Identity Design**

This course provides an examination of the role of design in brand strategy and cohesive identity systems. Historical and current systems will be researched and analyzed. Development of formal proposals, research, and design strategies for developing integrated solutions are explored. Projects will include client contact, writing of design briefs, collaborative projects, use of social networks for brand expansion, information structures, screen and print formats, and presentation methods. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) **Lecture 2, Credits 3 (Fall)**

VCDE-732**Branding and Identity Design**

This course provides an examination of the role of design in brand strategy and cohesive identity systems. Historical and current systems will be researched and analyzed. Development of formal proposals, research, and design strategies for developing integrated solutions are explored. Projects will include client contact, writing of design briefs, collaborative projects, use of social networks for brand expansion, information structures, screen and print formats, and presentation methods. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) **Studio 3, Credits 3 (Fall)**

VCDE-733**Digital Media Integration**

This course uses digital video cameras for motion recording and microphones for digital audio recordings. Emphasis is placed on digital video and audio design, production, and integration in multimedia applications. Course projects focus on shooting, digitizing and editing video plus recording, editing and mixing of audio for digital movies. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) **Lecture 2, Credits 3 (Fall)**

VCDE-733**Digital Media Integration**

This course uses digital video cameras for motion recording and microphones for digital audio recordings. Emphasis is placed on digital video and audio design, production, and integration in multimedia applications. Course projects focus on shooting, digitizing and editing video plus recording, editing and mixing of audio for digital movies. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) **Studio 3, Credits 3 (Fall)**

VCDE-736**Design Systems Intensive**

This intensive studio course investigates principles and theories related to systems thinking and application from diverse inter- and cross-disciplinary perspectives. Systems thinking is explored through many lenses that include concept, language, information, aesthetics, format, context, materiality and temporal considerations. Message-making, organization and implementation strategies are key components of this course. Students discover and practice design systems across a diverse range of studio, lecture and presentation experiences. The VCDE-717 Design Systems course is not a prerequisite for this course, but may be taken prior to this Design Systems Intensive course. **Studio 3, Credits 3 (Fall)**

VCDE-736**Design Systems Intensive**

This intensive studio course investigates principles and theories related to systems thinking and application from diverse inter- and cross-disciplinary perspectives. Systems thinking is explored through many lenses that include concept, language, information, aesthetics, format, context, materiality and temporal considerations. Message-making, organization and implementation strategies are key components of this course. Students discover and practice design systems across a diverse range of studio, lecture and presentation experiences. The VCDE-717 Design Systems course is not a prerequisite for this course, but may be taken prior to this Design Systems Intensive course. **Lecture 2, Credits 3 (Fall)**

VCDE-737**UX Design Strategies**

This course explores design strategies related to researching, identifying and implementing a digital user experience for online web and app development. Students will apply design research methodologies to gather and evaluate source material to design and implement user interactive solutions. Projects will include defining client and user goals, user identification, user empathy, content organization, information architecture, wire-framing methods and validation through user testing across various platforms. At the conclusion of the course students will design and document several different interactive projects. (Prerequisites: VCDE-707 or equivalent course.) **Lecture 2, Credits 3 (Fall)**

VCDE-737**UX Design Strategies**

This course explores design strategies related to researching, identifying and implementing a digital user experience for online web and app development. Students will apply design research methodologies to gather and evaluate source material to design and implement user interactive solutions. Projects will include defining client and user goals, user identification, user empathy, content organization, information architecture, wire-framing methods and validation through user testing across various platforms. At the conclusion of the course students will design and document several different interactive projects. (Prerequisites: VCDE-707 or equivalent course.) **Studio 3, Credits 3 (Fall)**

VCDE-741**Experiential Graphic Design**

This course focuses on the functions of environmental graphic design in a three-dimensional environment. Through studies of theory of environmental design, exploration and conceptual development, design solutions are directed to assist users in negotiating, or wayfinding, through a space or environment, to identify, direct and inform. Topics include learning methods, communication theory, ergonomics, visual hierarchy, design principles and process. Areas of application include architectural graphics, signage systems, dynamic environments, mapping, exhibit design, museum experiences, and themed environments. Students also explore how to integrate both two- and three-dimensional components to develop physical and digital-based environments. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) **Lecture 2, Credits 3 (Fall)**

VCDE-741**Experiential Graphic Design**

This course focuses on the functions of environmental graphic design in a three-dimensional environment. Through studies of theory of environmental design, exploration and conceptual development, design solutions are directed to assist users in negotiating, or wayfinding, through a space or environment, to identify, direct and inform. Topics include learning methods, communication theory, ergonomics, visual hierarchy, design principles and process. Areas of application include architectural graphics, signage systems, dynamic environments, mapping, exhibit design, museum experiences, and themed environments. Students also explore how to integrate both two- and three-dimensional components to develop physical and digital-based environments. (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) **Studio 3, Credits 3 (Fall)**

VCDE-742**Information Design**

This course explores the importance of reader and user responses to written and visually presented information. Problem-solving, functional requirements, information transmission, accessibility and design structure are integrated while investigating a variety of formats (i.e. charts, diagrams, business forms, tables, maps, instructional materials, wayfinding systems, and technical data.) Applied problems are solved through principles of language, structure, diagrammatic interpretation and the visual display of information. Solutions will be developed for both print media and digital use (i.e. mobile devices, computer screens, kiosks, etc.). (This course is restricted to students in the VISCOM-MFA, GRDE-MFA and CMGD-MFA programs.) **Studio 5, Credits 3 (Fall)**

VCDE-746**Professional Practices**

This course will help students prepare for a professional career in design. Equally as important as design theory, the content focuses on the practical knowledge of production and design skills, and exposure to basic business practices. An overview of business and economics related to the design world, goal setting and productivity skills, professional ethics, marketing, the interviewing process, and strategic analysis is addressed. Projects provide an in-depth look at creating an effective digital portfolio and curriculum vitae based upon personal strengths and interests, with professional standards, and career expectations in mind. (Prerequisites: VCDE-701 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

VCDE-763**Graphic Design Education Seminar**

This graduate design elective is a history of graphic design course which focuses on presenting significant pedagogical models that existed between the Bauhaus and the emergence of Post-Modernism (1919 to 1980). Master design educators, innovative educational programs and significant influences that have shaped contemporary design education and practice will be the primary content. The course will involve lectures, presentations, critical discussion and writing. (his course is restricted to Graduate College of Art and Design students.) **Lecture 3, Credits 3 (Spring)**

VCDE-790**Thesis: Research and Planning**

Research is the backbone for any project. This course will focus on the design research and planning stages of a thesis project. Students will define a design problem that provides a significant addition to the design field while addressing needs in the local, regional and/or global community. Course content addresses establishing content, planning, scheduling, and research seeking innovative solutions through the process of concept development, ideation, and in-process evaluation. (Prerequisites: VCDE-718 or VCDE-722 or equivalent course.) **Thesis 3, Credits 3 (Fall)**

VCDE-799**Visual Communication Design Independent Study**

Visual Communication Design Independent Study will allow students to obtain instruction in specialized areas of interest to enhance their individual course of study. Working with a faculty adviser, students will propose a focused curriculum related to their academic and/or future career interests. Visual Communication Design Independent Study students must obtain permission of an instructor to enroll. **NOTE: Student must have a minimum 3.0 GPA ** (Prerequisites: This class is restricted to students in VISCOM-MFA, CMGD-MFA, GRDE-MFA or IDDE-MFA with instructor permission.) **Ind Study, Credits 1 - 4 (Fall, Spring)**

VCDE-887 Visual Communication Design Part-Time Co-op
Cooperative Education will provide Visual Communication Design students with hands-on experience in their field, directly related to a student's major with an established studio or related business. Students will need to apply for co-ops, and interview as part of the selection process, based on available positions posted by the Co-op and Career Services Office, or found through the students' own research. In programs where co-op is a degree requirement, students must obtain permission of their program or graduate director prior to enrollment. Co-ops are typically paid work experience, and can be part-time (150-479 total hours within the term), or full-time (480+ hours within the term). Co-ops may be one or two consecutive terms - fall, spring, or summer - with department permission. (Prerequisites: This class is restricted to students in VISCOM-MFA, CMGD-MFA or GRDE-MFA with department permission.) **CO OP, Credits 0 (Fall, Spring, Summer)**

VCDE-890 Thesis: Implementation and Evaluation
This course will focus on the physical thesis project. Students will continue with concept development concluding with the implementation and retrospective evaluation of their chosen design problem. Solution is presented in a public exhibition, complemented by a written articulation of how the theories and methods employed in the project impact the current and future state of design in society. (Prerequisites: VCDE-790 or equivalent course.) **Thesis 9, Credits 6 (Spring)**

VCDE-892 Continuation of Thesis Visual Communication Design
The MFA Visual Communication Design Continuation of Thesis course provides student additional semester(s) to complete their thesis research, project, and thesis document. (Prerequisite: VCDE-890 or equivalent course and student standing in the VISCOM-MFA, CMGD-MFA or GRDE-MFA program.) **Cont, Credits 0 (Fall, Spring)**

UXDE-711 User Interface Design
This course provides an introduction to human-centered interface design. Students research, explore and create design-based solutions for user interfaces. An introduction to visual design elements and principles such as form, color, typography, imagery, visual hierarchy, layout and information architecture. Emphasis is placed on integrating and applying design skills and processes to web standards and device guidelines. Projects are focused on designing navigational solutions for online web and touch-screen applications such as mobile phones and touchpads. At the conclusion of the course students will be able to research, analyze and create user interface mock-ups based on appropriate visual design principles across multiple devices and platforms. Students will gain a core user interface design foundation to incorporate into their professional role during the planning and UI design phases of interactive projects. **Note: Course is restricted to RIT Online graduate students only** (Reserved for online students.) **Lecture 7, Credits 3 (Fall)**

UXDE-721 User Experience Design
This course introduces students to the design process for researching, identifying and implementing a user experience strategy for online web and app development. Students will learn to research, gather and evaluate source material to organize, write and design interaction solutions. The user experience workflow will cover: defining client and user goals, user identification, content organization, information architecture, wire-framing methods and basic UX validation through user testing across various platforms. At the conclusion of the course students will complete and document a UX project plan based on graphical user interface requirements and interactive conventions. Students will be able to incorporate the UX design process into their professional role during the research, planning and interaction design phases of user experience projects. and may have limited repeatability **Lecture 7, Credits 3 (Spring)**

UXDE-722 Interaction Design and Development
This course provides an introduction to interaction design and development including internet, web and mobile technologies. Topics covered include computer-based communication and information systems: basic HTML 5, CSS3, JavaScript and WYSIWYG editors for creating content and project workflows for delivery online and mobile content. The course will examine and integrate programmatic solutions and project planning processes for single and responsive design solutions. Best practices and technologies for hybrid, native and web solutions will also be identified and explored. At the conclusion of the course students will be able to programmatically implement web based user experiences which incorporates user interface mock-ups and basic interactive functionality. Students will gain the required technical knowledge to facilitate improved communication with developers and create stronger user experience design solutions during the planning and implementation of interactive projects. **Note: Course is restricted to RIT Online graduate students only** **Lecture 7, Credits 3 (Spring)**

Integrative Design

INGD-650 Contemporary Issues in Design: Topic
This course will explore a range of contemporary debates, themes, and issues relevant to designers. Through critical dialogue, students will examine the roles and responsibilities of designers now and in the future—particularly as they pertain to "wicked problems" and sustainable development. Underlying themes include systems analysis, critical thinking, and ethical practice. **Lecture 3, Credits 3 (Fall or Spring)**

INGD-674 Design Charrettes
This is an interdisciplinary course developing charrettes that address product, service and social challenges. In collaboration with individuals and organizations, students will utilize design ideation and iterative methods in defining and developing contextually relevant solutions. Final concepts will be analyzed and presented in a public forum. **Studio 6, Credits 3 (Fall, Spring)**

INGD-721 Elements and Methods
This course is an introductory experience building the visual, verbal and cognitive understanding of three-dimensional design elements and principles. Projects focus on developing the ability to see, organize, and manipulate design elements and abstraction to achieve the desired sensory responses. (This course is restricted to INTEGDE-MS Major students.) **Studio 6, Credits 3 (Fall)**

INGD-722 Emotion and Implementation
This course builds from the Elements and Methods course and introduces emotional design as a means of creating, understanding and implementing the relationship between the object, the user and the desired sensory response. Concepts of material selection, production processes, and sustainability are explored. Through projects students develop the tools and technical skills necessary for hands-on problem solving and three-dimensional communication of design intent. (Prerequisites: INGD-721 or equivalent course.) **Studio 6, Credits 3 (Spring)**

INGD-726 Visualization I: Development
This course is an introduction to drawing objects and three-dimensional space as a means of developing and communicating design concepts. Students will understand and use the basics of perspective sketching, mechanical perspective, grids and orthogonal views to communicate design concepts. (This course is restricted to INTEGDE-MS Major students.) **Studio 6, Credits 3 (Fall)**

INGD-727 Visualization II: Communication
This course continues developing more advanced visualization techniques, while expanding on visual communication skills: such as storytelling, graphic layout and presentations. Exercises will introduce students to various types of analog and digital visual communication techniques. (Prerequisites: INGD-726 or equivalent course.) **Studio 6, Credits 3 (Spring)**

INGD-731 Design Studio I: Concepts
This course is a theoretical and pragmatic approaches to responsible design practices through processes of iteration, divergent/convergent thinking and critical analysis. Projects focus on human-centered approaches and the contextual relevance of products, service and systems. (This course is restricted to INTEGDE-MS Major students.) **Studio 6, Credits 3 (Fall)**

INGD-732 Design Studio II: Capstone
This course will focus on the application of design methods and processes, design thinking, problem solving, concept development. Students will work with faculty and advisors in establishing a design project. Emphasis will be placed on collaborating with multidisciplinary partners and external resources such as clients or project sponsors. The course culminates with a public presentation of the design project. (Prerequisites: INGD-731 or equivalent course.) **Studio 6, Credits 3 (Spring)**

INGD-748 Continuation of Capstone
The course provides a student additional semester(s) to complete their capstone research, project and documentation. (Prerequisites: INGD-732 or equivalent course.) **Cont, Credits 0 (Fall, Spring, Summer)**

School of Film and Animation

Film and Animation

SOFA-601

Graduate Production

A fundamental course in 16mm non-synchronous film and basic digital video production. Filmmaking is presented as a means of interpretation and expression. This course will combine technical information, camera technique and editing with a theoretical and practical approach to motion picture continuity. Production is divided into two learning experiences: 16mm (non-sync) HD format and digital video format. Students will be responsible for purchasing their own film and processing. (This course is restricted to students in the FILMAN-MFA program.) **Lab 3, Credits 3 (Fall)**

SOFA-601

Graduate Production

A fundamental course in 16mm non-synchronous film and basic digital video production. Filmmaking is presented as a means of interpretation and expression. This course will combine technical information, camera technique and editing with a theoretical and practical approach to motion picture continuity. Production is divided into two learning experiences: 16mm (non-sync) HD format and digital video format. Students will be responsible for purchasing their own film and processing. (This course is restricted to students in the FILMAN-MFA program.) **Lecture 2, Credits 3 (Fall)**

SOFA-602

Production Processes

This course is an introduction to various aspects of professional film/video narrative production. Course content focuses on collaborative production techniques with various student levels to reinforce team building needed to produce a film. At the completion of this course, students create short projects while learning basic shooting and crewing procedures, studio protocol, equipment handling and maintenance, and basic sync editing. **A materials fee is required for this course** **Studio 10, Credits 6 (Fall)**

SOFA-602

Production Processes

This course is an introduction to various aspects of professional film/video narrative production. Course content focuses on collaborative production techniques with various student levels to reinforce team building needed to produce a film. At the completion of this course, students create short projects while learning basic shooting and crewing procedures, studio protocol, equipment handling and maintenance, and basic sync editing. **A materials fee is required for this course** **Lecture 2, Credits 6 (Fall)**

SOFA-603

2D Animation I: Fundamentals

This course will introduce graduate students to the concepts and mechanics of movement for animation, focusing on, but not limited to, character based movement. Animation principles and theories on movement and acting will be introduced and applied using hand-drawn methods, which will serve as the foundation for their application in any desired medium. Various styles of animation timing will be examined and students will have the opportunity to develop their own sense of timing and movement. Multi-week exercises will be recorded using standard animation software, and will be reviewed, discussed and open to group critique. (This course is restricted to students in the FILMAN-MFA program.) **Studio 6, Credits 3 (Fall)**

SOFA-604

2D Animation II: Mechanics

This course will build on information gained from foundation animation courses. Multi-week assignments will allow students to fully grasp the production process involved in hand-drawn animation and develop an understanding of different parameters commonly found in animated films, including but not limited to character interaction, emotion and animal movement. Students will have the opportunity to explore various approaches to timing, movement, acting and characterization. Character design and solid drawing skills are highly recommended. (Prerequisites: SOFA-603 or equivalent course.) **Lab 3, Credits 3 (Spring)**

SOFA-604

2D Animation II: Mechanics

This course will build on information gained from foundation animation courses. Multi-week assignments will allow students to fully grasp the production process involved in hand-drawn animation and develop an understanding of different parameters commonly found in animated films, including but not limited to character interaction, emotion and animal movement. Students will have the opportunity to explore various approaches to timing, movement, acting and characterization. Character design and solid drawing skills are highly recommended. (Prerequisites: SOFA-603 or equivalent course.) **Lecture 1, Credits 3 (Spring)**

SOFA-605

Basic Sound Recording

This course will provide specialized knowledge and work in sound to prepare the student to be able to distinguish and evaluate proper sound techniques for film and animation productions. The course lays the foundation for professional work in the sound industry. Each student will record an audio and prepare a mixed soundtrack to professional quality standards. (This course is restricted to students in the FILMAN-MFA program.) **Lecture 3, Credits 3 (Fall)**

SOFA-606

Graduate Directing

An introduction to the arts of directing and acting with an emphasis on script analysis, performance, and blocking. Students direct and act in scenes from professional productions. Scenes are rehearsed outside of class, and then staged and critiqued in class. (This course is restricted to students in the FILMAN-MFA program.) **Lecture 3, Credits 3 (Fall)**

SOFA-607

Advanced Directing

Students will deepen their skills in analyzing scripts and directing actors while adding the breakdown of scenes into shots and the choreography of the camera with actors. Students will stage scenes from professional productions in class, and then shoot and edit them outside of class with a focus on creative rather than technical accomplishment. (Prerequisites: SOFA-606 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

SOFA-608

Dramatic Structure

This course explores the theories of dramatic structure from Aristotle to the present and applies these theories to current and classic dramatic works. The class also explores dramatic script structure as it is used in dramatic works on stage and screen. (This course is restricted to students in the FILMAN-MFA program.) **Lec/Lab 5, Credits 3 (Fall)**

SOFA-610

Graduate Seminar

A forum to establish among a diverse student group a common vocabulary for discussing film language and structure, collaborative relationships, and a sense of community, while exploring issues related to scene analysis, production practice and planning, story boarding, story telling, visual music, School of Film and Animation policies and professional business realities. (This course is restricted to students in the FILMAN-MFA program.) **Lecture 2, Credits 2 (Fall)**

SOFA-611

History and Aesthetics of Animation

This course will explore the beginnings, the evolution, and the creative and practical history of the animated film. This will include prehistory of animation, early film and animation history development, major trends, artists, animation studios, theoretical distinctions, and international identities in animation. Issues of animation aesthetics will also be revealed through discussions, readings and reviews of exemplary films: emphasizing the unique characteristics of the animated art form and how those characteristics are used as a means of interpretation and expression. Both orthodox and unorthodox animation will be highlighted. Films will be screened at every lecture. (his course is restricted to Graduate College of Art and Design students.) **Lec/Lab 5, Credits 3 (Spring)**

SOFA-613

Graduate Screenwriting

This course focuses on the forms and techniques of writing for visual media, particularly the short film. Throughout the course, students develop resources for finding stories and concepts that can be turned into films. Students are responsible for writing a short script of their own choosing and for completing several brief written exercises in areas such as personal storytelling, character development, dialogue, and plot. Scripts written in this class can be used as the basis for films produced in other classes. (This course is restricted to students in the FILMAN-MFA program.) **Lecture 3, Credits 3 (Fall)**

SOFA-614

Business and Careers in Film

An introduction to all aspects of the business side of professional film/video narrative and commercial production. Students develop a business plan to create their own production company while learning alternative careers in film, basic financial and legal protocol, and mental preparation needed to enter the film business market. (Prerequisites: SOFA-621 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

SOFA-615

3D Animation Fundamentals

This course will provide a fundamental understanding of computer-generated three-dimensional imagery and world-building. Using top industry-standard software Autodesk Maya, students will explore the technology and processes of professional world-creation and animation. Students will experience the creation of completed digital animations and display skills in 3D modeling, animation, lighting and rendering. (This course is restricted to students in the FILMAN-MFA program.) **Lab 3, Credits 3 (Fall)**

SOFA-615

3D Animation Fundamentals

This course will provide a fundamental understanding of computer-generated three-dimensional imagery and world-building. Using top industry-standard software Autodesk Maya, students will explore the technology and processes of professional world-creation and animation. Students will experience the creation of completed digital animations and display skills in 3D modeling, animation, lighting and rendering. (This course is restricted to students in the FILMAN-MFA program.) **Lecture 2, Credits 3 (Fall)**

SOFA-616

Virtual Production I

Virtual Production I introduces the theory and practice in the evolving field of virtual cinematic and television production. Students are exposed to the techniques and workflows associated with virtual production and previsualization using current and future hardware and software, computer graphics, immersive technology, real-time rendering, game engines, and practical filmmaking. Technologies addressed include AR (augmented reality) and VR (virtual reality) for scouting, environment and asset creation, motion capture for previsualization and real-time production, virtual cinematography, lighting design, real-time visual effects (VFX), and set extension. Students will use project management techniques and work in teams to research and develop an array of pipeline and technology needs for the successful creation of creative narratives. By the completion of the course, students develop a working knowledge of engineering and design thinking and an immersion in the methods of teamwork in the disciplines which enable modern virtual production. **Lab 3, Credits 3 (Fall)**

SOFA-616

Virtual Production I

Virtual Production I introduces the theory and practice in the evolving field of virtual cinematic and television production. Students are exposed to the techniques and workflows associated with virtual production and previsualization using current and future hardware and software, computer graphics, immersive technology, real-time rendering, game engines, and practical filmmaking. Technologies addressed include AR (augmented reality) and VR (virtual reality) for scouting, environment and asset creation, motion capture for previsualization and real-time production, virtual cinematography, lighting design, real-time visual effects (VFX), and set extension. Students will use project management techniques and work in teams to research and develop an array of pipeline and technology needs for the successful creation of creative narratives. By the completion of the course, students develop a working knowledge of engineering and design thinking and an immersion in the methods of teamwork in the disciplines which enable modern virtual production. **Lecture 2, Credits 3 (Fall)**

SOFA-617

Stop Motion Puppet Fundamentals

This introductory course will give graduate students a basic and solid understanding of stop-motion animation. The class will cover aspects of stop-motion in its various forms but will mainly concentrate on stop-motion puppet / character animation. There will be demonstrations on model fabrication, animation techniques and camera / grip techniques. Topics, such as latex and silicon mold-making and intensive postproduction techniques will be introduced. (his course is restricted to Graduate College of Art and Design students.) **Lab 3, Credits 3 (Fall)**

SOFA-617

Stop Motion Puppet Fundamentals

This introductory course will give graduate students a basic and solid understanding of stop-motion animation. The class will cover aspects of stop-motion in its various forms but will mainly concentrate on stop-motion puppet / character animation. There will be demonstrations on model fabrication, animation techniques and camera / grip techniques. Topics, such as latex and silicon mold-making and intensive postproduction techniques will be introduced. (his course is restricted to Graduate College of Art and Design students.) **Lecture 2, Credits 3 (Fall)**

SOFA-618

Business and Careers in Animation

This class will be geared toward the small animation business owner, the studio employee, and the individual freelance animator. The course will discuss the setting up of a small business and all of its operations. The elements of discussion will teach students how to approach animation work in the industry from a small business perspective and from an individual approach. The class will discuss the creation of sample reels, websites, self-promotion, contracts, negotiation, pitching, fund-raising, research and interview techniques all related to the individual animator. Crowdfunding and grant writing will be discussed. There will be guest interviews from animation professionals. Discussions of ethics and individual responsibilities will be covered. (Prerequisites: SOFA-622 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

SOFA-620

3D Modeling Mastery

In this advanced three-dimensional modeling course, students will refine their knowledge and skills by creating objects and characters in 3D space. Students will build and create on their previous modeling knowledge and will be introduced to digital sculpting. Modeling concepts such as edge-loop placement for proper animation deformation will be emphasized. (Prerequisites: SOFA-615 or equivalent course.) **Lab 3, Credits 3 (Spring)**

SOFA-620

3D Modeling Mastery

In this advanced three-dimensional modeling course, students will refine their knowledge and skills by creating objects and characters in 3D space. Students will build and create on their previous modeling knowledge and will be introduced to digital sculpting. Modeling concepts such as edge-loop placement for proper animation deformation will be emphasized. (Prerequisites: SOFA-615 or equivalent course.) **Lecture 2, Credits 3 (Spring)**

SOFA-621

Spring Film

In this course students will complete their first full semester production. Students must decide on a concept, develop a treatment, write a script or research a non-fiction subject. Student will produce a film complete with mixed track and finished titles and credits. (Prerequisites: SOFA-602 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

SOFA-622

30 Second Film

An introduction into the world of producing television commercials or other 30 second films. Major emphasis will be placed on learning to generate and intensify a personal statement through creative projects. Work is critiqued weekly by the instructor and class. Students execute the production of a completed 30 second film. (Prerequisites: SOFA-603 or SOFA-615 or SOFA-617 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

SOFA-623

Stop Motion Master Class

This course will introduce stop motion MFA students to more advanced techniques of single frame production. The class will be divided into teams that will execute a finished short film complete with post and sound work. Although these finished films will be short and simple they will expose the students to stop motion set and puppet building, lighting, grip work, camera movement and post work. This class builds on the fundamentals that were taught in the Puppet Fundamentals class and advances the student in their understanding of stop motion production. The team members will specialize in certain areas of building, camera work, animation and post work and will contribute to the team film until the completion of that project. The next step for these advanced students upon completion of this class will be to create an MFA thesis film. (Prerequisites: SOFA-617 or equivalent course and graduate student standing in FILMAN-MFA.) **Lab 3, Credits 3 (Spring)**

SOFA-623

Stop Motion Master Class

This course will introduce stop motion MFA students to more advanced techniques of single frame production. The class will be divided into teams that will execute a finished short film complete with post and sound work. Although these finished films will be short and simple they will expose the students to stop motion set and puppet building, lighting, grip work, camera movement and post work. This class builds on the fundamentals that were taught in the Puppet Fundamentals class and advances the student in their understanding of stop motion production. The team members will specialize in certain areas of building, camera work, animation and post work and will contribute to the team film until the completion of that project. The next step for these advanced students upon completion of this class will be to create an MFA thesis film. (Prerequisites: SOFA-617 or equivalent course and graduate student standing in FILMAN-MFA.) **Lecture 2, Credits 3 (Spring)**

SOFA-624

Tradigital Animation

The computer has become an integral part of modern animation production. This course will introduce students to the application of computer technology to animation to aid them in incorporating it into their personal skill sets. The focus will be on adapting traditional techniques to the digital production environment. The student will work with professional level animation software using both raster and vector graphics to produce several short exercises adapted from traditional techniques that will develop the skills needed to efficiently and effectively use two-dimensional digital tools in their own work. (This course is restricted to students in the FILMAN-MFA program.) **Lab 3, Credits 3 (Fall)**

SOFA-624

Tradigital Animation

The computer has become an integral part of modern animation production. This course will introduce students to the application of computer technology to animation to aid them in incorporating it into their personal skill sets. The focus will be on adapting traditional techniques to the digital production environment. The student will work with professional level animation software using both raster and vector graphics to produce several short exercises adapted from traditional techniques that will develop the skills needed to efficiently and effectively use two-dimensional digital tools in their own work. (This course is restricted to students in the FILMAN-MFA program.) **Lecture 2, Credits 3 (Fall)**

SOFA-625

Animated Acting Principles

This course will give students an opportunity to explore a visual language of acting and posing that will help their storytelling abilities. Acting, timing and pacing are critical elements to any successful character animated film. Identifying and building a library of expressions, poses, and movement for emotional and visual expression is the goal for each student. Students will study reference material from silent and animated films. Students will also create their own reference material through acting and filming. The visual references will be scrutinized on a frame-by-frame basis for a deeper understanding of this visual language. Students will produce animated studies related to the acting principles. (Prerequisites: SOFA-630 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

SOFA-626

Writing the Short

This course will explore the short screenplay as its own genre and as a stepping-stone to writing longer forms. Students will improve their ability to develop goals and obstacles and, thereby, create a complete narrative journey. Students will write approximately a 15 minute film or animation scripts. Film scripts will be used in production courses. (Prerequisite: SOFA-613 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

SOFA-627**Pre-Production for Animators**

Using pre-production steps, students will produce short film ideas. The course will cover concept creation, treatments, scripts, storyboards, design, budgets and experimental film structures. Students will make weekly presentations and work will be critiqued. (This course is restricted to students in the FILMAN-MFA program.) **Lecture 3, Credits 3 (Fall)**

SOFA-628**Animation Writing and Visual Storytelling**

This course will provide an in-depth examination of structural elements of both the written and visual aspects of the animated film and the pre-production process. Particular attention will be given to: the application of materials, short film format, and layout of movements, visual composition, and storyboarding. Along with visualization and writing exercises, students will conceive a story idea, develop it in to formatted animation storyboards and create an animatic. (Prerequisite: SOFA-627 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

SOFA-629**Experimental Animation**

This course explores the concept of animation as a fine art practice. Course content will cover various techniques and concepts within experimental animation. Lectures will be enriched through film screenings and in-depth class discussions and demonstrations. Students will explore adventurous techniques and mediums such as, but not limited to, direct-on-film processes, stop motion paint, phenakistoscopes, stratacuts, charcoal/chalk board palimpsests, maximum loop cycles, paper cut-out animation, and sound. At the completion of the course, students will have a thorough understanding of the scope of experimental animation techniques. (Prerequisites: SOFA-603 or SOFA-615 or SOFA-617 or equivalent course.) **Lab 3, Credits 3 (Fall or Spring)**

SOFA-629**Experimental Animation**

This course explores the concept of animation as a fine art practice. Course content will cover various techniques and concepts within experimental animation. Lectures will be enriched through film screenings and in-depth class discussions and demonstrations. Students will explore adventurous techniques and mediums such as, but not limited to, direct-on-film processes, stop motion paint, phenakistoscopes, stratacuts, charcoal/chalk board palimpsests, maximum loop cycles, paper cut-out animation, and sound. At the completion of the course, students will have a thorough understanding of the scope of experimental animation techniques. (Prerequisites: SOFA-603 or SOFA-615 or SOFA-617 or equivalent course.) **Lecture 1, Credits 3 (Fall or Spring)**

SOFA-630**Animation Film Language**

This course will introduce the historical and contemporary discourse on the theory, aesthetics and characteristics of the animated film. Lectures, readings, writing assignments, classroom discussions, and film viewings will emphasize animation's diverse history, theories, philosophical and practical aspects. Concepts of animation production and related classification and terminology will be presented. (This course is restricted to students in the FILMAN-MFA program.) **Lecture 2, Credits 2 (Fall)**

SOFA-630**Animation Film Language**

This course will introduce the historical and contemporary discourse on the theory, aesthetics and characteristics of the animated film. Lectures, readings, writing assignments, classroom discussions, and film viewings will emphasize animation's diverse history, theories, philosophical and practical aspects. Concepts of animation production and related classification and terminology will be presented. (This course is restricted to students in the FILMAN-MFA program.) **Seminar 1, Credits 2 (Fall)**

SOFA-635**Acting for Film**

A course in basic acting technique with an emphasis on the requirements of film production. Students are introduced to various approaches to acting through exercises and by performing in scenes from professional productions. Scenes are rehearsed outside of class, and then staged and critiqued during class time. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall, Spring)**

SOFA-638**Complete 3D Character Creation**

This course will explore the process of character creation, specifically character rigging for digital animation. Students will learn to build a working rig by applying their research into body mechanics, character deformation, and dynamic restructuring. Students will combine their understanding of aesthetic character creation with the study of 3D technology. Students will be exposed to automation through code-building and expressions. This course has an additional research component. (Prerequisite: SOFA-695 or equivalent course.) **Lab 3, Credits 3 (Fall)**

SOFA-638**Complete 3D Character Creation**

This course will explore the process of character creation, specifically character rigging for digital animation. Students will learn to build a working rig by applying their research into body mechanics, character deformation, and dynamic restructuring. Students will combine their understanding of aesthetic character creation with the study of 3D technology. Students will be exposed to automation through code-building and expressions. This course has an additional research component. (Prerequisite: SOFA-695 or equivalent course.) **Lecture 2, Credits 3 (Fall)**

SOFA-641**Advanced Sound Recording**

This course continues the work from Basic Sound Recording to include audio synchronized or locked to picture and the use of Foley and ADR production techniques. Students will develop workflow approaches for complex multi-track mixing and signal manipulation. Each student will prepare a mixed track to professional quality standards and manages sound and video files between various hardware and software platforms. (Prerequisite: SOFA-605 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

SOFA-642**History and Aesthetics: Animation Stories**

This course will provide an in-depth study of an animation artist, animated genre, or other specific topic that has had a major impact on the animated film art form. Films will be viewed and discussed in the context of the specific time and places in which they were made. Emphasis will also be placed on determining the unique characteristics of the animation medium and how those characteristics are used as a means of interpretation and expression. (his course is restricted to Graduate College of Art and Design students.) **Lec/Lab 4, Credits 3 (Fall)**

SOFA-643**Targeting an Audience: Developing Content for TV**

This course will introduce students to the methods and strategies used by studios and TV networks to develop content that appeals to specific audiences. The student will gain insight into both the business and creative aspects of developing television content. Each student will choose a TV network to study and through a series of assignments will develop a profile of the audience their network attracts. This information is used by the student to create an appropriate 90-second film using the style and subject matter that fits the chosen network and its viewers. This course offers an unique feature through webcam interviews with Hollywood development executives, writers, and producers. Finished films will receive personalized feedback from a panel of entertainment professionals. (This course is restricted to students in the FILMAN-MFA program.) **Lecture 3, Credits 3 (Spring)**

SOFA-644**Cinematic Compositing**

Students will learn digital compositing using rotoscoping, image tracking, alpha channels and transparency. Composites may be accomplished through green screen shooting, transfer modes, masks, and/or traveling mattes. Students will shoot their own footage to combine with their effects to create the final image. Node based compositing will be addressed as well. (Prerequisite: (SOFA-602 or SOFA-624) or equivalent courses.) **Lab 3, Credits 3 (Spring)**

SOFA-644**Cinematic Compositing**

Students will learn digital compositing using rotoscoping, image tracking, alpha channels and transparency. Composites may be accomplished through green screen shooting, transfer modes, masks, and/or traveling mattes. Students will shoot their own footage to combine with their effects to create the final image. Node based compositing will be addressed as well. (Prerequisite: (SOFA-602 or SOFA-624) or equivalent courses.) **Lecture 2, Credits 3 (Spring)**

SOFA-652**Alternative Frame by Frame**

This course will give all students a chance to explore three different approaches to stop-motion animation. The class will study and experiment with pixilation, time-lapse and relief animation with a "down-shooter." These techniques will expand the student's knowledge of traditional and experimental animation and present an alternative means of expression. The class will study existing work with these techniques, analyze and discuss them with the instructor and then produce several examples of their own after instruction for each approach. There will be a final project in the technique of the student's choice. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall)**

SOFA-655**Film Practice:**

In this course students and faculty collaboratively produce a film project determined prior to the start of class. Students attend class and work on the production in specific job functions. This course can be taken twice with different topics. Topic is determined by the instructor. (Prerequisites: SOFA-621 or equivalent course.) **Studio 4, Credits 3 (Fall or Spring)**

SOFA-657**Digital Color Correction**

This course offers hands-on projects to develop the skills needed to understand and communicate the process of digital color correction and grading. Course content will cover technical workflow planning and calibration from simple primary color correction to advanced secondary and color separation methods. At the completion of this course, students will be able to use tone and color to augment theatrical storytelling and add a dimension of professional finish to their films. **Lab 3, Credits 3 (Spring)**

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This course offers hands-on projects to develop the skills needed to understand and communicate the process of digital color correction and grading. Course content will cover technical workflow planning and calibration from simple primary color correction to advanced secondary and color separation methods. At the completion of this course, students will be able to use tone and color to augment theatrical storytelling and add a dimension of professional finish to their films. **Lecture 2, Credits 3 (Spring)**

SOFA-660

Documentary Film History

This course will examine the development of documentary film from 1920 to the present. Key activities will explore: documentary filmmaking, including the Grierson social documentary, the Flaherty romantic tradition, cinema verité, propaganda films, first person narratives, and experimental documentary. Through film viewings, class discussions, and assigned readings, the student will critically examine how documentary film is constructed in relationship to the film's content and meaning. (his course is restricted to Graduate College of Art and Design students.) **Lec/Lab 5, Credits 3 (Spring)**

SOFA-661

New Documentary Issues

This course will examine the current trends in documentary film during the last decade. Students will view 1-2 documentary films each week. Students will examine each film critically; analyzing the film's theme, structure, style, relationship to reality, and effectiveness. In addition, students will examine how current filmmakers interpret and build upon the basic ideas and discourse that have defined documentary filmmaking since its beginnings. Graduate students will be required to do additional research on various topics and write extended papers. (This course is available to RIT degree-seeking graduate students.) **Lec/Lab 4, Credits 3 (Fall)**

SOFA-662

Film History

This course examines selected, varying film topics in a wider socio-historical context. Seminar themes change each year and may include topics such as post-war German film, films of the Holocaust, Japanese film, Surrealist and Magic Realist film, Soviet film, Native Americans on film, etc. Students are expected to participate actively in the course discussions. (This course is restricted to CAD Graduate students.) **Lec/Lab 5, Credits 3 (Fall, Spring)**

SOFA-663

Writing the Feature

This is course is an exploration of the feature film form. Students propose ideas for a feature length film and in consultation with the instructor and other students, write a detailed step outline and a substantial portion of the first draft. (Prerequisite: SOFA-626 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

SOFA-664

Writing the Series

This course is an introduction to all forms of series writing for television and the Internet. Students will choose to write either a one-hour pilot for a dramatic series, or a half-hour pilot and an additional episode for a single-camera comedy series. All students will develop and write a series "bible," a thorough description of all the characters and the world in which the series takes place as well as how the series may develop with future plotlines. (Prerequisite: SOFA-626 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

SOFA-665

Creative Research Workshop

A research and/or production opportunity for advanced students with extensive prior experience in the field of animation or live action filmmaking to work on a special project independently or collaboratively under the supervision of a faculty adviser. Enrollment in this course is by application only and with permission of a faculty adviser. (This course is restricted to students in the FILMAN-MFA program.) **Lecture, Credits 3 - 6 (Fall, Spring)**

SOFA-670

30 Second Commercial Production

An introduction to the world of producing television commercials. Students learn the workflow between advertising agencies, their clients and production companies. They also execute the production of a television commercial from conception to editorial. (Prerequisites: SOFA-602 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

SOFA-671

Advanced Production Immersion

This workshop provides students with the opportunity to learn more about a particular area of production—editing, cinematography, lighting, sound, etc.—with an industry professional. Different topics may be taken in the same semester. Topics may only be taken once. (Prerequisites: SOFA-602 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

SOFA-672

Mixing and Sound Design

This course will continues the work completed Advanced Sound Recording by mixing multi-track sessions with video to post-produce several different projects to professional standards. Students will learn how to listen and develop a trained ear while understanding proper equalization and use of effects and digital signal routing. Sessions can include documentaries, dialog and musical productions. Students will also create templates and develop editing/mixing techniques to balance creativity and time constraints of a typical project. (Prerequisite: SOFA-641 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

SOFA-675

3D Lighting and Texturing

This course will offer an intensive look at lighting for three-dimensional animation pipelines. The focus of the course will be: surfacing, set-dressing, production design, and economical rendering techniques. Students will learn to observe, plan, replicate real-world environments, and apply to artistic interpretations of style and design. The course will also provide a balance between artistic needs and technical limitations in order to prepare a scene for post-production practices. This course has an additional research component. (Prerequisites: SOFA-615 or equivalent course.) **Lab 3, Credits 3 (Spring)**

SOFA-675

3D Lighting and Texturing

This course will offer an intensive look at lighting for three-dimensional animation pipelines. The focus of the course will be: surfacing, set-dressing, production design, and economical rendering techniques. Students will learn to observe, plan, replicate real-world environments, and apply to artistic interpretations of style and design. The course will also provide a balance between artistic needs and technical limitations in order to prepare a scene for post-production practices. This course has an additional research component. (Prerequisites: SOFA-615 or equivalent course.) **Lecture 2, Credits 3 (Spring)**

SOFA-676

After Effects for Animators

This is an intermediate animation course that will focus on After Effects. The course will cover: visual effects development, character animation, puppet-building, world-building, time management, and post-production cleanup. Students will learn and engage with design and style development in animation production. (Prerequisites: SOFA-603 or SOFA-615 or SOFA-617 or equivalent course.) **Lab 3, Credits 3 (Fall)**

SOFA-676

After Effects for Animators

This is an intermediate animation course that will focus on After Effects. The course will cover: visual effects development, character animation, puppet-building, world-building, time management, and post-production cleanup. Students will learn and engage with design and style development in animation production. (Prerequisites: SOFA-603 or SOFA-615 or SOFA-617 or equivalent course.) **Lecture 2, Credits 3 (Fall)**

SOFA-678

Cinematography and Lighting I

This advanced level course will enable students to develop an appreciation for the multi-dimensional nature of the craft of cinematography and provide them with theoretical, technical and practical knowledge. Students will explore visual aesthetics and engage in conceptual and critical thinking. They will also learn about industry standards, best practices, and workflows and channel their learning into class projects. (Prerequisites: SOFA-602 or equivalent course.) **Lecture 4, Credits 3 (Fall or Spring)**

SOFA-681

Particle Effects and Dynamics

This course will introduce three-dimensionally generated visual effects designed to enhance film and animation productions. The course content will explore generated particle animation and dynamic simulations of fluid, hair and cloth. Students will work across multiple software platforms and learn to successfully integrate various elements together into single, cohesive scenes. (Prerequisites: SOFA-615 or equivalent course.) **Lab 3, Credits 3 (Fall)**

SOFA-681

Particle Effects and Dynamics

This course will introduce three-dimensionally generated visual effects designed to enhance film and animation productions. The course content will explore generated particle animation and dynamic simulations of fluid, hair and cloth. Students will work across multiple software platforms and learn to successfully integrate various elements together into single, cohesive scenes. (Prerequisites: SOFA-615 or equivalent course.) **Lecture 2, Credits 3 (Fall)**

SOFA-682

Underwater Cinematography

This course is designed to prepare students to professionally complete cinematography assignments in an underwater environment. To accomplish this, the student will complete basic scuba diving training and achieve scuba diving certification. The student will become familiar with underwater video camera housings and accessories and basic underwater shooting techniques. A facility fee covers all equipment, off campus facility use, texts and insurance. **Fee: There is a lab fee required for this course** (Prerequisites: SOFA-602 or equivalent course.) **Lecture 2, Credits 3 (Fall)**

SOFA-682

Underwater Cinematography

This course is designed to prepare students to professionally complete cinematography assignments in an underwater environment. To accomplish this, the student will complete basic scuba diving training and achieve scuba diving certification. The student will become familiar with underwater video camera housings and accessories and basic underwater shooting techniques. A facility fee covers all equipment, off campus facility use, texts and insurance. **Fee: There is a lab fee required for this course** (Prerequisites: SOFA-602 or equivalent course.) **Lab 3, Credits 3 (Fall)**

SOFA-683

Advanced Editing

This course is designed to teach students the professional workflow of editing digital film and video files. Students learn the technical craft as well as the aesthetic choices that editors make. Students practice the editing of all genres by editing short fiction, documentary, and experimental projects. Students will explore and learn advanced tools in editing software while cutting together short projects and tutorials. Areas of study include learning a cinema file database, media management, color correction, visual and time-based effects, sound processing and track building, multi-camera editing, and titling and graphics. (Prerequisites: SOFA-602 or equivalent course.) **Lab 3, Credits 3 (Spring)**

SOFA-683

This course is designed to teach students the professional workflow of editing digital film and video files. Students learn the technical craft as well as the aesthetic choices that editors make. Students practice the editing of all genres by editing short fiction, documentary, and experimental projects. Students will explore and learn advanced tools in editing software while cutting together short projects and tutorials. Areas of study include learning a cinema file database, media management, color correction, visual and time-based effects, sound processing and track building, multi-camera editing, and titling and graphics. (Prerequisites: SOFA-602 or equivalent course.) **Lecture 2, Credits 3 (Spring)**

Advanced Editing**SOFA-684**

This course focuses on the mechanics of motion as applied to animated characters, both human and non-human. Working directly from a live model, costumed and nude, and employing visualization techniques, students will apply figure-drawing skills along with gesture drawing, focusing on the correct representation of weight, energy and force in sequential poses. Specific attention is paid to improving drawing skills in order to create stronger storytelling poses for animated properties. A variety of drawn animation examples will be screened in class. (This course is restricted to students in the FILMAN-MFA program.) **Studio 6, Credits 3 (Spring)**

Animation Gesture**SOFA-688**

Students will develop a specific DVD that is based on a film they have completed. Class discussion will be geared towards presentation and interactivity. The student will use a variety of tools: menu development, subtitles, audio streams, encoding principles, hybrid DVD creation, web linking (DVD@ccess), and basic scripting. (Prerequisites: SOFA-601 or SOFA-622 or equivalent course and graduate student standing in FILMAN-MFA.) **Lab 3, Credits 3 (Spring)**

DVD Authoring**SOFA-688**

Students will develop a specific DVD that is based on a film they have completed. Class discussion will be geared towards presentation and interactivity. The student will use a variety of tools: menu development, subtitles, audio streams, encoding principles, hybrid DVD creation, web linking (DVD@ccess), and basic scripting. (Prerequisites: SOFA-601 or SOFA-622 or equivalent course and graduate student standing in FILMAN-MFA.) **Lecture 2, Credits 3 (Spring)**

DVD Authoring**SOFA-689**

This course will focus on enhancing aesthetic skills through advanced cinematography topics. Students will build on what they learned in Cinematography and Lighting I and continue their cinematography practice using the best available tools in the department. The ultimate goal of this course is to enable students to explore their own personal cinematography aesthetic and style. (Prerequisite: SOFA-678 or equivalent course.) **Lec/Lab 4, Credits 3 (Fall or Spring)**

Cinematography and Lighting II**SOFA-690**

An exploration of the interconnected careers of the entertainment industry and the city of Los Angeles for a behind-the-scenes look at either film or animation. Students travel during the winter break. During the course students will discuss the industry, city, and their travel. This course has a mandatory travel component and requires an additional travel fee. Permission to enroll is required. (This course is restricted to students in the FILMAN-MFA program.) **Lecture 1, Credits 3 (Spring)**

Los Angeles: Behind the Scenes**SOFA-691**

This course is one of three in the study of film sound theory. Through readings, focused group discussion, and the viewing of/listening to select films, the course promotes critical analysis of the varied and profound uses of music in sound design. Addressed is the history of music from the silent era to the modern score. The concepts studied include the modal changes in point-of-audition, and positioning across diegeses. Newer topics including audio-visualization and ventriloquism theory are also addressed. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lec/Lab 6, Credits 3 (Fall, Spring, Summer)**

Film Sound Theory Music**SOFA-692**

This course is one of three in the study of film sound theory. Through readings, focused group discussion, viewing of and listening to select films, the course promotes critical analysis of the varied and profound uses of effects in sound design. Addressed is the history of effects from the early sound era to the modern design. The concepts studied include the modal changes in point-of-audition, and positioning across diegeses. Other topics include complementarity and the acousmatic. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 4 (Fa/sp/su)**

Film Sound Theory: Effects**SOFA-692**

This course is one of three in the study of film sound theory. Through readings, focused group discussion, viewing of and listening to select films, the course promotes critical analysis of the varied and profound uses of effects in sound design. Addressed is the history of effects from the early sound era to the modern design. The concepts studied include the modal changes in point-of-audition, and positioning across diegeses. Other topics include complementarity and the acousmatic. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Seminar 3, Credits 4 (Fa/sp/su)**

Film Sound Theory: Effects**SOFA-693**

Through readings, focused group discussion, and the viewing/listening of select films, the course promotes critical analysis of the varied and profound uses of voice in sound design. The history of voice from the silent era to the modern sound design will be addressed. The concepts studied include the modal changes in point-of-audition, and positioning across diegeses. Other topics like vococentric mixing and separation; and dialogue theory, are also addressed. Each student gives a presentation on a chosen concept within film voice theory. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lab 3, Credits 4 (Fall, Spring, Summer)**

Film Sound Theory: Voice**SOFA-693**

Through readings, focused group discussion, and the viewing/listening of select films, the course promotes critical analysis of the varied and profound uses of voice in sound design. The history of voice from the silent era to the modern sound design will be addressed. The concepts studied include the modal changes in point-of-audition, and positioning across diegeses. Other topics like vococentric mixing and separation; and dialogue theory, are also addressed. Each student gives a presentation on a chosen concept within film voice theory. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 4 (Fall, Spring, Summer)**

Film Sound Theory: Voice**SOFA-695**

This course will explore advanced character animation utilizing performance, emotion, and speech. Course content will include facial expressions and scenes with multiple characters interacting. Professional animation software will be used. By the end of the course, students will be able to create advanced biped character animation with dialogue and emotion. (Prerequisites: SOFA-615 or equivalent course.) **Lab 3, Credits 3 (Spring)**

Advanced 3D Animation**SOFA-695**

This course will explore advanced character animation utilizing performance, emotion, and speech. Course content will include facial expressions and scenes with multiple characters interacting. Professional animation software will be used. By the end of the course, students will be able to create advanced biped character animation with dialogue and emotion. (Prerequisites: SOFA-615 or equivalent course.) **Lecture 2, Credits 3 (Spring)**

Advanced 3D Animation**SOFA-698**

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. (Prerequisites: This class is restricted to students in FILMAN-MFA with at least 3.0 cumulative GPA and department permission to enroll.) **Internship, Credits 1 - 6 (Fall, Spring, Summer)**

Film and Video Graduate Internship**SOFA-699**

Cooperative Education will provide Film and Animation students with hands-on experience in their field, directly related to a student's major with an established studio or related business. Students will need to apply for co-ops, and interview as part of the selection process, based on available positions posted by the Co-op and Career Services Office, or found through the students' own research. In programs where co-op is a degree requirement, students must obtain permission of their program or graduate director prior to enrollment. Co-ops are typically paid work experience, and can be part-time (150-479 total hours within the term), or full-time (480+ hours within the term). Co-ops may be one or two consecutive terms - fall, spring, or summer - with department permission. (Prerequisites: This class is restricted to students in FILMAN-MFA with department permission.) **CO OP, Credits 0 (Fall, Spring, Summer)**

Film and Animation Co-op**SOFA-717**

This course is the student's second experience producing a complete animated film individually or in collaboration with a classmate. In this workshop-style course, students will design and implement all phases of an animated film production and produce a short film with sound. Students will rely only on techniques learned in previous classes. The final film must be screened for the school community at the end of the course. (Prerequisites: SOFA-622 or equivalent course.) **Lecture 4, Credits 4 (Fall)**

Animation Workshop**SOFA-721**

This course allows 2nd year graduate student in production or screenwriting an opportunity to complete their second major production in the program. They must decide on a concept, develop a treatment, write a script or research a non-fiction subject and produce the film complete with mixed track and finished titles and credits. (Prerequisites: SOFA-602 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

Fall Film

SOFA-733

Hybrid Forms: Theory and Practice

This graduate seminar explores storytelling across a multitude of hybrid forms. It examines an array of fictional and non-fictional strategies as fluid and organic form-content relationships that constitute the shared language between Cinema and New Forms. The creation of a hybrid character in this class is complemented by experimentation in the ways in which we experience characters and stories in contemporary times. Students develop a final semester project, two position papers and an artist statement. The course encourages the use of new media technologies including archival material, prosumer cameras and software. **Lecture 4, Credits 3 (Spring)**

SOFA-748

Concept and Character Design

This course will introduce students to the basics of design as applied to characters and environments for animated productions. Line, color, texture, shape, form and story will be referenced when developing characters and environments. Projects will utilize drawing, digital painting, and live action. In this course, a variety of exercises will explore tone, mood, deep and shallow space, and natural and imagined spaces. Students will develop their own personal process of visual development through a variety of exercises, working toward a final finished project. (Prerequisites: SOFA-603 or equivalent course.) **Lecture 2, Credits 3 (Spring)**

SOFA-748

Concept and Character Design

This course will introduce students to the basics of design as applied to characters and environments for animated productions. Line, color, texture, shape, form and story will be referenced when developing characters and environments. Projects will utilize drawing, digital painting, and live action. In this course, a variety of exercises will explore tone, mood, deep and shallow space, and natural and imagined spaces. Students will develop their own personal process of visual development through a variety of exercises, working toward a final finished project. (Prerequisites: SOFA-603 or equivalent course.) **Studio 3, Credits 3 (Spring)**

SOFA-780

Thesis Preparation Seminar

The focus of this course is to develop a written proposal for an MFA Film Thesis. The thesis will provide the backbone of a candidate's final film-making production leading to the completion of MFA creative work and the supporting written document. Students must identify a thesis chair and form a committee. The course will prepare students to present and defend their thesis before a faculty committee seeking approval of the proposal. (Prerequisite: SOFA-717 or SOFA-721 or equivalent course.) **Seminar 2, Credits 1 (Spring)**

SOFA-790

Research and Thesis I

This is the first of two courses designed to advance a student towards completion of their thesis. Students will work independently on their approved plan of work for their thesis while meeting on a regular basis with their committee chair. They are required to meet at least twice with their full committee during the semester. (Prerequisites: SOFA-780 or equivalent course.) **Thesis, Credits 4 (Fall)**

SOFA-799

Film and Animation Graduate Independent Study

Film and Animation Graduate Independent Study will provide students with the ability to study in a specialized area with an individual faculty member. Students, with the assistance of a faculty adviser, should propose a course of study or project with clearly defined deliverables. Students must obtain permission of an instructor and complete the Independent Study Permission Form to enroll. Student must have a minimum of a 3.0 GPA to apply. (Prerequisites: This class is restricted to students in FILMAN-MFA with at least 3.0 cumulative GPA and instructor permission to enroll.) **Ind Study, Credits 1 - 4 (Fall, Spring, Summer)**

SOFA-887

Film and Animation Part-Time Co-op

Cooperative Education will provide Film and Animation students with hands-on experience in their field, directly related to a student's major with an established studio or related business. Students will need to apply for co-ops, and interview as part of the selection process, based on available positions posted by the Co-op and Career Services Office, or found through the students' own research. In programs where co-op is a degree requirement, students must obtain permission of their program or graduate director prior to enrollment. Co-ops are typically paid work experience, and can be part-time (150-479 total hours within the term), or full-time (480+ hours within the term). Co-ops may be one or two consecutive terms - fall, spring, or summer - with department permission. (Prerequisites: This class is restricted to students in FILMAN-MFA with department permission.) **CO OP, Credits 0 (Fall, Spring, Summer)**

SOFA-890

Research and Thesis II

This is the second of two courses designed to advance a student towards completion of their thesis. Students will work independently on their approved plan of work for their thesis while meeting on a regular basis with their committee chair. They are required to meet at least twice with their full committee during the semester as well as present a final screening of their thesis. (Prerequisite: SOFA-790 or equivalent course.) **Thesis 4, Credits 4 (Spring)**

SOFA-892

Continuation of Thesis Film and Animation

Continuation of thesis course provides MFA students' additional semester(s) to complete their thesis research and supporting documents. Taking COT before a Thesis film is screened needs to have the approval of the Graduate Director. (Prerequisite: SOFA-890 or equivalent course.) **Cont, Credits 0 (Fall, Spring, Summer)**

School of Media Sciences

Media Arts

PHMS-611

Media Foundations: the Digital File

This course will investigate the creation, workflow and output of digital media files, using a variety of capture devices including digital cameras, smartphones, 2D/3D scanners, audio and video recording devices. Course content will focus on device preferences, file attributes, workflow, output, compression with consideration of data management using different media. Hands-on exercises reinforce concepts such as: file types, data compression, color management, media delivery, and distribution. Students will evaluate the influences of operator choices at each stage along the image chain. Special attention will be given to identifying and cultivating industry best practices. At the conclusion of the course, students will be able to create optimized files using a variety of devices that include metadata construction. **Lecture 3, Credits 3 (Fall)**

PHMS-623

Leadership in Creative Spaces

This course is designed for students from a variety of educational backgrounds, and will explore leadership skills required in collaborative, contemporary, and dynamic professional environments. Course content will cover the intersection and divergence of management and leadership concepts using large group discussions, small group activities, and self-reflective exercises. Students will identify their own personal leadership strengths and goals and develop management strategies used in modern business environments. Students will also incorporate ways to succeed in progressively challenging roles and learn methods for fostering inclusive environments. At the completion of this course, students will be able to leverage their personal and professional networks to create a diverse community of peers and collaborative partnerships that will lead to innovative work. (This course is restricted to MEDART-MS Major students.) **Lecture 3, Credits 3 (Spring)**

PHMS-711

Industry Issues, Trends, and Opportunities

This course will present a detailed overview of critical trends and issues related to the graphic communications and imaging industries. It will provide an in-depth analysis of key technologies with a special emphasis on emerging, disruptive innovations as well as business, environmental and regulatory issues. The course content will emphasize cultural, economic, and technological trends and is intended to provide students with industry accepted methods used to identify changes in the industry. By tracing historical roots, analyzing present issues and detailing future trends, students will be prepared to develop insights into the nature and scope of the challenges and opportunities facing industry leaders and how to manage these challenges. As a part of the experience, students will develop sharply focused analytical skills and the ability to summarize findings based on industry normals. **Lecture 3, Credits 3 (Fall)**

PHMS-721

Implementing Imaging Business Change

This course will provide students with the knowledge required to improve an imaging or graphic communications business. Students will gain an understanding of the business assessment process and decision-making skills required for implementing change in the graphic communications and imaging industries. At the completion of this course, students will learn how to evaluate a firm's economic, operational, and market positions and apply practical solutions that improve business practices. (This course is restricted to MEDART-MS Major students.) **Lecture 3, Credits 3 (Fall)**

PHMS-731

Digital Content Management

This course will explore the subject of digital asset and content management. Course exercises will investigate the organization of digital media and optimized architecture of storage systems. Students will learn how to manage and optimize digital content efficiently in various traditional and emerging applications. At the completion of this course, students will be able to articulate, analyze, and apply digital content solutions in various business and workflow models in media organizations. (This course is restricted to MEDART-MS Major students.) **Lab 3, Credits 3 (Fall)**

PHMS-731

Digital Content Management

This course will explore the subject of digital asset and content management. Course exercises will investigate the organization of digital media and optimized architecture of storage systems. Students will learn how to manage and optimize digital content efficiently in various traditional and emerging applications. At the completion of this course, students will be able to articulate, analyze, and apply digital content solutions in various business and workflow models in media organizations. (This course is restricted to MEDART-MS Major students.) **Lecture 2, Credits 3 (Fall)**

PHMS-743**Contemporary Media and Communications**

This course will examine how media has evolved and how it has responded to changes in technology and social habits. Course content will cover various forms of media communication using both historical and contemporary perspectives. Topics include: trend recognition, monetization in media communications, materials, processes, audience, usability, accessibility, aesthetics, content, typography, copyright issues, and innovations in publishing. At the completion of this course, students will gain an understanding of various media structures and communication types through the analysis of audience and content. (This course is restricted to MEDART-MS Major students.) **Lecture 3, Credits 3 (Fall)**

PHMS-746**Capstone I**

This is the first of two courses designed to advance a student towards completion of their capstone. This course will guide students from their capstone proposal toward the completion of a capstone project. Students will learn project management skills required to successfully propose and begin a meaningful, relevant and feasible capstone project. **Lecture 3, Credits 3 (Fall)**

PHMS-747**Capstone II**

This is the second of two courses designed to advance a student towards completion of their capstone. This course will guide students from their capstone proposal through the completion of a meaningful and significant capstone project. Projects can either be research oriented or developmental and must include implementation and dissemination of the project using appropriate distribution technology. (Prerequisites: PHMS-746 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

PHMS-748**Continuation of Capstone**

The course provides a student additional semester(s) to complete their capstone research, project, and documentation. (Prerequisite: PHMS-747 or equivalent course.) **Cont, Credits 0 (Fall, Spring, Summer)**

PHMS-799**MS Media Arts Independent Study**

This course will allow graduate students in the Media Arts and Technology program the ability to study in a specialized area with an individual faculty member. Students, with the assistance of a faculty adviser, will propose a course of study or project with clearly defined goals and outcomes. Students must obtain permission of an instructor and complete the Independent Study Permission Form to enroll. *NOTE: Student must have a minimum 3.0 GPA * **Ind Study, Credits 1 - 6 (Fa/sp/su)**

School of Photographic Arts and Sciences

Graduate Photography

PHGR-611**Contemporary Issues**

This course will study current issues relevant to imaging-based 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 discourse and studio practice. This course is a touchstone to current and future fine art practices through its engagement with a variety of subjects. This course may be repeated with different topics. Topic is determined by the instructor. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall, Spring)**

PHGR-631**New York City Photography**

This course will offer students the unique opportunity to participate in a one-week intensive workshop in New York City. Students will meet with photographers, art gallery directors, museum personnel, artists, studio assistants, and RIT alumni in NYC. There will be accompanying lectures and studio/museum/gallery visits. Students will gain an immersive exposure to the field of fine art, applied photography, and related industries. Course work includes researching: professional photography studios, art magazines, galleries, photo/art museums, and universities. Permission to enroll is required. Travel fees will be required. (This course is available to RIT degree-seeking graduate students.) **Lecture 1, Credits 3 (Fall or Spring)**

PHGR-656**The Moving Image and Contemporary Practices**

This course will explore the history and evolution of the moving image in visual art. Students will use digital and analog technology to create new work that expands on the disciplines of photography and video. Throughout this course, students will explore time-based media for production, installation, web-based, and social media platforms using mobile devices, editing, compositing software, and projection technologies to create and display work. Exploring a wide range of video, digital imaging, projection, and photographic artists and methods, students will have an opportunity to integrate the moving image into their individual discipline and portfolio of work. Students will also read and discuss published writings and work by established artists. **Lab 3, Credits 3 (Fall, Spring)**

PHGR-656**The Moving Image and Contemporary Practices**

This course will explore the history and evolution of the moving image in visual art. Students will use digital and analog technology to create new work that expands on the disciplines of photography and video. Throughout this course, students will explore time-based media for production, installation, web-based, and social media platforms using mobile devices, editing, compositing software, and projection technologies to create and display work. Exploring a wide range of video, digital imaging, projection, and photographic artists and methods, students will have an opportunity to integrate the moving image into their individual discipline and portfolio of work. Students will also read and discuss published writings and work by established artists. **Lecture 2, Credits 3 (Fall, Spring)**

PHGR-660**Photography in Cuba**

This course will offer students an immersive educational experience while traveling and photographing in Cuba. Through photographic assignments, related field trips, and lectures, this course will introduce students to a new culture and environment, and critically engage with the concept of travel photography. Students will be exposed to challenges found in available light situations where they will photograph environments, architecture, and the people of Cuba. A final portfolio and exhibition will illustrate effective visual documentation of Cuban culture. Permission to enroll is required. Travel fees will be required. (Enrollment in this course requires permission from the department offering the course.) **Lab 2, Credits 3 (Spring)**

PHGR-660**Photography in Cuba**

This course will offer students an immersive educational experience while traveling and photographing in Cuba. Through photographic assignments, related field trips, and lectures, this course will introduce students to a new culture and environment, and critically engage with the concept of travel photography. Students will be exposed to challenges found in available light situations where they will photograph environments, architecture, and the people of Cuba. A final portfolio and exhibition will illustrate effective visual documentation of Cuban culture. Permission to enroll is required. Travel fees will be required. (Enrollment in this course requires permission from the department offering the course.) **Lecture 2, Credits 3 (Spring)**

PHGR-661**Digital Bootcamp**

This course introduces graduate students to file management and non-destructive editing of photographs. Course content will cover best practices working with appropriate digital imaging software. At the completion of the course, students will understand how to create their own digital asset management library and prepare files for output for print. (Co-requisites: PHGR-662 or equivalent course.) **Lab 2, Credits 1 (Fall or Spring)**

PHGR-662**Fine Print Workflow**

This course will discuss the latest advances in digital workflow, best practices and output technology. Course content will emphasize the creation of an optimal and efficient fine art print workflow with repeatable results through the integration of various software and technological tools. Lectures will cover various substrate options along with archival issues and finishing. At the completion of this course, students will build optimized files and produce exhibition quality prints. (Co-requisites: PHGR-661 or equivalent course.) **Lab 3, Credits 3 (Fall or Spring)**

PHGR-662**Fine Print Workflow**

This course will discuss the latest advances in digital workflow, best practices and output technology. Course content will emphasize the creation of an optimal and efficient fine art print workflow with repeatable results through the integration of various software and technological tools. Lectures will cover various substrate options along with archival issues and finishing. At the completion of this course, students will build optimized files and produce exhibition quality prints. (Co-requisites: PHGR-661 or equivalent course.) **Lecture 2, Credits 3 (Fall or Spring)**

PHGR-663**Forensic Photography**

This course will provide hands-on experience documenting crime scenes and related evidence and preparing those images for presentation in court. Topics covered will include crime scene management, evidence handling, crime scene documentation, general evidence documentation, photographic techniques for the enhancement of evidence, and court display preparation. At the conclusion of this course, students will be able to utilize forensic photography in their studio practice. **Lab 1, Credits 3 (Spring)**

PHGR-663**Forensic Photography**

This course will provide hands-on experience documenting crime scenes and related evidence and preparing those images for presentation in court. Topics covered will include crime scene management, evidence handling, crime scene documentation, general evidence documentation, photographic techniques for the enhancement of evidence, and court display preparation. At the conclusion of this course, students will be able to utilize forensic photography in their studio practice. **Lecture 2, Credits 3 (Spring)**

PHGR-665

Color Photography Seminar

This course will offer a creative exploration of technology through traditional analog color photography and digital imaging using both film and digital technologies. The class will explore effective film scanning techniques, color workflows and procedures for digital image editing and manipulation. The class will discuss various methods of output and experience them first-hand through assignments. Students will conceive and design their own photographic project and produce a body of work. Students will also undertake research and explore their findings through written research papers pertinent to their own artistic exploration. (This course is restricted to IMGART-MFA Major students.) **Lab 3, Credits 3 (Fall, Spring)**

PHGR-665

Color Photography Seminar

This course will offer a creative exploration of technology through traditional analog color photography and digital imaging using both film and digital technologies. The class will explore effective film scanning techniques, color workflows and procedures for digital image editing and manipulation. The class will discuss various methods of output and experience them first-hand through assignments. Students will conceive and design their own photographic project and produce a body of work. Students will also undertake research and explore their findings through written research papers pertinent to their own artistic exploration. (This course is restricted to IMGART-MFA Major students.) **Lecture 2, Credits 3 (Fall, Spring)**

PHGR-676

Preservation and Care of Photographs

This course will explore the field of photographic conservation and professional practices. The class will introduce students to photographic conservation, organization in conservation and preservation, leading experts in the field as well as possible career opportunities. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Spring)**

PHGR-698

MFA Photography Internship

The Photography Internship will provide students with the option to work in the photographic field. Students may apply for internships to businesses based on the availability of positions and business needs. Students must obtain permission of an instructor. (Prerequisites: This class is restricted to students in IMGART-MFA with department permission.) **Internship, Credits 1 - 3 (Fall, Spring, Summer)**

PHGR-699

MFA Photography Co-op

Cooperative Education will provide photography students with hands-on experience in their field, directly related to a student's major with an established studio or related business. Students will need to apply for co-ops, and interview as part of the selection process, based on available positions posted by the Co-op and Career Services Office, or found through the students' own research. In programs where co-op is a degree requirement, students must obtain permission of their program or graduate director prior to enrollment. Co-ops are typically paid work experience, and can be part-time (150-479 total hours within the term), or full-time (480+ hours within the term). Co-ops may be one or two consecutive terms - fall, spring, or summer - with department permission. (Prerequisites: This class is restricted to students in IMGART-MFA with department permission.) **CO OP, Credits 0 (Fall, Spring, Summer)**

PHGR-701

Histories and Aesthetics of Photography I

This course, the first in a two-semester sequence, will present an overview of the multiple and intersecting aesthetics, applications, perceptions, and philosophies of photography. Readings and discussions will examine the emergence and establishment of fine art photography, documentary and photojournalism, photography in the sciences, commercial and pop-cultural photographic applications, photography in the political arena, and photography as a mode of social interaction and identity formation. The class will also study the evolving technical history of photographic processes and the proliferation of critical theoretical perspectives on the medium during its first 100 years. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall)**

PHGR-702

Histories and Aesthetics of Photography II

This course, the second in the two-semester sequence, will offer an in-depth study of key historical, critical, and theoretical issues in photographic visual culture in the modern, postmodern, and contemporary periods. The course will explore aesthetic trajectories in modern and contemporary photography from the emergence of the modernist Avant Garde at the beginning of the 20th century to such contemporary phenomena as the deadpan aesthetic, performance documentation, fictive photography, and photographic appropriation. This course will also examine the evolving language of commercial photography, stylistic and ethical approaches to photojournalism, photography and the politics of the museum, vernacular photographs, and the presence of digital technologies and social media networks in the contemporary global media age. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Spring)**

PHGR-703

Studio Core I

This critique course, the first in a two semester sequence, will establish a working methodology, critically engage with peers, and develop a body of new artwork. At the conclusion of the semester, all students will participate in a work share event. (This course is restricted to IMGART-MFA Major students.) **Studio 9, Credits 6 (Fall)**

PHGR-704

Studio Core II

This critique course is the second in a two semester sequence. Having established a working methodology in Studio Core I, students will continue to experiment and produce a significant body of work through critical engagement with their peers and their own research and experimentation. Successful completion of the course will result in advancement to half-candidacy via a formal review by MFA faculty. (Prerequisites: PHGR-703 or equivalent course.) **Studio 9, Credits 6 (Spring)**

PHGR-705

Photography and Related Media Workshop

This workshop will allow students to participate in small classes discussing contemporary and historical topics. Topics may include, but are not limited to experimentation with specialized technology and creative processes such as historical processes, developing an installation, refining a body of work in print, moving image, or book form, or studying critical issues surrounding photography and related media. The content of the workshop will vary depending on the instructor. This course can be taken multiple times but individual topics must be different. (This course is restricted to IMGART-MFA Major students.) **Lab 3, Credits 3 (Fall, Spring)**

PHGR-705

Photography and Related Media Workshop

This workshop will allow students to participate in small classes discussing contemporary and historical topics. Topics may include, but are not limited to experimentation with specialized technology and creative processes such as historical processes, developing an installation, refining a body of work in print, moving image, or book form, or studying critical issues surrounding photography and related media. The content of the workshop will vary depending on the instructor. This course can be taken multiple times but individual topics must be different. (This course is restricted to IMGART-MFA Major students.) **Lecture 2, Credits 3 (Fall, Spring)**

PHGR-716

Integrated Practices I

In this course students will integrate writing, research methods, and experimental problem solving skills to further develop studio practices through integrated project based assignments and projects. Students will hone their skills in art practices, critical analysis, strategies for making, and writing about artwork through developing expanded practices within studio experimentation and artistic thinking. Throughout the semester, the students will become familiar with multiple research facilities throughout the University and the region. (This course is restricted to IMGART-MFA Major students.) **Lecture 2, Credits 3 (Fall)**

PHGR-716

Integrated Practices I

In this course students will integrate writing, research methods, and experimental problem solving skills to further develop studio practices through integrated project based assignments and projects. Students will hone their skills in art practices, critical analysis, strategies for making, and writing about artwork through developing expanded practices within studio experimentation and artistic thinking. Throughout the semester, the students will become familiar with multiple research facilities throughout the University and the region. (This course is restricted to IMGART-MFA Major students.) **Studio 3, Credits 3 (Fall)**

PHGR-717

Integrated Practices II

This course builds off Integrated Practices I, through projects and assignments designed to encourage experimentation and problem-solving in art making. The content will explore expanded forms of studio practice—including, but not limited to: installation art, book-making, video, performance, public art, and collaborative work. This course will also emphasize writing as a creative process integral to a successful studio practice. (Prerequisites: PHGR-716 or equivalent course.) **Lecture 2, Credits 3 (Spring)**

PHGR-717

Integrated Practices II

This course builds off Integrated Practices I, through projects and assignments designed to encourage experimentation and problem-solving in art making. The content will explore expanded forms of studio practice—including, but not limited to: installation art, book-making, video, performance, public art, and collaborative work. This course will also emphasize writing as a creative process integral to a successful studio practice. (Prerequisites: PHGR-716 or equivalent course.) **Studio 3, Credits 3 (Spring)**

PHGR-721

Research Core I

This course, following successful completion of half-candidacy, will outline the policies and procedures required for the MFA thesis defense and thesis publication for this program of study. Throughout the course, students will refine their research, presentation, and writing skills. Through assignments and in-class discussion and critique, students will begin developing their thesis defense presentations, conduct research relevant to their work, and begin drafting their thesis publication. **Studio 6, Credits 3 (Fall)**

PHGR-723

Research Core II

This course is the second in a sequence of two courses focusing on the completion of the thesis publication and thesis defense. Supported by the research tools and resources outlined in Research Core I, students will conduct mock defenses and complete all components of the thesis publication. At the conclusion of the course, students will successfully submit their thesis publication to ProQuest. (Prerequisite: PHGR-721 or equivalent course.) **Studio 6, Credits 3 (Spring)**

PHGR-724 Professional Development for the Emerging Artist

This course prepares students for entering a career in the arts. Course content covers practical information related to professional practice such as crafting a CV, grant writing, writing an artist's statement, creating a professional application packet and researching exhibition spaces and other opportunities for artists. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall)**

PHGR-776 Artist as Teacher

This graduate seminar course will introduce students to practices and processes used for teaching art in higher education. The course will focus on the development of teaching methods and introduce graduate students to the scholarship of teaching. This course explores a range of perspectives on pedagogical practice, curriculum development, and the assessment of learning from the perspective of the visual arts will be covered. Course components include: readings, research, discussions, project assignments, lectures, and peer presentations. The final outcome will be a teaching portfolio including a teaching philosophy, course proposals, a detailed syllabus, sample class assignments, and evaluation and assessment guides. Blended learning will support classroom instruction, in addition to lectures and other forms of media. (his course is restricted to Graduate College of Art and Design students.) **Lecture 3, Credits 3 (Fall, Spring)**

PHGR-799 MFA Photography Independent Study

An independent study allows graduate students in the Photography and Related Media program the ability to study in a specialized area with an individual faculty member. Students, with the assistance of a faculty adviser, should propose a course of study or project with clearly defined goals and outcomes. Students must obtain permission of an instructor and complete the Independent Study Permission Form to enroll. ****NOTE: Student must have a minimum 3.0 GPA * (Prerequisites: This class is restricted to students in IMGART-MFA with instructor permission.) Ind Study, Credits 1 - 4 (Fall, Spring, Summer)**

PHGR-887 Photography MFA Part-time Co-op

Cooperative Education will provide photography students with hands-on experience in their field, directly related to a student's major with an established studio or related business. Students will need to apply for co-ops, and interview as part of the selection process, based on available positions posted by the Co-op and Career Services Office, or found through the students' own research. In programs where co-op is a degree requirement, students must obtain permission of their program or graduate director prior to enrollment. Co-ops are typically paid work experience, and can be part-time (150-479 total hours within the term), or full-time (480+ hours within the term). Co-ops may be one or two consecutive terms - fall, spring, or summer - with department permission. (Prerequisites: This class is restricted to students in IMGART-MFA with department permission.) **CO OP, Credits 0 (Fall, Spring, Summer)**

PHGR-890 Thesis

Students produce a thesis as a component of the MFA degree in Photography and Related Media. The completion of the thesis exhibition, from artwork to the installation, is the focus of this course. (Co-requisites: PHGR-721 or equivalent course.) **Thesis 6, Credits 6 (Fall, Spring)**

PHGR-892 Continuation of Thesis Imaging Arts

The Continuation of Thesis Imaging Arts course provides students additional semester(s) to complete their thesis research, project, and thesis document. (Prerequisite: PHGR-890 or equivalent course.) **Cont, Credits 0 (Fall, Spring)**

Saunders College of Business

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Course numbering: RIT courses are generally referred to by their alphanumeric registration label. The four alpha characters indicate the discipline within the college. The final three digits are unique to each course and identify whether the course is noncredit (less than 099), lower division (100-299), upper division (300-599), or graduate level (600 and above).

Unless otherwise noted, the following courses are offered annually. Specific times and dates can be found in each semester's schedule of courses. Prerequisites/corequisites are noted in parentheses near the end of the course description.

Accounting

ACCT-603 Accounting for Decision Makers

A graduate-level introduction to the use of accounting information by decision makers. The focus of the course is on two subject areas: (1) financial reporting concepts/issues and the use of general-purpose financial statements by internal and external decision makers and (2) the development and use of special-purpose financial information intended to assist managers in planning and controlling an organization's activities. Generally accepted accounting principles and issues related to International Financial Reporting Standards are considered while studying the first subject area and ethical issues impacting accounting are considered throughout. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall, Spring, Summer)**

ACCT-641 Cases in Forensic Accounting and Fraud Examination

Overview of the nature of occupational fraud and how it is committed including an introduction to the actions that can be taken to determine the presence of occupational fraud and procedures that can be implemented to deter fraud. Also covered is the proper manner in which allegations of fraud should be investigated and documented to meet the requirements of civil/criminal court procedure. Course is principally taught through case study. (Prerequisites: ACCT-603 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

ACCT-650 Financial Reporting for Government and Not-for-Profit Entities

This course provides a detailed examination and discussion of the accounting principles used by governmental and not-for-profit entities. The course focuses on the use of special funds for such entities as state and local governments, hospitals and other health care entities, voluntary health and welfare organizations, and other organizations. Students will learn what characterizes an entity as one for which the GASB is the authoritative standard-setting body versus one for which the FASB is the authoritative standard-setting body and develop an understanding of why two unique sets of accounting principles were developed to serve these entities. (Prerequisites: ACCT-603 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

ACCT-704 Corporate Financial Reporting I

A comprehensive exposure at an intermediate level to financial accounting theory and practice under U.S. Generally Accepted Accounting Principles. Emphasis is placed on applying underlying accounting theory to complex accounting and reporting problems. The effects of alternative accounting methods are considered. International Financial Reporting Standards are introduced as they relate to course subject matter. (Prerequisites: ACCT-603 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

ACCT-705 Corporate Financial Reporting II

Continuation of Corporate Continuation of Corporate Financial Reporting I with emphasis on equity and special measurement and reporting problems. Topics include liabilities and contingencies, stockholders' equity, earnings per share, pensions, leases, revenue recognition, income tax accounting, and the statement of cash flows. International Financial Reporting Standards are introduced as they relate to course subject matter. (Prerequisites: ACCT-704 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

ACCT-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. (Prerequisites: ACCT-603 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

ACCT-707 Advanced Accounting

Study of 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. (Prerequisites: ACCT-705 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

ACCT-708 Advanced Topics in Auditing and Assurance

A study of the legal, ethical, and technical environment in which the auditor works. Current auditing theory, standards, procedures, and techniques are studied. The audit process is studied to ascertain how it leads to the development of an audit opinion. (Prerequisites: ACCT-490 or ACCT-704 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

ACCT-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. **Lecture 3, Credits 3 (Spring)**

ACCT-710 Tax Analysis and Strategy

A continuation of Basic Taxation. Emphasis is on taxation of business entities, as well as estate and gift taxation and planning. Students use technology to prepare complex returns and to research tax issues. Tax analysis and planning are integrated throughout. **Lecture 3, Credits 3 (Fall)**

ACCT-711 Internal Auditing

Course explores the role of the internal audit function in the management of companies. Topics include internal vs. external auditing, internal control issues, reliability and integrity of information; compliance with policies, procedures, laws and regulations; efficiency of operations. Ethical considerations affecting the internal audit function are introduced. (Prerequisites: ACCT-603 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

ACCT-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. (Prerequisites: ACCT-705 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

ACCT-740 Comparative Financial Statement Analysis

This course is designed to prepare students to interpret and analyze financial statements effectively. Explores in greater depth some of the financial reporting topics introduced in the core accounting course and includes a discussion of International Financial Reporting Standards. (Prerequisites: ACCT-603 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

ACCT-745 Accounting Information and Analytics

The objective for this course is helping students develop a data mindset which prepare them to interact with data scientists from an accountant perspective. This course enables students to develop analytics skills to conduct descriptive, diagnostic, predictive, and prescriptive analysis for accounting information. This course focuses on such topics as data modeling, relational databases, blockchain, visualization, unstructured data, web scraping, and data extraction. (Prerequisites: ACCT-110 or ACCT-603 or equivalent course.) **Lecture 3, Credits 3 (Fall, Summer)**

ACCT-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 semester will be announced prior to the course offering. These seminars may be repeated for credit since topics normally vary from semester to semester. (Depends on topic) **Lecture 3, Credits 3**

ACCT-790 Field Exam Prep

All MS-Accounting students will take a field exam at the end of their program. This course provides basic help to students taking this exam. Note: all required courses in the MS-Accounting program. (Prerequisites: This course is restricted to students in ACCT-MS.) **Comp Exam 1, Credits 0 (Fall, Spring, Summer)**

ACCT-794**Cost Management 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. *Note: This course is not intended for Saunders College of Business students. (Enrollment in this course requires permission from the department offering the course.) **Lecture 3, Credits 3 (Spring)**

ACCT-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. It also considers the historical development of accounting standards, contemporary issues in financial reporting including international standards, and research methods used to determine the appropriate methods to comply with accounting standards. Course requires writing and student presentations. (Prerequisites: ACCT-705 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

ACCT-796**Accounting Capstone Experience**

The principal focus of this course is students completing several projects provided by members of CPA firms and industry employers. Employers provide assignments, which may include data or require students to gather relevant data, and students use defined technology, which may include a variety of applications common in technological accounting practice, to complete projects in teams. Students also write comprehensive individual reports and analyses related to the projects. Peripheral work in the course includes examination of theoretical concepts, definitions, and models espoused in the accounting literature and relevant to analyzing various contemporary issues in financial accounting and reporting. The historical development of accounting standards and contemporary issues in financial reporting are integrated. The course requires writing and student presentations. Subject to approval by the Program Director, an individual student internship/coop followed by an in-depth report may obtain equivalent credit. **Lecture 3, Credits 3 (Spring)**

ACCT-799**Independent Study Accounting**

The student will work independently under the supervision of a faculty adviser. (Enrollment in this course requires permission from the department offering the course.) **Ind Study 3, Credits 3 (Fall, Spring, Summer)**

ACCT-801**Accounting and Organizational Goals**

This course provides an understanding of how accounting helps organizations achieve their goals. Special emphasis is given to the resolution of controversial accounting issues within the context of a firm's goals. Topics include standards and practices of financial reporting, financial statements, inventories, long-term assets, bonds and other liabilities, and stockholders' equity. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 2, Credits 2 (Fall)**

ACCT-802**Managerial Accounting**

Managerial Accounting emphasizes identifying and applying the techniques used by managerial accountants to measure the cost of goods and services produced by the firm. The course focuses on understanding how managerial accounting is used to help organizations achieve their goals. (Prerequisites: ACCT-801 or equivalent course.) **Lecture 2, Credits 2 (Fall)**

Business Analytics

BANA-680**Data Management for Business Analytics**

This course introduces students to data management and analytics in a business setting. Students learn how to formulate hypotheses, collect and manage relevant data, and use standard tools such as Python and R in their analyses. The course exposes students to structured data as well as semi-structured and unstructured data. There are no pre or co-requisites; however, instructor permission is required for students not belonging to the MS-Business Analytics or other quantitative programs such as the MS-Computational Finance which have program-level pre-requisites in the areas of calculus, linear algebra, and programming. **Lecture 3, Credits 3 (Fall)**

BANA-780**Advanced Business Analytics**

This course provides foundational, advanced knowledge in the realm of business analytics. Advanced topics such as machine learning, analysis of structured data, text mining, and network analysis are covered. Industry standard tools such as R and Python are extensively used in completing student projects. (Prerequisite: BANA-680 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

BANA-785**Business Analytics Experience**

Students apply their mathematical, data analytic, and integrative business analytics skills in a complex project involving real or simulated data. Under the supervision of an advisor, students work in teams to perform a stipulated task/project and write a comprehensive report at the end of the experience. Subject to approval by the program director, an individual student internship/coop followed by an in-depth report may obtain equivalent credit. (Prerequisite: BANA-780 or equivalent course.) **Lecture 3, Credits 3 (Summer)**

Business Legal Studies

BLEG-612**Legal and Accounting Issues for New Ventures**

An introduction to basic legal and accounting issues that managers and developers of new business ventures must understand at the outset. Topics include financial statements prepared using both the cash basis and GAAP, differences among basic legal forms of business organization and related income tax issues, budgeting and cash flow management, and product costing. The focus is on understanding the legal and accounting components of the business plan. **Lecture 3, Credits 3 (Spring)**

BLEG-730**Business Legal Concepts**

An introduction to legal principles and their relationship to business organizations. Explores the U.S. legal system, the U.S. court system, civil and criminal procedure, the role of government agencies, legal research, and the substantive areas of law most relevant to business, including constitutional law, tort law, criminal law, contract law, intellectual property, debtor-creditor relations, bankruptcy, business entities, securities regulation and antitrust law. Extensive legal research projects are an essential part of the course. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Spring)**

BLEG-731**Commercial Law and Professional Skills**

Explores the impact of the Uniform Commercial Code and other substantive areas of law on business operations. Emphasis is on topics included on the certified public accounting exam, including provisions of the Uniform Commercial Code dealing with the sale and lease of goods, product warranties, commercial paper, negotiable instruments and secured transactions. Other topics include business entities, creditors' rights, bankruptcy, and insurance law. A research project on legal issues is an important aspect of this course. (Prerequisites: BLEG-730 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

BLEG-745**Legal and Ethical Issues in 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 encounters such situations throughout their careers. Coupled with technical proficiency, the ability to deal with legal and ethical issues shapes professional successes and failures. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall, Spring)**

BLEG-758**Seminar in Business Legal Studies**

Special topics seminars offer an in-depth examination of current events, issues and problems unique to Business Legal Studies. Specific topics will vary depending upon student and faculty interests and on recent events in the business world. Seminar topics for a specific semester will be announced prior to the course offering. These seminars may be repeated for credit since topics will normally vary from semester to semester. **Lecture 3, Credits 3**

Decision Sciences

DECS-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. (Prerequisites: DECS-782 or MGIS-650 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring, Summer)**

DECS-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. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall, Spring)**

DECS-745

Quality Control and Improvement

Study of total quality management (TQM), including Deming's philosophy, Six Sigma, quality planning, quality cost principles, problem-solving methods and tools, the use of statistical methods for quality control and improvement, supplier relations, and recent developments in quality. The course focus is on the management and continuous improvement of quality and efficiency in manufacturing and service organizations. (Prerequisites: DECS-782 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

DECS-750

Supply Chain Analysis

This course provides an overview of quantitative supply chain modeling and analysis. Accordingly, this course will discuss several strategic, tactical, and operational concepts used in improving the distribution of goods and services throughout the supply chain. The course emphasis is on understanding when and how to use these mathematical programming and optimization methods as well as how to interpret the results for actionable information. (Prerequisites: DECS-743 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

DECS-758

Seminar in Decision Sciences

Special topics seminars offer an in-depth examination of current events, issues and problems unique to decision science. Specific topics will vary depending upon student and faculty interests and on recent events in the business world. Seminar topics for a specific semester will be announced prior to the course offering. These seminars may be repeated for credit since topics will normally vary from semester to semester. (instructor-determined) **Lecture 3, Credits 3**

DECS-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. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall, Spring, Summer)**

DECS-799

Independent Study Decision Sciences

The student will work independently under the supervision of a faculty adviser. (Instructor approval) (Enrollment in this course requires permission from the department offering the course.) **Ind Study 3, Credits 3 (Fall, Spring, Summer)**

DECS-810

Statistical Analysis for Managers

This course introduces concepts for interpreting and analyzing data as a tool for assisting managers in making complex business decisions. Topics to be covered include: review of descriptive statistics, normal distribution, sampling distributions, estimation, test of hypothesis for single and two populations, linear regression, multiple regression and model building. The application of appropriate statistical tools will be required. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 2, Credits 2 (Fall)**

DECS-864

Systems Support for Operations

This course focuses on the application of information technology to gain greater efficiency and effectiveness from operational and managerial processes and systems. The conceptual foundations of operations, supply chain management and information technology are surveyed and contemporary approaches analyzed from a managerial perspective. **Lecture 2, Credits 2 (Summer)**

DECS-875

Business Simulation

Teams of students manage a company in a computer simulated oligopoly industry, competing against companies managed by other student teams. The overall purpose of the Business Simulation course is to: enhance the participant's ability to make effective business decisions; encourage cross-functional thinking; foster strategic and systems thinking; and enhance team building and reinforce continuous improvement opportunities. (Prerequisites: MGMT-818 and FINC-845 or equivalent courses.) **Lecture 2, Credits 2 (Summer)**

Economics

ESCB-705

Economics and Decision Modeling

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. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall, Spring, Summer)**

ESCB-758

Seminar in Economics

Special topics seminars offer an in-depth examination of current events, issues and problems unique to economics. Specific topics will vary depending upon student and faculty interests and on recent events in the business world. Seminar topics for a specific semester will be announced prior to the course offering. These seminars may be repeated for credit since topics will normally vary from semester to semester. (Instructor determined) **Lecture 3, Credits 3 (Fall, Spring)**

ESCB-799

Independent Study Economics

The student will work independently under the supervision of a faculty adviser. *Note: Instructor approval (This course requires permission of the Instructor to enroll.) **Ind Study 3, Credits 1 - 3 (Fall, Spring, Summer)**

ESCB-840

Microeconomics and Pricing

This course introduces microeconomic concepts and how they can be employed to examine business decisions such as pricing under conditions of uncertainty. Models and applications are employed that describe the efficient allocation of resources within a firm. Topics include supply and demand, consumer behavior, production, cost and pricing. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 2, Credits 2 (Fall)**

ESCB-841

Macroeconomics

Fundamental macroeconomic theories will be examined to explain and predict changes in economic growth, employment, inflation, consumer spending, business investment, and foreign trade. Financial markets, domestic and foreign, will be examined to understand changes in interest rates and exchange rates. The likely affects of government spending, taxes, and Federal Reserve Bank policies on the economy and business will be evaluated. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 2, Credits 2 (Fall)**

Finance

FINC-605

Financing New Ventures

A focus on financial issues affecting an entrepreneur. The course emphasizes, identifies, and follows the wealth creation cycle. The wealth creation cycle begins with an idea for a good, product or service, progresses to an initial company startup, passes through successive stages of growth, considers alternative approaches to resource financing, and ends with harvesting the wealth created through an initial public offering, merger or sale. Identification and valuation of business opportunities, how and from whom entrepreneurs raise funds, how financial contracts are structured to both manage risk and align incentives, and alternative approaches by which entrepreneurs identify exit strategies are reviewed. **Lecture 3, Credits 3 (Fall)**

FINC-671

Survey of Finance

This course introduces students to the field of finance and prepares them to undertake a study of advanced topics in other courses. Students learn about financial markets, regulation, and the fundamentals of corporate finance in areas such as investment and financing decisions. A brief overview of financial reporting allowing students to understand firm performance is also provided. (Prerequisites: ACCT-603 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

FINC-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 and spreadsheet analysis. (Prerequisites: ACCT-603 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

FINC-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. (Prerequisites: FINC-721 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

FINC-725

Securities and Investment Analysis

A survey of topics in investment analysis, including the study of financial markets, features of various financial assets and security pricing. Focus is on individual security analysis (as distinct from portfolio analysis). Asset pricing theory is used in valuing securities. Practical issues in equity valuation are discussed including risk evaluation, macroeconomic/industry/competitive analysis, and the use of corporate SEC filings. (Prerequisites: FINC-721 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

FINC-732**Portfolio Management**

This course extends the knowledge of risk and return in a portfolio context to portfolio management. Topics include portfolio optimization, diversification strategies, hedging strategies and performance evaluation. A variety of investment tools (e.g., fixed income securities) and investment contexts (e.g., pensions) will be studied. (Prerequisites: FINC-725 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

FINC-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 options and futures pricing models, options strategies, and contemporary topics such as index arbitrage. (Prerequisites: FINC-721 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

FINC-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. (Prerequisites: FINC-722 and FINC-725 or equivalent courses.) **Lecture 3, Credits 3 (Fall, Spring)**

FINC-758**Seminar in Finance**

Special topics seminars offer an in-depth examination of current events, issues and problems unique to finance. Specific topics will vary depending upon student and faculty interests and on recent events in the business world. Seminar topics for a specific semester will be announced prior to the course offering. These seminars may be repeated for credit since topics will normally vary from semester to semester. (instructor-determined) **Lecture 3, Credits 3**

FINC-760**International Finance**

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. (Pre or Corequisites: FINC-721 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

FINC-761**Stock Market Algorithmic Trading**

The course is a "hands-on" lab-based class designed to help students develop algorithmic trading strategies to invest in the stock market that can be implemented by retail and professional traders. What sets this course apart from many others is a strong emphasis on practical application with the purpose of building marketable skills for careers in finance. Concepts are not only taught, they are brought to life by learning how to design algorithmic trading models through the use of a computerized trading platform, that allows back-testing of data on thousands of different stocks. The software platform includes an automated wizard for building advanced technical trading models without programming knowledge; but also has an embedded programming language, similar to C-sharp, for those students that have those skills and elect to use them. (Knowledge of programming is not required; and there are no pre or co-requisites; but a lap-top is strongly recommended.) **Lecture 3, Credits 3 (Spring)**

FINC-772**Equity Analysis**

Students learn about various equity markets, trading, and valuation. The focus of this course is on valuing equities using widely used methods and in forming and analyzing equity portfolios. Students also learn portfolio optimization methods. (Prerequisites: FINC-671 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

FINC-773**Debt Analysis**

Students learn about various debt markets, trading, and valuation. The focus of this course is on valuing debt instruments using widely used methods and in forming and analyzing debt portfolios. (Co-requisites: FINC-671 & FINC-721 or equivalent courses.) **Lecture 3, Credits 3 (Spring)**

FINC-774**Advanced Derivatives**

Students learn about derivatives contracts, their pricing, and uses. The course will cover advanced financial engineering topics such as the engineering of fixed-income contracts, volatility positions, credit default swaps, and structured products. (Co-requisites: FINC-671 & MATH-736 or equivalent courses.) **Lecture 3, Credits 3 (Spring)**

FINC-780**Financial Analytics**

This course provides a survey of financial analytics applications in contexts such as investment analysis, portfolio construction, risk management, and security valuation. Students are introduced to financial models used in these applications and their implementation using popular languages such as R, Matlab, and Python, and packages such as Quantlib. A variety of data sources are used: financial websites such as www.finance.yahoo.com, government sites such as www.sec.gov, finance research databases such as WRDS, and especially Bloomberg terminals. Students will complete projects using real-world data and make effective use of visualization methods in reporting results. There are no pre or co-requisites; however, instructor permission is required – student aptitude for quantitative work will be assessed; waived for students enrolled in quantitative programs such as the MS-Computational Finance which have pre-requisites in the areas of calculus, linear algebra, and programming. **Lecture 3, Credits 3 (Fall)**

FINC-790**Field Exam Preparatory**

All MS-Finance students take a field exam at the end of their program. This course provides basic help to students taking this exam. (all required finance courses in the MS-finance program) (This course is restricted to FINC-MS Major students.) **Comp Exam 1, Credits 1 (Fall, Spring, Summer)**

FINC-791**Computational Finance Exam Preparatory**

Computational finance students take a field exam at the end of their program. This course provides basic help to students taking this exam. (all required finance courses in the computational finance program) **Comp Exam, Credits 0 (Fall, Spring, Summer)**

FINC-795**Computational Finance Experience**

Students apply their mathematical, data analytic, and integrative finance skills in a complex project involving real or simulated data. Under the supervision of an advisor, students work in teams to perform a stipulated task/project and write a comprehensive report at the end of the experience. Subject to approval by the program director, an individual student internship/co-op followed by an in-depth report may obtain equivalent credit. (This course is restricted to CMPFINC-MS Major students.) **Lecture 3, Credits 3 (Summer)**

FINC-799**Independent Study Finance**

The student will work independently under the supervision of a faculty adviser. (Instructor approval) (Enrollment in this course requires permission from the department offering the course.) **Ind Study 3, Credits 3 (Fall, Spring, Summer)**

FINC-845**Valuation and Capital Budgeting**

The course introduces financial concepts of risk, return and valuation. The main application studied in this course, Capital Budgeting, arises in the corporate setting where managers allocate scarce resources to projects. Basic issues of capital budgeting covered include cash flow estimation and valuation techniques. Advanced issues include sensitivity analysis and the consideration of real options. (Prerequisites: ACCT-802 or equivalent course. Corequisites: DECS-810 or equivalent course.) **Lecture 2, Credits 2 (Spring)**

FINC-846**Financial Planning and Analysis**

This is the second-part of a two-course corporate finance sequence for EMBA students. The overall theme is one of strategic control of corporate assets and liabilities. The five topics covered in this course are: (a) long-term financial planning, corporate financing and cost of capital (b) short-term financial planning and the analysis of short-term assets and liabilities (c) risk management and the corporate use of derivatives (d) the analysis of international activities (e) corporate control activities. Three topics are explored in depth: short-term financial management, capital structure and dividend policy, and risk and hedging. Short-term financial management includes the topics of credit analysis, financial forecasting and planning, working capital management and cash flow management. (Prerequisites: FINC-845 or equivalent course.) **Lecture 2, Credits 2 (Spring)**

FINC-850**International Finance**

This course examines how the international environment affects the practice of corporate finance by using a combination of theory and cases. 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. (Prerequisites: FINC-846 or equivalent course.) **Lecture 2, Credits 2 (Fall)**

Hospitality Management

HSPT-730 Strategic Hospitality and Tourism Branding
This class will concentrate on how the differences between product and service branding and marketing apply to travel destinations and tourist services such as lodging and recreational activities. Specific emphasis will be placed on the branding and marketing of tourism suppliers. Special attention will also be paid to promoting destinations as they move through their life cycle. The role of experiences in the marketing system will be covered from both the destination and supplier perspective. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall)**

HSPT-735 Hospitality and Tourism Customer Experience and Engagement
Creating memorable experience is a crucial differentiator for hospitality and tourism enterprises. Guided by the concepts of “hospitality” and “being hospitable”, this course introduces theories and methods that can be utilized during the service encounter to trigger optimal customer experiences through physical, social, and cultural interactions. This course addresses the co-creation of the experiences and value not only from hospitality and tourism service providers but also from the engagement of customers. The course puts an emphasis on the design of the customer journey, including theming, storytelling, and sensory, as well as unfolding customer experience in the phygital (physical and online) platform. **Lecture 3, Credits 3 (Fall)**

HSPT-740 Economic Performance Analysis for Hospitality and Tourism
Applications of economic analysis to hospitality and tourism including estimation and prediction of demand and supply, valuation, determination of regional economic impacts, and use of economic analysis in management, marketing, and policy decisions. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall, Spring)**

HSPT-750 Strategic Processes and Assessment of Hospitality and Tourism Industries
This class will apply customer relationship management methods to hospitality and tourism industries in order to develop new service experiences and maintain the economic viability of others. A review of the quality models and strategies available for maintaining hospitality and tourism competitiveness will be covered. The use of the six sigma quality improvement process will be applied to hospitality industries. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Spring)**

HSPT-761 Planning and Development for Hospitality and Tourism Industries
This course analyzes tourism as a system of interrelationships between markets (demand) and destinations (supply), and between governments and private businesses. This analysis provides a framework for the in-depth study of policy initiatives at the local, regional, and international levels. Additionally this course will address tourism and hospitality planning as it defines the frames of reference used in making choices concerning the development of tourism facilities and use of space. Scenario planning will be used to create new service systems for hospitality and tourism industries. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall)**

HSPT-763 Resort Amentities and Attraction Development
This course gives the student an understanding of how resort amenities and visitor attractions are developed and managed in destinations. Focus is on the planning, development, operation, design, and special needs of recreational amenities such as golf, tennis, skiing, spas, and marinas. Additional emphasis is placed on managing both historical, cultural, and natural resource based tourist attractions. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall)**

HSPT-767 Convention and Event Management
This class provides the student an opportunity to explore the function of a convention from the point of view of the convention center manager. Consideration is given to various methods used to sell a location to an event planner and the servicing of large groups. Students also examine the various ways to evaluate floor and meeting space as to profitability and quality related to the goals and objectives of the client. Various forms of business are ranked and the ability of one convention to enhance a second are considered in the decision making process. Finally codes, regulations, and licensing considerations are explored. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall, Spring)**

HSPT-789 Graduate Special Topic
Graduate Special Topic (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 4, Credits 1 - 4 (Fall, Spring, Summer)**

HSPT-790 Research Thesis
A thesis is based on experimental evidence obtained by the candidate in an appropriate topic demonstrating the extension of theory into practice. A written proposal which is defended and authorized by the faculty adviser/committee followed by a formal written thesis and oral presentation of findings are required. Typically the candidate will have completed research methods, data analysis, and graduate writing strategies prior to enrolling in this course and will start the thesis process as soon as they have completed these courses to allow them to finish the thesis when they have finished their coursework. The candidate must obtain the approval of their graduate adviser who will guide the thesis before registering for this course. **Thesis 6, Credits 6 (Fall, Spring, Summer)**

HSPT-791 Continuation of Project Cont, Credits 0
Continuation of Project Cont, Credits 0

HSPT-795 Comprehensive Examination
A written comprehensive exam is one of the non-thesis methodologies for completion of the MS degree. Students will demonstrate a fundamental knowledge of the theories and foundation principles. This course will include a review of the main concepts of each of the core subjects and at the conclusion of the course the student will take a written examination and must receive a passing grade of at least 80 percent to be successful. Students will have one additional opportunity to pass this examination if their initial attempt results in a failing grade. (This course will be taken with not less than 16 hours of course work remaining to complete the program, completion of core courses, and the student should be currently enrolled in the program. Possess a GPA of 3.0 or higher; no outstanding incomplete grades, nor can the student be on academic/disciplinary probation) **Comp Exam 3, Credits 0 (Fall, Summer)**

HSPT-797 Capstone Project in Hospitality and Tourism
This course is practical, project-based approach to a more traditional master's thesis. Students in the course will design and develop a project which reflects a viable option for an existing or putative organization. After a review of essential project management and planning skills as well as financial skills, the student designs and develops the project with continual review and feedback from the supervising faculty. **Project 3, Credits 3 (Spring, Summer)**

HSPT-798 Continuation of Thesis Cont, Credits 0
Continuation of Thesis Cont, Credits 0

HSPT-799 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. **Ind Study, Credits 1 - 6**

Human Resource Development

HRDE-710 Foundations in Human Resource Development
This course introduces students to the concepts that are the foundation of HRD and how these concepts are applied in a real-world environment. Human resource development is a distinct and unique area of practice that focuses on aligning employee learning and development with the strategic direction of an organization. This course provides an orientation to the profession and explores historical perspectives, theoretical foundations, and the practice of HRD. (This course is restricted to student in the HRDE-MS program.) **Lecture 3, Credits 3 (Fall, Summer)**

HRDE-711 Program Evaluation and Design
This course teaches the systematic application of social research procedures to evaluate the conceptualization, design, implementation, and utility of human resource development programs. (This course is restricted to student in the HRDE-MS program.) **Lecture 3, Credits 3 (Fall, Spring)**

HRDE-712 Performance Analysis and Development
This course provides individuals with a framework needed to successfully analyze performance and design learning interventions that drive performance improvements in an organization. Students will examine performance measurement, adult learning principles, and learning styles as well as best practices in organizational learning, employee development, and alternative delivery strategies. Additionally, students will identify how to link learning initiatives with strategy and gain commitment to those initiatives from senior leaders. (This course is restricted to student in the HRDE-MS program.) **Lecture 3, Credits 3 (Fall, Spring)**

HRDE-715 Human Performance Design and Development
A systematic approach to improve organizational productivity and competence of the internal workforce. It is a process of selection, analysis, design, development, implementation, and evaluation of programs to allow the most cost effective influence on human behavior and accomplishment to solve organizational problems. (This course is restricted to student in the HRDE-MS program.) **Lecture 3, Credits 3 (Fa/sp/su)**

HRDE-720**Theories of Organizational Development**

As organizations undergo continual change, HR leaders play a pivotal role enabling their organizations to anticipate, plan, and profit from change. This course introduces the student to theories and practices of organization development and change leadership. Such leadership requires competencies of identifying and framing challenges, consulting with clients, researching solutions, creating, implementing, and evaluating action plans. Through study, practice, and application, students will gain knowledge and skills to foster change, innovation, and the adaptability of an organization. **Lecture 3, Credits 3 (Spring)**

HRDE-721**Organizational Learning and Knowledge Management**

This is an introductory graduate-level survey course for organizational learning and knowledge management. The course will provide a broad overview of the concepts, practices, and challenges associated with learning in organizational contexts. Principles, techniques, and structures used to create, capture, store, value, distribute, and leverage knowledge to enhance organizational performance in continuously changing environments will be examined. Topics covered include types and nature of knowledge, levels of organizational learning, communities of practice, social and technological systems for capturing, storing, and distributing knowledge, valuation of knowledge assets, innovation and creativity, barriers to organizational learning, and knowledge as a source of competitive advantage. (Prerequisites: HRDE-710 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

HRDE-722**Talent Development**

This course provides skills to develop, retain, and engage the best available talent required for current and future success. Students examine benchmark practices from all industry types to derive effective strategies for their own organizations, develop a human capital strategy development, and complete an integrated set of projects to implement selected components of the strategy. **Lecture 3, Credits 3 (Fall, Summer)**

HRDE-726**Technology and the Future of Work**

The rapid pace of progress in technology and the change in demographics of the workforce are anticipated to affect what work will look like in the future, in addition to the structure and nature of work itself. Some of these changes might be incremental and others more radical and disruptive affecting the conduct of business. The pace, nature, and magnitude of these changes demand that businesses, organizations, educators, policy makers, leaders, managers, and individual employees reimagine models of employment including the organization and functioning of the workforce. This course is intended to provide students with a global perspective of the future of work and employment, and insights into the implications on their designated professions and careers. Among others, this course will address the following questions: What are the skills and competencies required of the workforce for this new future of work? What skills, competencies, and job roles may become redundant? How should corporations preempt and prepare to deal with these changes? What will be the role of leaders and managers in reimagining and developing the workforce of the future? **Seminar 3, Credits 3 (Fall)**

HRDE-731**Team Process and Facilitation Skills**

The ability to build a functioning team and then facilitate the group process ranks among the most critical competencies for HRD practitioners today. HRD practitioners are required to develop work teams and facilitate a variety of events from meetings and new employee orientations to training sessions. This course provides the HRD practitioner with the skills required to effectively develop teams, and plan for and facilitate a variety of events. Individuals in other disciplines will benefit from this course as well. (Prerequisites: HRDE-710 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

HRDE-732**Learning Transfer**

Learning transfer is the ability of an organization to promote the individuals transfer of learning back to their job. This course examines the research conducted in this area and how it is applied in practice. As an HRD practitioner it is imperative that the impact of training, the transfer of knowledge, is built in to the design of every program. By focusing on learning transfer, the goal of any program is to ensure that employees in the workplace are applying the newly acquired knowledge in the fulfillment of their job. This course examines the theoretical foundations of knowledge transfer, how to measure and evaluate this transfer, and strategies for increasing the probability this transfer will occur. (Prerequisites: HRDE-710 or equivalent course.) **Lecture 3, Credits 3 (Fa/sp/su)**

HRDE-735**Leading Human Resources**

The goal of this course is to develop knowledge of Human Resource Development and Management practices for the purpose of analyzing, communicating, evaluating, and leading the development of strategic human resource initiatives that react to emerging organizational concerns. This course is a foundation course for those seeking a leadership opportunity in Human Resources in which students will demonstrate their ability to analyze and lead the alignment of strategic organizational goals into HR functions. **Lecture 3, Credits 3 (Spring)**

HRDE-740**Strategic HRD for Global Organizations**

Global human resource development is a method for developing employees in global organizations. In this course, students will be exposed to the fundamentals of developing HRD programs within a multicultural framework. The need to be aware of cultural differences and how to best address them is critical for the global company. This course will explore globalization and HRD, design and development of global HRD programs, delivery and assessment of global HRD programs, and consulting across cultures. (Prerequisites: HRDE-710 or equivalent course.) **Lecture 3, Credits 3 (Fall, Summer)**

HRDE-741**Global Human Resource Development Leadership**

This course provides students with a theoretical foundation of global leadership. The frameworks presented in this course will help to guide students through a critical perspective of how they view leadership and how HRD can take part in developing leaders. Additionally, the global context of leadership will provide knowledge of the foundational concepts of leadership and how it impacts multinational organizations. Course focuses on human resource development applications and problem solving and not on human resource management. (Prerequisites: HRDE-710 or equivalent course.) **Lecture 3, Credits 3 (Fa/sp/su)**

HRDE-742**Leading Change**

Major change initiatives within organizations fail because of lack of understanding of the process of change and the lack of deliberate and focused attention to the change process. This course teaches students the change process and the alterations required in structures, processes, and activities to effectively implement change initiatives within organizations. The components of this course include applied approaches and tools to help analyze barriers for change, leverage power and influence, and provide frameworks to plan and implement change. **Lecture 3, Credits 3 (Summer)**

HRDE-743**Training for Global Organizations**

This course is designed to develop a student's understanding of cross-cultural communication and adaptation and how to design and deliver formal training. The course provides an introduction to different theoretical perspectives on cross-cultural communication and adaptation and the application of these perspectives to the design of training. Issues examined include culture theory, cross-cultural competence, and techniques and design of cross-cultural training. **Lecture 3, Credits 3 (Fa/sp/su)**

HRDE-745**Information Systems in HRD**

The workforce of the future is changing. It is creating challenges for organizations to continue to grow and develop their human capital. The role of the HRD professional is to act strategically, utilizing information system tools to ensure the workforce has the skills to meet the challenges of tomorrow. This course will provide a comprehensive overview of information systems used in HR to develop, assess, and provide data analysis of the workforce to meet the present and evolving needs of the organization. **Lecture 3, Credits 3 (Fall)**

HRDE-765**Diversity in Global Workplace**

As strategic partners in global workforce development, human resource development professionals guide organizations to build and maintain a diverse workforce. Diversity and inclusion exploit the natural synergies of a multicultural workforce. This course will examine dimensions of diversity beyond race, ethnicity, and gender and create opportunities to develop an understanding about how these dimensions intersect and play out in the workplace. The purpose of this course is to provide HRD professionals the knowledge required to manage these dynamics in an organizational setting and lead initiatives that will create and maintain an inclusive workplace. Project work will allow for the in-depth ability to assess the current state of diversity within a defined organization, conduct research and benchmarking to build a diverse workforce, and develop a diversity strategic plan with an on-going evaluation component to assess the success of diversity initiatives. **Lecture 3, Credits 3 (Spring)**

HRDE-780**Internship**

This course provides the student with the opportunity to apply their graduate course work to the world of work. Students will participate in internship opportunities in a work scenario similar to their ultimate career choice in the field. A mentor for the student must be identified in the place of the internship. The role of the mentor will be to work with students to develop a plan for the internship, facilitate the internship experience, and verify the student's accomplishment of specified outcomes as a result of the internship. Once the mentor approves of the plan of work and student accomplishments at the conclusion of the internship they will send this final report to the student's program adviser. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 1 - 3 (Fall, Spring, Summer)**

HRDE-785

Strategic HRD

Students will apply strategies to solve industry HRD problems as defined by the instructor. This will require the use of strategic HRD practices to influence and support the larger organizational strategy as it relates to their human capital. Incorporated in the course is a review of HRD strategies including an exploration of the boundaries of the practice of HRD; identification of organizational accountability structures and functions; application of strategic HRD concepts taken from core subjects; and identification of strategic HRD tools and interventions. Ultimately students will develop a plan to resolve a strategic HRD issue. (This course is restricted to student in the HRDE-MS program.) **Lecture 3, Credits 3 (Fall, Spring)**

HRDE-789

Special Topics

Special topics is an innovative course not reflected in the accepted curriculum. Once the outline is submitted titles will appear in the course listing for the semester. The course may be taken more than once as topics change. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fa/sp/su)**

HRDE-794

Integrative Problem Solving

Students will demonstrate synthesis and integration of the theories and foundation principles of their discipline. This will be achieved through application of core knowledge in a series of progressive problem situations culminating in a comprehensive examination. Completion of all HRDE core and required courses required. Students must receive a passing grade of at least 80 percent in the course to be allowed to take the comprehensive exam. **Lecture 3, Credits 3 (Fall, Summer)**

HRDE-795

Comprehensive Examination

A written comprehensive exam is one of the non-thesis methodologies for completion of the MS degree. Students will demonstrate a fundamental knowledge of the theories and foundation principles. This course will include a review of the main concepts of each of the core subjects. Completion of all HRDE core and required courses required. Students must receive a passing grade of at least 80 percent to be successful. Students will have one additional opportunity to pass this examination if their initial attempt results in a failing grade. **Comp Exam 3, Credits 0 (Fall, Summer)**

HRDE-797

Graduate Capstone Project

The purpose of this course is to provide students the opportunity to conduct research, develop a plan and evaluation components, and submit the project as a demonstration of final proficiency in the program. The topic selected by the student will be guided by the faculty teaching the class and it will require the student to coalesce and incorporate into the final project a culmination of all their course work in the program to date. **Project 3, Credits 3 (Fall, Spring, Summer)**

HRDE-798

Research Thesis

A thesis is based on experimental evidence obtained by the candidate in an appropriate topic demonstrating the extension of theory into practice. A written proposal which is defended and authorized by the faculty adviser/committee followed by a formal written thesis and oral presentation of findings are required. Typically the candidate will have completed research methods, data analysis and graduate writing strategies prior to enrolling in this course and will start the thesis process as soon as they have completed these courses to allow them to finish the thesis when they have finished their coursework. The candidate must obtain the approval of their graduate adviser who will guide the thesis before registering for this course. **Thesis 3, Credits 1 - 6 (Fall, Spring, Summer)**

HRDE-799

Independent Study

This course 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. **Ind Study, Credits 1 - 3 (Fall, Spring, Summer)**

International Business

INTB-710

Global Business Analytics

This course is designed to help students, regardless their backgrounds, to identify global business opportunities, possess necessary analytical skills to evaluate these opportunities, and understand the strategies to explore these opportunities to serve transnational businesses' goals. Students will be exposed to a variety of analytical skill sets such as collecting and analyzing institutional and primary international business data, reading the multinational firm-level data and understanding how global expansion impacts firms' bottom lines, developing foreign exchange hedging strategies, and apprehending the basic practices of international trade and foreign investment. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall)**

INTB-730

Cross-Cultural Management

An analysis of comparative global business behavior and organization with particular emphasis on values, authority, individual and group relations, labor-management ties, risk tolerance, and motivational techniques. The course will prepare students to recognize different values and cultural factors in the global business community and how these shape and determine appropriate management behavior. The problems and opportunities of transferring management practices from one culture to another will also be examined. **Lecture 3, Credits 3**

INTB-750

Global Marketing Management

A managerial-focused course that examines global marketing from a strategic perspective. This course provides a framework for identifying and analyzing the cultural and environmental differences of countries and regions that impact global marketing. Students will evaluate opportunities and challenges in global markets to develop appropriate marketing programs and market-entry strategies. Topics include foreign market opportunity assessment, commercialization and entry strategy development, customer analysis, distribution channels, and promotion in global markets. (Prerequisites: MKTG-761 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

INTB-755

Export, Import, and Global Sourcing

Exporting, importing, global sourcing and cross-border investing practice is detailed-oriented and complex. Market forces and government regulations create challenges and opportunities to move goods, services and capital between nations. Students will study issues of compliance, risk assessment and management, analyze international information, understand logistics and intermediaries, and management of international payments and financing. Students will be able to apply their knowledge and skills to the practice of cross border transactions. **Lecture 3, Credits 3 (Fall, Spring)**

INTB-758

Seminar in Global Business

This course offers an in-depth analysis of the global institutional environment and provides students the opportunity to research a variety of global business issues, such as regional business studies, emerging markets, and global industry analysis. Specific topics will vary depending upon student and faculty interest and on recent events in the business world. Seminar topics for a specific semester will be announced prior to the course offering. (Instructor determined) (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Spring)**

INTB-780

Global Issues and Strategies

This course will focus on contemporary international and global business issues, such as governance, outsourcing and offshoring, role of non-governmental organizations (NGOs), etc. It will emphasize faculty-directed student research projects. (Prerequisites: INTB-710 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

INTB-799

Independent Study - International Business

The student will work independently under the supervision of a faculty adviser. *Note: Instructor approval (This course requires permission of the Instructor to enroll.) **Ind Study 3, Credits 3 (Fall, Spring, Summer)**

INTB-820

International Business

The primary objective of the course is to examine the strategies, concepts, theories, and practices associated with conducting international business. It seeks to develop practical and theoretical problem solving skills needed in the global business environment. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 2, Credits 2 (Fall)**

INTB-825

International Study Seminar

This international study tour is an integral part of semester long focus on the strategic and operational issues facing organizations in a global competitive environment. Students will engage in lectures, plant visits, and interviews with international corporate managers. Students will apply the insights gained from their previous and concurrent coursework. This seminar offers students an inside view of individual companies and industries, and some of the broader economic, political, social, and cultural factors that influence business opportunities and practices in a particular region of the world. (Corequisites: INTB-820 or equivalent course.) **Lecture 2, Credits 2 (Fall)**

Management

MGMT-610

Global Entrepreneurship

Global entrepreneurs need to utilize both domestic and overseas resources, explore transnational opportunities, and leverage worldwide networks at early stages of the development. This course is designed to address the unique challenges of this global challenge, as well as the richer opportunities faced by the “born globals.” Students will learn how to discover, evaluate, and enact opportunities across national borders in order to create goods and services that serve various company goals. Students will also be informed of the competitive strategies normally adopted by international entrepreneurs in other major economies such as EU, China, and India. **Lecture 3, Credits 3 (Spring)**

MGMT-699

Honors Co-op

One semester of paid MBA related work experience. **Lecture, Credits 0 (Fall, Spring, Summer)**

MGMT-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. **Lecture 3, Credits 3 (Spring)**

MGMT-720

Entrepreneurship and Technology Entrepreneurship

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. **Lecture 3, Credits 3 (Fall, Spring, Summer)**

MGMT-730

Technology Entrepreneurship

This course addresses the unique challenges for the entrepreneur in management of value capture through innovation, and the importance of technology-based innovation for the establishment and growth of the new venture in global products and services industries. The course integrates four major themes: (1) Appropriability and Entrepreneurial Innovation (2) the relationships between innovation, value creation, and value capture amongst customers, stakeholders, and the marketplace, (3) the role of technology in creating global competitive advance in both product-based and services-based industries, and (4) developing and monitoring the operational framework for the delivery of new value in products and services. (Prerequisites: MGMT-720 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

MGMT-735

Management of Innovation

This course addresses the management of innovation, sustainable technology, and the importance of technology-based innovation for the growth of the global products and services industries. The course integrates three major themes: (1) leading-edge concepts in innovation, (2) the role of technology in creating global competitive advance in both product-based and services-based industries, and (3) the responsibility of businesses related to sustainability. The importance of digital technology as an enabler of innovative services is covered throughout the course. (completion of four graduate business courses) **Lecture 3, Credits 3 (Fall, Spring, Summer)**

MGMT-740

Leading Teams in Organizations

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 learn a number of frameworks for diagnosing and dealing with managerial challenges dynamics at the individual, group and organizational level. Topics include leadership, motivation, team building, conflict, organizational change, cultures, decision making, and ethical leadership. **Lecture 3, Credits 3 (Fall, Spring, Summer)**

MGMT-741

Managing Organizational Change

This course addresses the importance of organizational change in maintaining a flexible, dynamic, and responsive organization, by examining various theories and approaches currently used to assist organizations in achieving planned change. The role of the leader in achieving organizational change is emphasized. The features of successful change in organizations will be discussed, including the structural, motivational, interpersonal, and social aspects of organizational change. (Prerequisites: MGMT-740 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

MGMT-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. **Lecture 3, Credits 3 (Fall, Spring)**

MGMT-743

Advanced Topics in Technology Management

This course is the advanced treatment of topics introduced in the core course offering, MGMT 735. It reviews topics introduced in the core such as disruptive technology and adds significant new content on such topics as user innovation and organizational ambidexterity. Successful completion will prepare students for leadership and significant contributions as group members for any new technology development project. (Prerequisites: MGMT-735 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

MGMT-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, the pros and cons of various regulatory approaches, and the role of the firm in the policy making process. The class also looks at current debates on corporate social responsibility with regard to stakeholders, including government, consumers, employees, communities and the environment. **Lecture 3, Credits 3 (Fall)**

MGMT-753

Field Experiences in Business Consulting

Students work in consulting teams to assist startup ventures and/or small businesses. Students focus on multiple aspects of consulting including client engagement, negotiating statements of work, project management, and final briefings and reports. From problem identification through the application of relevant analytical models, course projects may focus on a number of areas. For example, they may seek to develop commercialization plans for specific technologies, products, or services; craft marketing plans; focus on unique problems associated with small businesses; and develop growth strategies. Recommended for students nearing the completion of their program. (Prerequisites: ACCT-603 and FINC-721 and MKTG-761 or equivalent courses.) **Lecture 3, Credits 3 (Spring)**

MGMT-755

Negotiations

This course is designed to teach the art and science of negotiation so that one can negotiate successfully in a variety of settings, within one's day-to-day experiences and, especially, within the broad spectrum of negotiation problems faced by managers and other professionals. Individual class sessions will explore the many ways that people think about and practice negotiation skills and strategies in a variety of contexts. **Lecture 3, Credits 3 (Fall, Spring)**

MGMT-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. (Prerequisites: MGMT-740 or equivalent course.) **Lecture 3, Credits 3 (Summer)**

MGMT-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 semester will be announced prior to the course offering. These seminars may be repeated for credit since topics normally vary from semester to semester. (Depends on topic) **Lecture 3, Credits 3**

MGMT-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 strategies, developing and implementing business-level and corporate-level strategies, and managing strategy in the multi-business corporation. *Note: All MBA core courses. (Enrollment in this course requires permission from the department offering the course.) **Lecture 3, Credits 3 (Fall, Spring, Summer)**

MGMT-761

Managing Research and Innovation

This course deals with the responsibilities and operating problems of managers responsible for research and innovation within firms. Topics will include: internal technology assessments, the acquisition of technology, domestic and international technology transfer, and the selection and management of research and development projects. Managerial techniques for stimulating and managing innovation are discussed, based on descriptive and prescriptive readings and cases. Particular attention will be given to managing creative individuals, the nature of disruptive technical innovations, and techniques for overcoming barriers to innovation. (Prerequisites: MGMT-742 or MGMT-735 or equivalent courses.) **Lecture 3, Credits 3 (Spring)**

MGMT-762

Managing New Process and Product Development

The course deals with the internal organizational challenges faced by managers of innovative and technology-intensive companies. Particular attention is given to management techniques for successfully developing and introducing into the marketplace new products and services. Also discussed are the management of technical groups and project teams, cross-functional integration, and organizational processes and procedures that support innovation and creativity. (Prerequisites: MGMT-742 or MGMT-735 or equivalent courses.) **Lecture 3, Credits 3 (Spring)**

MGMT-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 assessed, and the impact is clarified of the behaviors that flow from each style on the perceptions and performance of others in the organization. (No prerequisite for MS-Manufacturing Leadership students.) (Prerequisites: MGMT-740 or equivalent course.) **Lecture 3, Credits 3 (Fall, Summer)**

MGMT-765

Applied Venture Creation

This graduate course enables students to learn the entrepreneurial (value creation) process by advancing a business idea. The course provides weekly seminars focusing on customer discovery and business model development and weekly coaching mentoring sessions with an established entrepreneur/early stage marketer. The project is team based. Students may enter the course with a business concept or be integrated into an existing team in the course. **Lecture 3, Credits 3 (Fall, Spring, Summer)**

MGMT-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, rationalization 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. (Prerequisites: DECS-782 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

MGMT-775

Ethical Decision Making and Corporate Social Performance

This course is designed to equip business practitioners with scientifically supported frameworks and methods for recognizing, analyzing, deciding on, and implementing ethical courses of action in business. Selected topics include stakeholders needs analysis, the science of decision-making, corporate social performance, issues involved with emerging technologies, and doing business in a global context. **Lecture 3, Credits 3 (Fall, Spring)**

MGMT-780

Technology Strategy

Strategy-making in technology faces special challenges: risk assessment in the face of uncertainty, predicting trends and changes in social issues, government policy, and technology, stakeholder management and technology ethics, fitting your organization to the evolving demands of your technology, integrating new technology with your existing technology, globalization, and more. It also calls for decisions on issues such as how to diversify your technology, collaboration, merger and acquisition possibilities. This course covers how to make technology strategy, including such components as quantitative and qualitative forecasting, risk assessment, the use of statistical analysis in decision-making, and the application of decision-making theories. The class includes a capstone experience. (Prerequisites: INTB-710 or MKTG-768 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

MGMT-790

Field Exam Prep

All MS-Management students who do not complete a capstone project will take a field exam at the end of their program. This course provides basic help to students taking this exam. *Note: All required courses in the MS-Management program. (This course is restricted to MGMT-MS Major students.) **Comp Exam 3, Credits 0 (Fall, Spring, Summer)**

MGMT-791

This course is used to fulfill the graduate project requirement for the MS degree in management. The candidate must obtain approval from an appropriate faculty member to supervise the paper before registering for this course. A corporate-oriented research project designed by the candidate and his or her advisor to explore a salient management-related issue. (This course is restricted to MGMT-MS Major students.) **Project, Credits 3 - 6 (Spring, Summer)**

MGMT-794

Innovation Project

This course is limited to students in the Master of Science in Innovation Management Program. It is the first of two courses (Innovation Project and Innovation Capstone) that complete the degree program. Students will analyze an innovation issue and develop a plan to put the innovation into practice. Circumstances permitting, they may test the plan. 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 integrate knowledge of innovation, creativity, and business practice while developing and applying innovation skills. Students will receive a grade of Incomplete for this course. A final grade for both the Innovation Project and Innovation Capstone courses will be assigned upon completion of the Capstone course. 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. *Note: Permission of the Program Director. **Lecture 3, Credits 3 (Fall, Spring)**

MGMT-795

Innovation Capstone

Students work with faculty and industry advisors to integrate their business and innovation learning through an applied project. In this project, real-world business problems will be addressed, and solutions will be planned, developed, and potentially deployed. The project may be entrepreneurial in nature, or it may be carried out within an existing company. The project 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. Students are required to formally present and defend their proposed innovation to the program director and capstone committee at least six weeks before they start this course. Students may not register for the course unless they have successfully completed this defense. *Note: Permission of program director. (Prerequisites: MGMT-794 or MGMT-765 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring, Summer)**

MGMT-799

Independent Study Management

The student will work independently under the supervision of a faculty adviser. *Note: Instructor approval **Ind Study 3, Credits 3 (Fall, Spring, Summer)**

MGMT-800

Leadership Development I

This course builds on the assessment activities that are part of course MGMT-806. Each student participates in a 360-degree leadership assessment process. Based on this formal review, personal development plans are created and serve as dynamic documentation of individual professional progress. Students arrange individual counseling sessions with a leadership coach. Students then take action on the feedback received in order to develop self awareness. (Corequisite: MGMT-806 or equivalent course) **Lecture 1, Credits 1 (Summer)**

MGMT-801

Leadership Development II

This course is a continuation of MGMT-800. Leadership Development II requires student to explore and expand their potential as leaders. Through self and peer assessment, one-on-one coaching, career counseling, and written assignments, students develop leadership goals and create a plan to realize those goals. Students arrange individual counseling sessions with a leadership coach. (Prerequisites: MGMT-800 or equivalent course.) **Lecture 1, Credits 1 (Fall)**

MGMT-804

Critical Thinking for Decision Making

An introduction to the issues related to managerial problem solving, planning, decision making and implementation in complex organizations. The goal of the course is to help students think systematically about the practice of general management and how managers translate ideas into action. The types of decisions faced by executives and the various approaches available to managers for solving cross-functional, organizational-wide problems are examined. Students learn and practice essential skills required of general managers including critical thinking, problem solving, and oral and written communication. **Lecture 2, Credits 2 (Fall)**

MGMT-805

Current Topics Seminar

Current topics seminars offer an in-depth examination of current events, issues and problems. Specific topics will vary depending upon student and faculty interest and on recent events in the business world. Seminar topics for a specific semester will be announced prior to the course offering. (topic-dependent) **Lecture 2, Credits 2 (Fall)**

MGMT-806**Team Building and Ethics**

During this one-week course, students will understand how to motivate and lead teams as well as how to support the leadership of others. Students will undertake a critical evaluation of the ethical responsibilities of managers and corporations. Each incoming student joins a study group of around four or five students selected for diversity of skills and experience. This course also serves as a general orientation for incoming EMBA students. **Lecture 1, Credits 1 (Summer)**

MGMT-810**Leadership**

This course focuses on the role of the general manager as a leader in an organization. The course addresses analytical and behavioral strategies and techniques for leadership by examining problem-solving models, personal values, and communications. The emphasis is on the interpersonal skills needed to express different leadership styles and behaviors. Cases, exercises, and class discussions will be used to examine and explore opportunities for managers to become more effective as leaders in modern organizations. (Prerequisites: MGMT-806 or equivalent course.) **Lecture 2, Credits 2 (Fall)**

MGMT-818**Strategic Thinking I**

The primary theme of this course is to examine how firms can achieve superior financial performance through the establishment of a sustainable competitive advantage at the business level. Contemporary theories of strategic management will be discussed and critically examined for their relevance to the problems facing many of today's managers. Topics include analysis of industry attractiveness, value-chain analysis, core competencies, and business-level strategies. (Prerequisites: ESCB-840 and FINC-845 or equivalent courses.) **Lecture 2, Credits 2 (Spring)**

MGMT-819**Strategic Thinking II**

This course covers corporate-level strategy and strategy implementation. The focus of the course is on the strategy of the firm as a whole, and the interrelations between different divisions. Topics will include related and unrelated diversification, and the various means of engaging in diversification, mergers and acquisitions, joint ventures, and strategic alliances. Contemporary theories of strategic management will be discussed and critically examined for their relevance to the problems facing many of today's managers. (Prerequisites: MGMT-818 or equivalent course.) **Lecture 2, Credits 2 (Spring)**

MGMT-850**Negotiations and Decision-making**

This course is designed to teach the art and science of negotiation so that one can negotiate successfully in a variety of settings, in day-to-day experiences and, especially, within the broad spectrum of negotiation problems faced by managers and other professionals. Individual class sessions will explore the many ways that people think about and practice negotiations skills and strategies in a variety of contexts. Special emphasis will be on decision-making biases that are often inherent in any negotiation setting and compromise the quality of negotiated agreements. **Lecture 2, Credits 2 (Fall, Spring)**

MGMT-860**Executive Leadership Series**

The course explores leadership topics in depth with an emphasis on current management and leadership issues. During each class a community leader guest lectures on topics of leadership. Past speakers have included senior-level executives from local industry, government, and not-for-profit organizations. (Prerequisites: MGMT-810 or equivalent course.) **Lecture 2, Credits 2 (Fall)**

MGMT-861**Managing Technology, Innovation and Research**

This course deals with the responsibilities and challenges faced by managers responsible for research and innovation within high-technology firms. Topics will include: the critical role of innovation, internal technology assessments, technology transfer, the selection and management of R&D projects, and the identification of and management of disruptive technologies and business models. Particular attention will be given to overcoming systemic barriers to innovation. (Prerequisites: MGMT-818 or equivalent course.) **Lecture 2, Credits 2 (Summer)**

MGMT-862**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. (Prerequisites: MGMT-810 or equivalent course.) **Lecture 2, Credits 2 (Spring)**

MGMT-877**Graduate Part-Time Co-op**

Half semester of paid MBA related work experience. *Note: Departmental approval required. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **CO OP, Credits 0 (Fall, Spring)**

MGMT-888**Graduate Co-op Summer**

One summer semester of paid MBA related work experience. *Note: Departmental approval required. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **CO OP, Credits 0 (Summer)**

MGMT-889**Capstone Consulting Project I**

Teams of students analyze specific operational problems or improvement opportunities in client organizations. Under the guidance of a faculty supervisor, teams identify relevant issues, collect data, develop alternatives and make recommendations to the client. The project, a two-course equivalent, is the capstone experience of the Executive MBA program. (Prerequisites: MGMT-818 and FINC-846 and MKTG-851 or equivalent courses.) **Lecture 3, Credits 3 (Summer)**

MGMT-890**Capstone Consulting Project II**

This course is a continuation of MGMT-889. Teams of students analyze specific operational problems or improvement opportunities in client organizations. Under the guidance of a faculty supervisor, teams identify relevant issues, collect data, develop alternatives and make recommendations to the client. The project, a two-course equivalent, is the capstone experience of the Executive MBA program. (Prerequisites: MGMT-889 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

MGMT-999**Graduate Co-op**

One semester of paid MBA related work experience. *Note: Departmental approval required. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **CO OP, Credits 0 (Fall, Spring, Summer)**

Management Information Systems

MGIS-650**Introduction to Data Analytics and Business Intelligence**

This course serves as an introduction to data analysis including both descriptive and inferential statistical techniques. Contemporary data analytics and business intelligence tools will be explored through realistic problem assignments. **Lecture 3, Credits 3 (Fall)**

MGIS-720**Information Systems Design**

This course provides students with fundamental knowledge and skills required for successful analysis of problems and opportunities related to the flow of information within organizations and the design and implementation of information systems to address identified factors. Students are provided with knowledge and experience that will be useful in determining systems requirements and developing a logical design. **Lecture 3, Credits 3 (Fall)**

MGIS-725**Data Management and Analytics**

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. **Lecture 3, Credits 3 (Spring)**

MGIS-735**Design and Information Systems**

Students who complete this course will understand the principles and practices employed to analyze information needs and design appropriate IT-based solutions to address business challenges and opportunities. They will learn how to conduct requirements analysis, approach the design or redesign of business processes, communicate design decisions to various levels of management, and work in a project-based environment. **Lecture 3, Credits 3 (Spring)**

MGIS-745**Information Systems Development**

Systems development provides MBA students with the fundamental techniques and concepts necessary for programming in a modern programming language. Emphasis will be placed on object-oriented programming concepts. By the end of the course, students will demonstrate core programming concepts, and will be able to write simple business applications. **Lecture 3, Credits 3 (Fall, Spring)**

MGIS-758**Seminar in Management Information Systems**

Special topics seminars offer an in-depth examination of current events, issues and problems unique to MIS. Specific topics will vary depending upon student and faculty interests and on recent events in the business world. Seminar topics for a specific semester will be announced prior to the course offering. These seminars may be repeated for credit since topics will normally vary from semester to semester. (Instructor determined) **Lecture 3, Credits 3 (Fall, Spring)**

MGIS-760

Integrated Business Systems

This course focuses on the concepts and technologies associated with Integrated Business Information Systems and the managerial decisions related to the implementation and ongoing application of these systems. Topics include business integration and common patterns of systems integration technology including enterprise resource planning (ERP), enterprise application integration (EAI) and data integration. The key managerial and organizational issues in selecting the appropriate technology and successful implementation are discussed. Hands-on experience with the SAP R/3 system is utilized to enable students to demonstrate concepts related to integrated business systems. (familiarity with MS Office suite and Internet browsers) **Lecture 3, Credits 3 (Spring)**

MGIS-799

Independent Study Management Information Systems

The student will work independently under the supervision of a faculty adviser. (Instructor approval) **Ind Study 3, Credits 3 (Fall, Spring, Summer)**

Marketing

MKTG-758

Seminar in Marketing

Special topics seminars offer an in-depth examination of current events, issues and problems unique to marketing. Specific topics will vary depending upon student and faculty interest and on recent events in the business world. Seminar topics for a specific semester will be announced prior to the course offering. These seminars may be repeated for credit since topics normally vary from semester to semester. (varies according to topic) **Lecture 3, Credits 3**

MKTG-761

Marketing Concepts and Commercialization

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. **Lecture 3, Credits 3 (Fall, Spring, Summer)**

MKTG-762

Strategic Marketing Management

This course is an advanced study of the strategic and operational decisions facing a marketing executive today. Topics covered include market segmentation, branding and positioning, channel management, strategic pricing, marketing communications, marketing analytics and marketing in the new social economy. The course will present various concepts and tools for evaluating the marketplace (external environment, competitors, marketing opportunities and threats), and analyzing marketing strategies. Time will be spent on developing, evaluating and implementing marketing strategy at the corporate level using case analysis and formal decision making techniques. Students will be expected to make use of analytical, problem solving and communication skills to drive the development of a marketing plan focused on an actual company. The course also includes a business simulation with emphasis on advanced marketing management skills (CapSim: Capstone). The course will weave together a study of classical marketing theory and strategic planning with applied marketing management skills within the context of a business simulation. (Prerequisites: MKTG-761 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

MKTG-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, social and psychological perspectives will be discussed. All perspectives will be applied to designing marketing strategy. (Prerequisites: MKTG-761 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

MKTG-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. (Prerequisites: MKTG-761 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

MKTG-768

Marketing Analytics

This course provides an overview of marketing analytics in the context of marketing research, product portfolios, social media monitoring, sentiment analysis, customer retention, clustering techniques, and customer lifetime value calculation. Students will be introduced to, mathematical and statistical models used in these applications and their implementation using statistical tools and programming languages such as SAS, SPSS, Python and R. Multiple data sources will be used ranging from structured data from company databases, scanner data, social media data, text data in the form of customer reviews, and research databases. Students will complete guided projects using real time data and make effective use of visualization to add impact to their reports. There are no listed pre or co-requisites; however, instructor permission is required – student aptitude for quantitative work will be assessed; waived for students enrolled in quantitative programs such as the MS-Computational Finance which have pre-requisites in the areas of calculus, linear algebra, and programming. **Lecture 3, Credits 3 (Spring)**

MKTG-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. (Prerequisites: MKTG-761 and DECS-782 or equivalent courses.) **Lecture 3, Credits 3 (Fall, Spring)**

MKTG-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. (Prerequisites: MKTG-761 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

MKTG-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. (Prerequisites: MKTG-761 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

MKTG-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. (Prerequisites: MKTG-761 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

MKTG-799

Independent Study Marketing

The student will work independently under the supervision of a faculty adviser. (Instructor approval) **Ind Study 3, Credits 3 (Fall, Spring, Summer)**

MKTG-851

Marketing Strategy

A general management perspective on the critical impact of marketing in organizations. Topics include an overview of the marketing process, market research, segmentation, and target markets. The focus is on the process of creating, communicating, and delivering customer value through the marketing mix. The course is structured around the managerially controllable elements of product, price, promotion and distribution, plus the interrelationships of these elements. (Pre or Corequisites: MGMT-818 or equivalent course.) **Lecture 2, Credits 2 (Spring)**

MKTG-865

Managing New Product Commercialization

This course emphasizes the marketing and product strategy 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 product development process, developing the marketing plan for launching new products, and managing the product life cycle. Best practices in activities required for successful new product commercialization are reviewed. (Prerequisites: MKTG-851 or equivalent course.) **Lecture 2, Credits 2 (Summer)**

Service Leadership and Innovation

SERQ-710

Service Design Fundamentals

Service design is a holistic design process. It uses skills from a variety of disciplines (design, management and process engineering) to develop models to create new services or to improve existing services in the most efficient and effective manner possible. The emphasis of the process is to provide value to the customer; as a service differentiator or create unique experiences for the customer. Service design uses methods and tools from a variety of disciplines to assist with the analysis and creation of enhanced systems. These tools include; mapping, blueprinting, analysis of customer behavior, market analysis, service marketing, and service recovery. The outcome of this course is to provide students with the fundamentals of service design thinking to allow them to lead the efforts of systematic design in a variety of disciplines. (SVCLED-MS, HSPT-MS) **Lecture 3, Credits 3 (Fall, Spring)**

SERQ-712

Breakthrough Thinking, Creativity, and Innovation

This is an introductory-level survey course on the dynamics of innovation. The course focuses on individual, team and organization-human and systems dynamics that impact organizational innovation. Students gain awareness in, understanding of and important skills in fostering multi-level organizational human ecologies conducive to the creation of innovation. Issues and challenges important to leaders at all levels in an organization, entrepreneurs and talent management practitioners will be examined and explored. There is a required fee for the class to pay for the administration of the ISPI and Meyers Briggs evaluation instruments. Students will develop in their understanding of innovation, their own personal innovation capabilities, preferences, and the human dynamics unique to innovation applied in an organizational context. This background is becoming increasingly critical to developing innovation capabilities in and across organizations in our increasingly competitive and complex world. This course will build awareness and improve competency in the application of overall course content and design principles particular to developing innovation-competent individuals, teams, and organizations. **Lecture 3, Credits 3 (Fall, Summer)**

SERQ-714

Service Leadership and Innovation Practicum

To gain experience in applied innovation students will observe, interact and discuss with service organizations how they develop and execute innovation strategies to enhance their service environment. At the conclusion of the experience students will relate this benchmarking experience to innovation strategies in the service industries (Prerequisite: SERQ-712 or equivalent course.) **Ind Study, Credits 1 - 3 (Fa/sp/su)**

SERQ-720

Service Scenario and Strategy Development

The service world has many examples of once-successful companies that failed to accomplish the primary goal of every organization: consistently design, deliver value to customers and other key stakeholder groups in a highly competitive and ever-changing service environment. Today's organizational leaders must be able to develop and implement strategies that ensure the continued competitiveness of their organizations, and identify and leverage opportunities for growth and innovation brought about by change. Firmly grounded in the fundamentals of strategy development this course prepares students to create and sustain competitive advantage; and to apply key foresight techniques including scenario planning to anticipate future opportunities. **Lecture 3, Credits 3 (Spring, Summer)**

SERQ-722

Customer Centricity

The Customer Centricity course develops the learners ability to help their organization manage its interactions with its valued customers across multiple channels, maximize revenue opportunities, build foundations to increase customer satisfaction, and drive customer retention and loyalty. **Lecture 3, Credits 3 (Spring)**

SERQ-723

Service Analytics

Analytics in service organizations is based on four phases: analysis and determination of what data to collect, gathering the data, analyzing it, and communicating the findings to others. In this course, students will learn the fundamentals of analytics to develop a measurement strategy for a given area of research and analysis. While this measurement process is used to ensure that operations function well and customer needs are met; the real power of measurement lies in using analytics predictively to drive growth and service, to transform the organization and the value delivered to customers. Topics include big data, the role of measurement in growth and innovation, methodologies to measure quality, and other intangibles. **Lecture 3, Credits 3 (Fall, Summer)**

SERQ-730

Project Management in the Service Sector

Managing public and private sector projects is a complex, demanding process involving ethical considerations, leadership, the ability to understand complex rules and regulations, the politics of the administration and the vagaries of the budget process. This conceptual framework will address planning, selection of team members, contracts and agreements, monitoring and adjusting the project progress and completion of the project through turnkey stages. The end result of this process is to contribute to establishment of trust of the stakeholders, minimize failure and maximize success. (Prerequisites: SERQ-710 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

SERQ-732

Assessment of Service Quality

The service sector encompasses a large and varied arena making the assessment of service quality challenging. This course will provide quality evaluation strategies which span a variety of service sectors. To build a comprehensive picture of public and private sector quality service indicators will be reviewed as well as strategies to assess service quality. Each of these approaches will be analyzed, discussed and evaluated for the output generated. To assist with this overview, the Serve/Qual model, including the identification of service standards to meet and exceed customer expectations, will be used to evaluate service quality. **Lecture 3, Credits 3 (Fall)**

SERQ-735

Data Mining in the Service Sector

To gather and analyze public/private service sector information to inform decisions is the goal of every public/private sector administration. Data can drive success of governments and organizations or lead to their downfall. This course will explore data mining used in the public/private sector, how to gather it and utilize the results of the data collections to inform decisions that reflect the needs and desires of the stakeholders in this sector. **Lecture 3, Credits 3 (Fall)**

SERQ-737

Leadership Development

The course approaches leadership development from a systems perspective examining and mastering proactive leadership approaches, understanding and using team building and team learning, examining various leadership techniques including, benchmarking, continuous improvement, six sigma and lean, gap analysis, and more. Dialog and case analysis are used to enable all students to comprehend the myriad of tools available to be able to construct a strong learning organization. **Lecture 3, Credits 3 (Summer)**

SERQ-740

Leading Innovation

Achieving competitive advantage in today's world demands that organizations know how to innovate, and do so not once, but repeatedly. Creativity, rapid learning through continuous improvement, and the ability to turn ideas into action, products, processes and services are crucial. How do leaders foster and sustain a culture of innovation? What unique competencies and skills do you need as a leader and what skills do your teams need? How is managing an innovation team different than managing other kinds of teams within an organization? Through this course, service leadership students will leverage and build on their growing knowledge about innovation, the individual and group skills required for innovating gained in SERQ-712. Students will gain deeper insights into innovation leadership requirements for creating, managing and curating a thriving environment in which cutting edge ideas are encouraged, born and grown. Open to students in the service leadership and innovation MS program and non-majors on a space available basis with department permission. (Prerequisite: SERQ-712 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

SERQ-745

Social Psychology of Service

Service interactions are an increasing segment of human interactions in today's society. This course will examine service relationships, encounters and experiences from the perspective of human motivation and relating existing theories of social psychology to the delivery of services. An analysis of the interactions of customers and employees will help the student restrain their use of intuition and overlay critical thinking skills with human dynamics. The areas to be included in this course include; emotional intelligence, reciprocity, persuasion, conflict and communication, motivation, diversity, retention, and other related theories. **Lecture 3, Credits 3 (Summer)**

SERQ-747

Design Thinking and Creativity

The use of creative problem solving to discover new alternatives in the design of products and services is the essence of design thinking. The innovation design thinking process seeks creative inspiration to solve a problem, generating and selecting ideas to develop a path from design to market. Design thinking tools and strategies are discussed as are "Wicked Problems" and the impact design thinking can have on developing a solution for these problems. An in-depth approach uses stories and prototypes to design products/ services in an effort to solve problems in an innovative and sustainable manner. **Lecture 3, Credits 3 (Fall)**

SERQ-775

Leading Not for Profit (NFP) Organizations

A leader for a not-for-profit organization, whether private enterprises or government, requires an orientation for leadership based on a mission to achieve stability, growth and consumer satisfaction with outcomes. This course will deal with the realities of leadership in a not-for-profit organization and how leadership skills are applied in this environment. The course will explore the nuances for collaboration and networking as a leadership strategy as well as achieving clarity in the mission, vision and goals of the organization. The unique aspects of leadership in this environment will be discussed as well as the role of stakeholders, whether they are board members or those in government charged with overseeing the use of public resources. **Lecture 3, Credits 3 (Fall)**

SERQ-780

Internship

This course provides the student with the opportunity to apply their graduate coursework to the world of work. Students will be placed or seek out internship opportunities in a work scenario similar to their ultimate career choice in the field. A mentor for the student must be identified in the place of the internship. The role of the mentor will be to work with students to develop a plan for the internship, facilitate the internship experience, and verify the student's accomplishment of specified outcomes as a result of the internship. Once the mentor approves of the plan of work and student accomplishments at the conclusion of the internship they will send this final report to the student's program adviser. (Enrollment in this course requires permission from the department offering the course.) **Lecture 3, Credits 3 (Fall, Spring, Summer)**

SERQ-787

Service Design and Implementation

Internally driven service businesses have been the norm for many years, at best, customer-compelled companies understand the value of co-creation and customer centricity. In this course, students research and select design theories and customer centric processes to construct a customer co-created service system/process. This future-oriented approach allows the learner to apply foundation principles of service design and innovation to invent strategies to resolve customer problems. (Prerequisite: SERQ-710 and SERQ-720 and SERQ-712 and SERQ-723 and SERQ-740 or equivalent courses.) **Lecture 3, Credits 3 (Fall, Spring, Summer)**

SERQ-789

Special Topics

Selected topics is an innovative course not reflected in the accepted curriculum. Once the outline is submitted titles will appear in the course listing for the semester. The course may be taken more than once as topics change. (This course is restricted to students in the SVCLED-MS program.) **Lecture 3, Credits 3 (Fall, Spring, Summer)**

SERQ-790

Research Thesis

A thesis is based on experimental evidence obtained by the candidate in an appropriate topic demonstrating the extension of theory into practice. A written proposal which is defended and authorized by the faculty adviser/committee followed by a formal written thesis and oral presentation of findings are required. Typically the candidate will have completed research methods, data analysis, and graduate writing strategies prior to enrolling in this course and will start the thesis process by taking thesis planning as soon as they have completed the prerequisites to allow them to finish the thesis when they have finished their coursework. The candidate must obtain the approval of their graduate adviser who will guide the thesis before registering for this course. (Enrollment in this course requires permission from the department offering the course.) **Thesis, Credits 1 - 6 (Fall, Spring, Summer)**

SERQ-791

Continuation of Research Thesis

Continuation of Research Thesis (Enrollment in this course requires permission from the department offering the course.) **Cont, Credits 0 (Fall, Spring, Summer)**

SERQ-794

Integrative Problem Solving

Students will demonstrate synthesis and integration of the theories and foundation principles of their discipline. This will be achieved through application of core knowledge in a series of progressive problem situations culminating in a comprehensive examination. To be successful students must receive a passing grade of at least 80 percent in the course. Students will have one additional opportunity to register for and pass the Integrative problems solving course if their initial attempt result in a failing grade. (No more than 12 semester hours of course work remaining to complete the program; completion of all core courses in their program; be currently enrolled in the program; possess a program GPA of 3.0 or higher; no outstanding incomplete grades, nor can the student be on academic/disciplinary probation.) (Enrollment in this course requires permission from the department offering the course.) **Lecture 3, Credits 3 (Fall, Summer)**

SERQ-795

Comprehensive Exam

Students will demonstrate synthesis and integration of the theories and foundation principles of their discipline to respond to questions found in the comprehensive examination. This demonstration will apply core knowledge to problem situations to be successful students must receive a passing grade of at least 80 percent. (12 semester hours or less of coursework remaining to complete the program; completion of all core courses in the discipline; currently enrolled in the program; possess a program GPA of 3.0 or higher; no outstanding incomplete grades; student cannot be on academic/disciplinary probation; for disciplines requiring integrative problem solving successful completion of that course.) (Enrollment in this course requires permission from the department offering the course.) **Comp Exam, Credits 0 (Fall, Summer)**

SERQ-797

Capstone Project

The purpose of this course is to provide students the opportunity to conduct research, develop a plan and evaluation components and submit the project as a demonstration of final proficiency in the program. The topic selected by the student will be guided by the faculty teaching the class and it will require the student to coalesce and incorporate into the final project a culmination of all their course work in the program to date. (Enrollment in this course requires permission from the department offering the course.) **Project 3, Credits 3 - 4 (Fall, Spring, Summer)**

SERQ-798

Continuation of Capstone Project

Continuation of Capstone Project (Enrollment in this course requires permission from the department offering the course.) **Cont, Credits 0 (Fall, Spring, Summer)**

Golisano College of Computing and Information Sciences

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Course numbering: RIT courses are generally referred to by their alphanumeric registration label. The four alpha characters indicate the discipline within the college. The final three digits are unique to each course and identify whether the course is noncredit (less than 099), lower division (100-299), upper division (300-599), or graduate level (600 and above).

Unless otherwise noted, the following courses are offered annually. Specific times and dates can be found in each semester's schedule of courses. Prerequisites/corequisites are noted in parentheses near the end of the course description.

Computer Science

CSCI-603

Computational Problem Solving

This course focuses on the application of computational thinking using a problem-centered approach. Specific topics include: expression of algorithms in pseudo-code and a programming language; elementary data structures such as lists, trees and graphs; problem solving using recursion; and debugging and testing. Assignments (both in class and homework) requiring a pseudo-code solution and implementation in a programming language are an integral part of the course. Note: This course serves as a bridge course for graduate students and cannot be taken by undergraduate students without permission from the CS Undergraduate Program Coordinator. (This course is restricted to students in COMPSCI-MS.) **Lecture 3, Credits 3 (Fall, Spring)**

CSCI-605

Advanced Object-Oriented Programming Concepts

This course focuses on identifying advanced object-oriented programming concepts and implementing them in the context of specific problems. This course covers advanced concepts such as event-driven programming, design patterns, distributed and concurrent programming, and the use, design and implementation of applications. Assignments (both in class and as homework) requiring a solution to a problem and an implementation in code are an integral part of the course. Note: This course serves as a bridge course for graduate students and cannot be taken by undergraduate students without permission from the CS Undergraduate Program Coordinator. (This course is restricted to students in COMPSCI-MS.) **Lecture 3, Credits 3 (Fall, Spring)**

CSCI-610

Foundations of Computer Graphics

Foundations of Computer Graphics 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 graphics systems. The course will focus on rasterization techniques and emphasize the hardware rasterization pipeline including the use of hardware shaders. Students will use a standard computer graphics API to reinforce concepts and study fundamental computer graphics algorithms. Programming projects and a survey of the current graphics literature will be required. Note: students who complete CSCI-510 may not take CSCI-610 for credit. (Prerequisite: (CSCI-603 or CSCI-605 with a grade of B or better) or (CSCI-243 or SWEN-262). May not take and receive credit for CSCI-610 and CSCI-510. If earned credit for/or currently enrolled in CSCI-510 you will not be permitted to enroll in CSCI-610.) **Lecture 3, Credits 3 (Fall, Spring)**

CSCI-620

Introduction to Big Data

This course provides a broad introduction to the exploration and management of large datasets being generated and used in the modern world. First, practical techniques used in exploratory data analysis and mining are introduced; topics include data preparation, visualization, statistics for understanding data, and grouping and prediction techniques. Second, approaches used to store, retrieve, and manage data in the real world are presented; topics include traditional database systems, query languages, and data integrity and quality. Case studies will examine issues in data capture, organization, storage, retrieval, visualization, and analysis in diverse settings such as urban crime, drug research, census data, social networking, and space exploration. Big data exploration and management projects, a term paper and a presentation are required. Sufficient background in database systems and statistics is recommended. (Prerequisite: CSCI-603 or CSCI-605 with a grade of B or better or (CSCI-320 or SWEN-344). May not take and receive credit for CSCI-620 and CSCI-420. If earned credit for/or currently enrolled in CSCI-420 you will not be permitted to enroll in CSCI-620.) **Lecture 3, Credits 3 (Fall, Spring, Summer)**

CSCI-621

Foundations of Database System Implementation

This course provides a broad introduction to database management systems including data modeling, the relational model, and SQL. Database system implementation issues are covered next, where the focus is on 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 also explored. Programming projects, a term paper, and presentations will be required. Note: Students who take this course may not take CSCI-421 for credit. (Prerequisites: CSCI-620 or CSCI-420 or equivalent course. May not take and receive credit for CSCI-621 and CSCI-421. If earned credit for/or currently enrolled in CSCI-421 you will not be permitted to enroll in CSCI-621.) **Lecture 3, Credits 3 (Fall, Spring)**

CSCI-622

Data Security and Privacy

This course examines policies, methods and mechanisms for securing enterprise and personal data and ensuring data privacy. Topics include data integrity and confidentiality; access control models; secure database architectures; secure transaction processing; information flow, aggregation, and inference controls; auditing; securing data in contemporary (relational, XML and other NO SQL) database systems; data privacy; and legal and ethical issues in data protection. Programming projects are required. (Prerequisites: CSCI-620 or CSCI-420 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

CSCI-630

Foundations of Artificial Intelligence

An introduction to the theories and algorithms used to create artificial intelligence (AI) systems. Topics include search algorithms, logic, planning, machine learning, and applications from areas such as computer vision, robotics, and natural language processing. Programming assignments and oral/written summaries of research papers are required. (Prerequisites: ((CSCI-603 or CSCI-605) & CSCI-661) with grades of B or better or ((CSCI-243 or SWEN-262) & (CSCI-262 or CSCI-263)). If you have earned credit for CSCI-331 or you are currently enrolled in CSCI-331 you won't be permitted to enroll in CSCI-630.) **Lecture 3, Credits 3 (Fall, Spring)**

CSCI-631

Foundations of 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. Note: students who complete CSCI-431 may not take CSCI-631 for credit. (Prerequisites: (CSCI-603 and CSCI-605 and CSCI-661 with grades of B or better) or ((CSCI-243 or SWEN-262) and (CSCI-262 or CSCI-263)) or equiv courses. If earned credit for/or currently enrolled in CSCI-431 you will not be permitted to enroll in CSCI-631. Prerequisites: (CSCI-603 and CSCI-605 and CSCI-661 with grades of B or better) or ((CSCI-243 or SWEN-262) and (CSCI-262 or CSCI-263)) or equiv courses. If earned credit for/or currently enrolled in CSCI-431 you will not be permitted to enroll in CSCI-631.) **Lecture 3, Credits 3 (Fall, Spring)**

CSCI-632

Mobile Robot Programming

This course covers standard and novel techniques for mobile robot programming, including software architectures, reactive motion control, map building, localization and path planning. Other topics may include multiple robot systems, robot vision and non-traditional and dynamic robots. Students will implement various algorithms in simulation as well as on a real robot, and investigate and report on current research in the area. Course offered every other year. (Prerequisites: CSCI-630 or CSCI-331 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

CSCI-633

Biologically Inspired Intelligent Systems

There have been significant advances in recent years in the areas of neuroscience, cognitive science and physiology related to how humans process information. In this course students will focus on developing computational models that are biologically inspired to solve complex problems. A research paper and programming project on a relevant topic will be required. A background in biology is not required. (CSCI-603,605,661 or CSCI ETC..) **Lecture 3, Credits 3 (Fall)**

CSCI-635

Introduction to Machine Learning

This course offers an introduction to supervised machine learning theories and algorithms, and their application to classification and regression tasks. Topics include: Mathematical background of machine learning (e.g. statistical analysis and visualization of data), neural models (e.g. Convolutional Neural Networks, Recurrent Neural Networks), probabilistic graphical models (e.g. Bayesian networks, Markov models), and reinforcement learning. Programming assignments are required. (Prerequisites: CSCI-630 or CSCI-331 or equivalent course. Students may not take and receive credit for CSCI-635 and CSCI-335.) **Lecture 3, Credits 3 (Fall, Spring)**

CSCI-636

Information Retrieval

An introduction to the theories and techniques used to construct search engines. Topics include search interfaces, traditional retrieval models (e.g., TF-IDF, BM25), modern retrieval techniques (e.g., neural reranking and retrieval), search engine evaluation, and search applications (e.g., conversational IR, enterprise search). Students will also review current IR research, provide written summaries of current research papers, and complete a group project in which they will design and execute experiments for search engine components. (Prerequisites: (CSCI-603 and CSCI-605 and CSCI-661 with grades of B or better, including familiarity with computer-science concepts) or CSCI-331 or equivalent courses. Students may not take and receive credit for CSCI-636 and CSCI-536.) **Lecture 3, Credits 3 (Spring)**

CSCI-641

Advanced Programming Skills

The goal of this course is to introduce the students to a programming paradigm and an appropriate programming language chosen from those that are currently important 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. The instructor will post specifics prior to registration. With the approval of the program coordinator, the course can be taken for credit more than once, provided each instance deals with a different paradigm and language. A term project involving independent investigation is also required. Note: students who complete CSCI-541 may not take CSCI-641 for credit. (Prerequisites: (CSCI-603 or CSCI-602) and (CSCI-605 or CSCI-604) or equivalent courses with grades of B or better or successful completion of CSCI-344.) **Lecture 3, Credits 3 (Fall, Spring)**

CSCI-642

Secure Coding

This course provides an introduction to secure coding including topics such as principles of secure coding, security architectures and design, operational practices and testing, programmatic use of cryptography, and defenses against software exploitation. Other topics include software based fault isolation, type-safe languages, certifying compilers; proof-carrying code, and automated program analysis and program rewriting. Programming projects, presentations, and a term paper will be required. (Prerequisites: (CSCI-603 and CSCI-605 with grades of B or better) or (CSCI-243 or SWEN-262) or equivalent courses.) **Lecture 3, Credits 3 (Fall)**

CSCI-651

Foundations of Computer Networks

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. The course also includes an introduction to local area networks, data transmission fundamentals, and network security. Programming projects and reading research papers will be required. (Prerequisites: (CSCI-605 with grade of B or better) or (CSCI-243 or SWEN-262) or equivalent course and sufficient background in statistics. Students cannot take and receive credit for this course if they have taken CSCI-351.) **Lecture 3, Credits 3 (Fall)**

CSCI-652

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. Students will also learn about ethical and legal concerns in computing and research. Programming projects are required. (Prerequisites: (CSCI-603 with grade of B or better) or (CSCI-243 or SWEN-262) or equivalent course and sufficient background in Operating Systems.) **Lecture 3, Credits 3 (Fall, Spring)**

CSCI-654

Foundations of Parallel Computing

This course is 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, granularity, applications, parallel programming design and debugging. Students will become familiar with various types of parallel architectures and programming environments. (Prerequisites: (CSCI-603 and CSCI-605 and CSCI-661 with grades of B or better) or ((CSCI-243 or SWEN-262) and (CSCI-262 or CSCI-263)) or equivalent courses.) **Lecture 3, Credits 3 (Fall)**

CSCI-655

Foundations of Cybersecurity

This course provides a graduate-level introduction to cybersecurity principles and practices, and emphasizes policies and mechanisms for building secure and trusted computer systems. It will cover cybersecurity principles, policies and mechanisms; core knowledge areas of data, software, component, connection, system, human, organizational and societal security; and crosscutting concepts of confidentiality, integrity, availability, risk, adversarial thinking, and systems thinking. Topics in privacy, and legal and ethical aspects will also be emphasized. The course also explores the current research in cybersecurity. Presentations, reports and projects are required. (CSCI-605 and (CSCI-660 or CSCI-661) with B or better in all courses or CSEC-600 and CSEC-604 with B or better in both courses or CSCI-250 and (CSCI-262 or CSCI-263). Students may not take and receive credit for both CSCI-455 and CSCI-655.) **Lecture 3, Credits 3 (Summer)**

CSCI-661

Foundations of Computer Science Theory

This course provides an introduction to the theory of computation, including formal languages, grammars, automata theory, computability, and complexity. This course serves as a bridge course for graduate students and cannot be taken by undergraduate students without permission from the CS Undergraduate Program Coordinator. Note: Students who complete CSCI 262 or CSCI 263 may not take CSCI 661 for credit. (This course is restricted to students in COMPSCI-MS.) **Lecture 3, Credits 3 (Fall, Spring)**

CSCI-662

Foundations of Cryptography

This course provides an introduction to cryptography, its mathematical foundations, and its relation to security. It covers classical cryptosystems, private-key cryptosystems (including DES and AES), hashing and public-key cryptosystems (including RSA). The course also provides an introduction to data integrity and authentication. Note: students who complete CSCI-462 may not take CSCI-662 for credit. (Prerequisites:(CSCI-603 and CSCI-605 and CSCI-661 with grades of B or better) or ((CSCI-243 or SWEN-262) and (CSCI-262 or CSCI-263)) or equiv courses. If earned credit for/or currently enrolled in CSCI-462 you will not be permitted to enroll in CSCI-662.) **Lecture 3, Credits 3 (Fall, Spring)**

CSCI-664

Computational Complexity

This course provides an introduction to computational complexity theory. It covers the P=NP problem, time and space complexity, randomization, approximability, and relativization. (Prerequisites: (CSCI-661 or CSCI-660 or CSCI-262 or CSCI-263) and (CSCI-665 or CSCI-261 or CSCI-264) or equivalent courses.) **Lecture 3, Credits 3 (Spring)**

CSCI-665

Foundations of Algorithms

This course provides an introduction to the design and analysis of algorithms. It covers a variety of classical algorithms and their complexity and will equip students with the intellectual tools to design, analyze, implement, and evaluate their own algorithms. Note: students who take CSCI-261 or CSCI-264 may not take CSCI-665 for credit. (Prerequisites: (CSCI-603 and CSCI-605 and CSCI-661 with grades of B or better) or ((CSCI-243 or SWEN-262) and (CSCI-262 or CSCI-263)) or equivalent courses. This course is restricted to COMPSCI-MS, COMPSCI-BS/MS, or COMPIS-PHD students.) **Lec/Lab 3, Credits 3 (Fall, Spring)**

CSCI-686

Graduate Professional Seminar

This course provides students with skills required to succeed as Computer Science professionals, balancing the divergent needs of computing technology, employee, employer, and societal needs. Topics covered include skills in professional communication; skills to determine and effectively address needs of diverse audiences; research skills such as the ability to perform a literature review, design and conduct studies; team participation and management skills; conflict management; and skills to handle legal, ethical and societal challenges faced by CS professionals. **Lecture 3, Credits 3 (Fall, Spring, Summer)**

CSCI-687

Graduate Research Seminar

This course provides students with the theoretical background and practical application of various research methods that can be used in computing and information sciences. The course provides an overview of the research process and literature review, and provides initial study in correlation and experimental research methods and design. Students will analyze several existing research studies and design and conduct studies. **Lecture 3, Credits 3 (Fall, Spring, Summer)**

CSCI-699**Computer Science Graduate Co-op**

Students perform professional work related to Computer Science for which they are paid. Students work full time during the term for which they are registered. Students must complete a student co-op work report for each term for which they are registered; students are also evaluated each term by their employer. A satisfactory grade is given for co-op when both a completed student co-op work report and a completed, corresponding employer evaluation are received and when both documents are generally consistent. Co-op is an optional part of the MS in Computer Science degree. Graduate students are eligible to do a maximum of 364 days of co-op and students must register for co-op by the end of add/drop period for the appropriate term. See the CS graduate program coordinator or RIT's Office of Cooperative Education and Career Services for further details. (Enrollment in this course requires permission from the department offering the course.) **CO OP, Credits 0 (Fall, Spring, Summer)**

CSCI-709**Topics in Computer Science**

This course examines current topics in Computer Science. This is intended to allow faculty to pilot potential new graduate offerings. Specific course details (such as prerequisites, course topics, format, learning outcomes, assessment methods, and resource needs) will be determined by the faculty member(s) who propose a specific seminar course in this area. Specific course instances will be identified as belonging to no cluster; hence, such courses will count only as general Computer Science electives. **Lec/Lab 3, Credits 3**

CSCI-711**Global Illumination**

This course will investigate the theory of global illumination (GI) in computer image synthesis. Seminal computer graphics papers will be used to explore the various components of the GI pipeline and explain how the path of light in a virtual scene can be simulated and used to create photorealistic imagery. The course will emphasize the theory behind various GI rendering tools and libraries available for image synthesis. The student will put theory into practice via a set of programming assignments and a capstone project. Topics will include light and color, three-dimensional scene specification, camera models, surface materials and textures, GI rendering methods, procedural shading, tone reproduction, and advanced rendering techniques. Readings and summaries of Computer Graphics literature will be required. (Prerequisites: CSCI-610 or CSCI-510 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

CSCI-712**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 at least one 3D API (e.g. OpenGL, DirectX, Java3D). Readings and summaries of Computer Graphics literature will be required. Offered every other year. (Prerequisites: CSCI-610 or CSCI-510 or 4005-762 or 4003-570 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

CSCI-713**Applied Perception in Graphics and Visualization**

The goal of this course is to introduce students to the field of applied perception in graphics and visualization and demonstrate how it has contributed to the development of better display systems and computer graphics rendering techniques. The delivery of the course material will be done primarily through lectures with biweekly programming assignments based upon the techniques presented in class. Students will also be exposed to a wide range of technical papers and be expected to make classroom presentations on selected topics in the field of applied perception in graphics and visualization. (Prerequisites: CSCI-610 or CSCI-510 or 4005-762 or 4003-571 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

CSCI-714**Scientific Visualization**

Visualizations of scientific data are helpful in order to understand complex, n-dimensional behavior of simulations. This course covers techniques that are needed to visualize n-dimensional data sets produced by real scientific simulations. Topics include: Visualization design, discrete visualization techniques, scalar and volume visualization techniques and perception of visualizations. Additionally topics such as distributed file systems, specialized file systems and distributed computing needed in order to create the visualizations will be covered. A team project and presentations are required. Course offered every other year. (Prerequisites: CSCI-610 or CSCI-510 or 4005-762 or 4003-572 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

CSCI-715**Applications in Virtual Reality**

This course will investigate the application of virtual reality software and technology within a given domain. Working in sets of technical teams, students will collectively investigate and solve a large-scale visualization task within that problem domain. Focus of individual student teams may include (but is not limited to) distributed VR framework, viewing applications, interaction with VR devices / displays, and audio in virtual environments. Students will be required to read and summarize selected articles from VR literature, as well as papers specific to the problem domain being investigated, to assist in making design decisions. A report or survey of one aspect of using a virtual reality system within the given domain is also required. 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. Offered every other year. (Prerequisites: CSCI-610 or CSCI-510 or 4005-762 or 4003-573 or equivalent course.) **Lec/Lab 3, Credits 3 (Fall)**

CSCI-716**Computational Geometry**

Computational Geometry is a subfield of algorithm theory that involves the design and analysis of efficient algorithms for problems involving geometric input and output. In this course the focus will be largely on problems in 2-dimensional space (lines, line segments, polygons, planes, polyhedral, curved objects, etc.) with occasional inclusion of higher dimensional problems. There are many fields of computer science that deal with solving problems of a geometric nature. These include computer graphics, computer vision and image processing, robotics, computer-aided design and manufacturing, computational fluid-dynamics, and geographic information systems, to name a few. One of the goals of this computational geometry course is to provide the basic geometric tools necessary to solve problems in these fields. Note: Programming projects are required. (Prerequisites: CSCI-261 or CSCI-264 or CSCI-665 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

CSCI-719**Topics in Computer Graphics**

This course examines current topics in Computer Graphics. This is intended to allow faculty to pilot potential new graduate offerings. Specific course details (such as prerequisites, course topics, format, learning outcomes, assessment methods, and resource needs) will be determined by the faculty member(s) who propose a specific topics course in this area. Specific course instances presented will be identified as belonging to the Computer Graphics and Visualization cluster. **Lecture 3, Credits 3**

CSCI-720**Big Data Analytics**

This course provides a graduate-level introduction to the concepts and techniques used in data mining. Topics include the knowledge discovery process; prototype development and building data mining models; current issues and application domains for data mining; and legal and ethical issues involved in collecting and mining data. Both algorithmic and application issues are emphasized to permit students to gain the knowledge needed to conduct research in data mining and apply data mining techniques in practical applications. Data mining projects, a term paper, and presentations are required. (Prerequisites: CSCI-620 or (CSCI-420 and CSCI-320) or (4003-485 and 4003-487) or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

CSCI-721**Foundations of 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. Data cleaning projects, a term paper, and presentations are required. Note: Students who take this course may not take CSCI-521 for credit. (Prerequisites: CSCI-620 or (CSCI-420 and CSCI-320) or (4003-485 and 4003-487) or equivalent course.) **Lecture 3, Credits 3 (Spring)**

CSCI-722**Data Analytics Cognitive Comp**

Building on prior knowledge of data analytics, this course brings in the impact of natural language processing and cognitive computing on data analysis. Topics include an overview of natural language processing; data mining, information retrieval and knowledge processing; corpus identification and preparation; training and test data and methods; current research in the field; and ethical concerns. Students will apply the concepts learned in class through team projects, programming assignments, presentations, and a research paper. (Prerequisites: CSCI-620 or (CSCI-420 and CSCI-320) or (4003-485 and 4003-487) or equivalent course.) **Lecture 3, Credits 3 (Fall)**

CSCI-723**Advanced Database Skills: Graph Databases**

This course starts with an introduction to advanced topics in relational databases, including their implementation and advanced SQL queries. Discussions about benefits and drawbacks of relational databases will arise, which will be the foundation for introducing new types of NoSQL databases; that is, column, key-value, and graph databases. This course will then focus on the rationale, implementation, and storing and querying capabilities of graph databases. Assignments of various kinds will be used to assess individual performance of students. Additionally, the course requires a team-based project in which students will analyze and implement state-of-the-art approaches over graph databases. Teams will present the results of their projects in class. (Prerequisites: CSCI-320 or CSCI-620 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

CSCI-724 **Web Services and Service Oriented Computing**
This course introduces fundamental concepts of Web services and the Service-Oriented Computing (SOC) paradigm, and reviews seminal work, current research, and modern practices in these areas. Topics in Web Services include XML; reference model (WSDL, UDDI, SOAP); service coordination and composition; and service security and privacy. Big data analytics in SOC will also be covered, such as large scale service data retrieval and storage, service clustering and classification, service recommendation, and service discovery. Students will apply the concepts learned in the class through programming assignments and a comprehensive term project. (Prerequisites: CSCI-620 or (CSCI-320 and CSCI-420) or CSCI-652 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

CSCI-725 **Advanced Database Skills: NoSQL and NewSQL Data Systems**
This course examines how database systems evolved to meet the workloads of modern applications. Limitations of relational databases led to NoSQL systems that are highly scalable and provide flexible data modeling but sacrifice important consistency properties. More recently, "NewSQL" data systems seek to understand and address fundamental scalability bottlenecks while maintaining relational database consistency. This course will describe shortcomings of relational databases for certain data management tasks and the specific challenges addressed by NoSQL and NewSQL database systems. Case studies will investigate both established and state-of-the-art systems. Students will critique and present existing work in the area and complete a research project individually or in teams that explores an outstanding problem in the area. (Prerequisites: CSCI-320 or CSCI-620 or (DSCI-633 and ISTE-608) or equivalent courses.) **Lecture 3, Credits 3 (Fall)**

CSCI-729 **Topics in Data Management**
This course examines current topics in Data Management. This is intended to allow faculty to pilot potential new graduate offerings. Specific course details (such as prerequisites, course topics, format, learning outcomes, assessment methods, and resource needs) will be determined by the faculty member(s) who propose a specific topics course in this area. Specific course instances will be identified as belonging to the Data Management cluster, the Security cluster, or both clusters. **Lecture 3, Credits 3 (Fall, Spring)**

CSCI-731 **Advanced Computer Vision**
This course examines advanced topics 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. (Prerequisites: CSCI-631 or CSCI-431 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

CSCI-732 **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 a 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. Offered every other year. (Prerequisites: CSCI-631 or CSCI-431 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

CSCI-734 **Foundations of Security Measurement and Evaluation**
The course will introduce students into the algorithmic foundations and modern methods used for security evaluation. It will combine a theoretical revision of the methods and models currently applied for computer security evaluation and an investigation of computer security through study of user's practice. The students will be required to complete a few home assignments, to deliver a class presentation, to implement a team project, to lead the team's work and to undertake research on the topic assigned. (Prerequisites: CSCI-651 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

CSCI-735 **Foundations of Intelligent Security Systems**
The course will introduce students to the application of intelligent methodologies applications in computer security and information assurance system design. It will review different application areas such as intrusion detection and monitoring systems, access control and biological authentication, firewall structure and design. The students will be required to implement a course project on design of a particular security tool with an application of an artificial intelligence methodology and to undertake research and analysis of artificial intelligence applications in computer security. (Prerequisites: CSCI-630 or CSCI-651 or CSCI-331 or equivalent course.) **Lec/Lab 3, Credits 3 (Spring)**

CSCI-736 **Neural Networks and Machine Learning**
The course will introduce students into the current state of artificial neural networks. It will review different application areas such as intrusion detection and monitoring systems, pattern recognition, access control and biological authentication, and their design. The students will be required to conduct research and analysis of existing applications and tools as well as to implement a course programming project on design of a specified application based on neural networks and/or fuzzy rules systems. (Prerequisites: CSCI-630 or CSCI-331 or equivalent course.) **Lec/Lab 3, Credits 3 (Spring)**

CSCI-739 **Topics in Intelligent Systems**
This course examines current topics in Intelligent Systems. This is intended to allow faculty to pilot potential new graduate offerings. Specific course details (such as prerequisites, course topics, format, learning outcomes, assessment methods, and resource needs) will be determined by the faculty member(s) who propose a specific topics course in this area. Specific course instances will be identified as belonging to the Intelligent Systems cluster, the Computational Vision and Acoustics cluster, the Security cluster, or some combination of these three clusters. Course offered every other year. **Lec/Lab 3, Credits 3 (Fall)**

CSCI-740 **Programming Language Theory**
This course is an introduction to the formal study of programming languages, demonstrating important intellectual tools for the precise description of programming languages and investigating the essential features of programming languages using these tools. Topics include: dynamic semantics (such as operational semantics); static semantics (such as type systems); proofs by induction on structures and derivations; formal treatment of essential programming-language features (such as assignment, scope, functions, objects, and threads). Both written and programming assignments will be required. (Prerequisites: (CSCI-603 and CSCI-605 and CSCI-661) with grades of B or better or ((CSCI-262 or CSCI-263) and CSCI-344) or equivalent courses.) **Lec/Lab 3, Credits 3 (Fall)**

CSCI-742 **Compiler Construction**
This course discusses design and implementation of language processors and translators. Topics include lexical, syntactic, and semantic descriptions, algorithms for analysis tools, and programming techniques, as well as 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. (Prerequisites: (CSCI-603 and CSCI-605 and CSCI-661) with grades of B or better or ((CSCI-262 or CSCI-263) and CSCI-344) or equivalent courses.) **Lecture 3, Credits 3 (Spring)**

CSCI-746 **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 an important part of the course. Programming projects will be required. (Prerequisites: (CSCI-603 and CSCI-605 and CSCI-661) with grades of B or better or ((CSCI-262 or CSCI-263) and CSCI-344) or equivalent courses.) **Lecture 3, Credits 3 (Spring)**

CSCI-749 **Topics in Languages and Tools**
This course examines current topics in Languages and Tools. This is intended to allow faculty to pilot potential new graduate offerings. Specific course details (such as prerequisites, course topics, format, learning outcomes, assessment methods, and resource needs) will be determined by the faculty member(s) who propose a specific topics course in this area. Specific course instances will be identified as belonging to the Languages and Tools cluster, the Security cluster, or both clusters. **Lecture 3, Credits 3**

CSCI-759 **Topics in Systems**
This course examines current topics in Systems. This is intended to allow faculty to pilot potential new graduate offerings. Specific course details (such as prerequisites, course topics, format, learning outcomes, assessment methods, and resource needs) will be determined by the faculty member(s) who propose a specific topics course in this area. Specific course instances will be identified as belonging to the Distributed Systems cluster, the Architecture and Operating Systems cluster, the Security cluster, or some combination of these three clusters. **Lecture 3, Credits 3**

CSCI-761 **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 area. 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. (Prerequisites: CSCI-261 or CSCI-264 or CSCI-665 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

CSCI-762**Advanced Cryptography**

This course investigates advanced topics in cryptography. It begins with an overview of necessary background in algebra and number theory, private- and public-key cryptosystems, and basic signature schemes. The course will cover number theory and basic theory of Galois 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, and one or more of digital watermarking, fingerprinting and stenography. Programming will be required. (Prerequisites: CSCI-662 or CSCI-462 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

CSCI-769**Topics in Theory**

This course examines current topics in Theory. This is intended to allow faculty to pilot potential new graduate offerings. Specific course details (such as prerequisites, course topics, format, learning outcomes, assessment methods, and resource needs) will be determined by the faculty member(s) who propose a specific topics course in this area. Specific course instances will be identified as belonging to the Theory cluster, the Security cluster, or both clusters. **Seminar 3, Credits 3**

CSCI-787**Master's Thesis Proposal and Preparation**

Students work with a supervising faculty member to complete their MS thesis proposal, and do additional background preparation (e.g., programming, study, exercises, and analysis) for the subject area and specific problem(s) to be addressed in their thesis. By the end of the semester, a thesis proposal must be submitted and approved by the student's advisor and thesis committee. Additional deliverables as set by the advisor are also required (e.g., source code, bibliographies, notes, presentations, etc.). **Ind Study 1, Credits 3 (Fall, Spring, Summer)**

CSCI-788**Computer Science MS Project**

Project capstone of the master's degree program. Students select from a set of possible projects and confirm that they have a project adviser. Students enroll in a required colloquium component that meets weekly, during which they present information, related to their projects. Projects culminate with delivery of a final report and participation in a poster session open to the public. (Restricted to students in COMPSCI-MS and COMPSCI-BS/MS programs.) **Colloquium 3, Credits 3 (Fall, Spring, Summer)**

CSCI-788**Computer Science MS Project**

Project capstone of the master's degree program. Students select from a set of possible projects and confirm that they have a project adviser. Students enroll in a required colloquium component that meets weekly, during which they present information, related to their projects. Projects culminate with delivery of a final report and participation in a poster session open to the public. (Restricted to students in COMPSCI-MS and COMPSCI-BS/MS programs.) **Project 3, Credits 3 (Fall, Spring, Summer)**

CSCI-790**Computer Science MS Thesis**

Thesis capstone of the master's degree program. Student must submit an acceptable thesis proposal in order to enroll. It is expected that the work would lead to a paper of the caliber of those generally acceptable to a national conference. (Enrollment in this course requires permission from the department offering the course.) **Thesis, Credits 6 (Fall, Spring, Summer)**

CSCI-799**Computer Science Graduate Independent Study**

Students work with a supervising faculty member on topics of mutual interest. A student works with a potential faculty sponsor to draft a proposal that describes what a student plans to do, what deliverables are expected, how the student's work will be evaluated, and how much credit will be assigned for successful completion of the work. The faculty sponsor proposes the grade, but before the grade is officially recorded, the student must submit a final report that summarizes what was actually accomplished. (Enrollment in this course requires permission from the department offering the course.) **Ind Study, Credits 1 - 3 (Fall, Spring, Summer)**

CSCI-888**CS Graduate Summer Co-op**

Students perform professional work related to Computer Science for which they are paid. Students must complete a student co-op work report for each term for which they are registered; students are also evaluated each term by their employer. A satisfactory grade is given for co-op when both a completed student co-op work report and a completed, corresponding employer evaluation are received and when both documents are generally consistent. When registered for co-op, students are considered by RIT to have full-time status. In order to register for co-op for summer term, we expect that students will work a minimum of 10 weeks and work a minimum of 35 hours per week. Note: Co-op is an optional part of the MS in Computer Science degree. (Enrollment in this course requires permission from the department offering the course.) **CO OP, Credits 0 (Summer)**

CSCI-909**Proposal Development**

MS Students who are preparing for their capstone experience. (Enrollment in this course requires permission from the department offering the course.) **Research, Credits 0 (Fall, Spring, Summer)**

Computing and Information Sciences**CISC-807****Teaching Skills Workshop**

Teaching is a valuable and desirable skill for PhD students. This workshop course 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. Prerequisites: Limited to students in the Ph.D. program. Class 2, Credit 2 (F) (This course is restricted to students in the COMPIS-PHD program.) **Lecture 2, Credits 2 (Spring)**

CISC-810**Research Foundations**

This course provides students with the theoretical background and practical experience with a variety of research techniques and methods. The course provides an overview of the research process along with opportunities for hands-on projects. Major topics for the course include: formulating research questions, conducting literature reviews, selecting appropriate methodologies, data sampling, analyzing statistics, qualitative techniques, technical writing research papers, and presentation skills. (Knowledge in probability and statistics, or permission of instructor) (This course is restricted to students in the COMPIS-PHD program.) **Lecture 3, Credits 3 (Fall)**

CISC-820**Quantitative Foundations**

This course provides an introduction in the fundamentals of working with quantitative information. Topics include matrix algebra (matrices, vectors, direct and indirect methods for solving linear systems, eigenvectors, singular value decomposition, least-squares systems) optimization (convex analysis, gradient descent, Newton's method, interior-point methods), statistics (random variables, p-values, hypothesis testing, confidence intervals) and data exploration (clustering, dimensionality reduction, curve fitting). Note: Knowledge in probability and statistics calculus, and computer programming or permission of instructor is required. (This course is restricted to students in the COMPIS-PHD program.) **Lecture 3, Credits 3 (Fall)**

CISC-830**Cyberinfrastructure Foundations**

Cyberinfrastructure integrates all parts of large-scale computing including a set of software, services, and tools in order to solve large-scale computing problems. This course will give an overview of the problems and solutions of large-scale computing, e.g., Large Hadron Collider. Students will design and develop new tools for cyberinfrastructure. Presentations and written reports are required. Note: Knowledge in data structure and object-oriented design, or permission of instructor is required. (This class is restricted to students in the COMPIS-PHD program.) **Lecture 3, Credits 3 (Spring)**

CISC-835**Connectivity**

This course studies commonalities underlying a variety of networks including social networks, communication networks, biological networks, the Web, and even an abstract model of networks like graphs. Topics include basic graph theory, graph algorithms, fundamental and emerging concepts in networking, and the analytical and heuristic tools that people use to develop and analyze connectivity in networks. Computing and programming exercises will be required to provide hands-on experience with selected tools and technologies. Note: CSCI-651 or equivalent knowledge in concepts and principles of computer networks, or permission of instructor is required. (Prerequisites: CSCI-651 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

CISC-849**PhD Seminar**

Current advances in computing and information sciences. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall, Spring)**

CISC-860**Optimization Methods**

In this course, the basic knowledge and skills of optimization will be introduced. Students will learn how to recognize, formulate, and solve linear and nonlinear optimization problems. The concentration will be focused on the algorithms and applications, with the necessary theories presented in a comprehensive way. The characteristics of linear and nonlinear programming problems will be discussed with the corresponding solutions, such as the simplex method and Karmarkar's method for linear optimization, and Newton's method and Powell's method for nonlinear optimization. Students are required to complete a project on a given problem, or a problem of their own choices but approved by the course instructor, to gain practical experience. Note: Knowledge in linear algebra and calculus, experiences in computer programming/MATLAB, or permission of instructor is required. (This course is restricted to students in the COMPIS-PHD program.) **Lecture 3, Credits 3 (Fall)**

CISC-861

Numerical Methods

This course introduces the knowledge and skills of numerical methods. Numerical methods are the bases of computational analysis to approximate complicated formulations whose analytical solutions are unavailable or infeasible. Numerical methods provide computational algorithms to solve mathematical problems, for example, integration, differentiation, and large systems of linear or nonlinear equations. The course is focused on the algorithms and applications, presented with the rationales, benefits, and limitations so that students can choose the appropriate methods with the highest computational efficiency, stability, and accuracy based on the characteristics of the problems. Students are required to complete a project on a given problem, or a problem of their own choice but approved by the course instructor, to gain practical experience. Note: Knowledge in linear algebra and calculus, experiences in computer programming/MATLAB, or permission of instructor is required. (This course is restricted to students in the COMPIS-PHD program.) **Lecture 3, Credits 3 (Spring)**

CISC-862

Computational Modeling and Simulation

Everyone uses modeling and simulation even without being aware of it. This course talks about mathematical and computational modeling and simulation as the tools to solve complex problems in the real world. Topics are divided by the category of modeling method: phenomenological models vs. mechanistic models. For mechanistic models, the course will cover differential equations (including variational principle to construct the differential equations, solutions to ordinary differential equations (ODE), and classical ODE systems) and cellular automaton in detail, and mention other mechanistic models. Similarly, for phenomenological models, the course will cover regression and neural networks in detail, and introduce other phenomenological models such as networks and power-law distributions. In parallel, paper review and discussion will serve as case studies of modeling of real-world complex systems, illustrating application domains. Course projects are required. Note: Knowledge in probability and statistics, linear algebra and calculus, experiences in computer programming/MATLAB, or permission of instructor is required. (This course is restricted to students in the COMPIS-PHD program.) **Lecture 3, Credits 3 (Spring)**

CISC-863

Statistical Machine Learning

This course will cover the theory and practice of statistical machine learning, focusing on computational methods for supervised and unsupervised data analysis. Specific topics include Bayesian, maximizing a posteriori (MAP), and maximum likelihood (ML) parameter estimation, regularization and sparsity-promoting priors, kernel methods, adaptive basis function methods, the expectation maximization algorithm, Monte Carlo methods, variational methods, and models for data with temporal or hierarchical structure. Applications to regression, categorization, clustering, and dimensionality reduction problems are illustrated by examples. Each student will complete several problem sets, including both mathematical and computer implementation problems. Probability and Statistics I, Linear Algebra, and Introduction to Computer Programming. Familiarity with a numerical mathematics package (e.g. Matlab, Maple, Mathematica) is helpful but not required. (This course is restricted to students with graduate standing in GCCIS, KGCOE, or COS.) **Lecture 3, Credits 3 (Spring)**

CISC-864

Medical Imaging and Image Informatics: Principles and Algorithms

Tomographic medical images, along with computer-aided image processing and understanding methods, have been widely utilized in clinical practice for health evaluation and disease detection. This course focuses on the principles of medical imaging technology, i.e. physiological origins, data acquisition and image formation, as well as algorithmic strategies for quantitative understanding of various medical images. It provides students with a general physics-signal-system understanding of the medical imaging modalities. The course also addresses the clinical needs, the technical problems, and the rationales and strategies of quantitative image analysis. Current and potential clinical applications will be used as illustrations throughout the course. The course also strives to demonstrate the general process of conducting applied research, from problem finding through scientific analysis, solution proposal, implementation, experimentation and evaluation. Note: Knowledge in probability and statistics, linear algebra, calculus, and image processing/computer vision, experiences in computer programming or MAT/LAB, or permission of instructor is required. (This course is restricted to students in the COMPIS-PHD program.) **Lecture 3, Credits 3 (Spring)**

CISC-865

Deep Learning

Deep learning represents a set of emerging techniques in machine learning that has quickly become prevalent in the analysis of big data. The power and potential of this recent breakthrough in intelligent computer systems has been demonstrated through many successes. Deep learning systems are the current best performer in computer vision and speech processing. A wide variety of active researches are being conducted to leverage the capability of deep learning for achieving automation in areas such as autonomous driving, robotics, and automated medical diagnosis. There is a crucial need to educate our students on such new tools. This course gives an in-depth coverage of the advanced theories and methods in deep learning including basic feedforward neural networks, convolutional neural networks, recurrent neural networks including long short-term memory models, deep belief nets, and autoencoders. It will make an emphasis on approaches with practical relevance, and discusses a number of recent applications of deep networks applications in computer vision, natural language processing and reinforcement learning. (Prerequisites: CISC-863 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

CISC-866

Deep Learning for Visual Analytics

Deep learning is an area of machine learning that has enabled enormous progress on long-standing problems in visual analytics and machine perception. This course will start with a graduate-level introduction to deep learning, and review neural networks and related theory in machine learning that is needed to understand how deep learning algorithms work. After gaining the prerequisite background knowledge, the class will review the latest deep learning algorithms for computer vision and machine perception. Students will read and present recent papers on visual analytics topics, including eye tracking, image classification, video understanding, model explanation, etc. The course will make an emphasis on approaches with practical relevance, and prepare students to use state-of-the-art deep learning algorithms for processing and understanding highly structured data such as images, videos, and time-series. Students are expected to have programming experience and to be comfortable with probability, linear algebra and calculus. No prior background in machine learning or pattern recognition is required. (Prerequisites: CSCI-631 or equivalent course and graduate standing in the COMPIS-PHD program.) **Lecture 3, Credits 3 (Fall)**

CISC-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 advisor(s) in choosing an appropriate topic and activity. Note: Permission of the Ph.D. Director is required. (Enrollment in this course requires permission from the department offering the course.) **Thesis, Credits 1 - 32 (Fall, Spring, Summer)**

CISC-896

Colloquium in Computing and Information Sciences

This course develops the student's knowledge and understanding of various contemporary research issues, especially in the interdisciplinary areas of computing and information sciences. The student will get involved by attending a number of research presentations and discussions. The choice of topics considered may vary and will be determined by the instructor. (This course is restricted to students in the COMPIS-PHD program.) **Lecture, Credits 0 (Fall, Spring)**

CISC-897

PHD Research Co-op

This course provides an opportunity for PhD students to complete a formal internship in a business, industry, government, educational, or research setting. The internship provides students with the opportunity to gain familiarity with practical research problems and methods. Students gain experience working in collaborative research teams with a variety of researchers, focusing on problems of multiple scales, using techniques that go beyond those available at RIT. Note: Completion of Research Potential Assessment and adviser approval; permission of the Ph.D. Director are required. (Enrollment in this course requires permission from the department offering the course.) **CO OP, Credits 0 (Fall, Spring, Summer)**

CISC-899

Independent Study

PhD 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 PhD Director. Note: Permission of the instructor and PhD Director is required. (Enrollment in this course requires permission from the department offering the course.) **Lecture, Credits 1 - 6 (Fall, Spring, Summer)**

Computing Security

CSEC-600

Introduction to Computing Security

This is a graduate level introduction to the field of computing security. An extensive overview of various branches of computing security areas will be presented including concepts, issues, and tools that are critical in solving problems in computing security domain. Students will have opportunities to learn essential techniques in protecting systems and network infrastructures, analyzing and monitoring potential threats and attacks, devising and implementing security solutions for organizations large or small. **Lec/Lab 3, Credits 3 (Fall)**

CSEC-601

Research Methods and Proposal Development

Students in the graduate program not only learn skills, they also learn how to learn, including how to do research. This course covers the process of research: how to survey an area, how to formulate a research question, how to design a study and develop a well-supported solution, and finally, how to communicate, by writing a paper or proposal or by giving a formal talk. The course includes writing, presentations, and also basic statistics (design of experiments). Students are then exposed to problems in the field of computing security, in the form of invited talks from faculty; they are expected to explore the area, specify a problem, and develop a proposal for their Masters' project or Masters' thesis. The final deliverable of the course is a formal proposal with a timeline, signed by a faculty member who is willing to serve as the student's advisor. **Lecture 3, Credits 3 (Fall)**

CSEC-603**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. (This course is restricted to students in the COMPSEC-MS program.) **Lecture 3, Credits 3 (Spring)**

CSEC-604**Cryptography and Authentication**

In this course, students will gain in depth knowledge of cryptography and authentication. Students will explore various cryptographic algorithms and authentication protocols, focusing on their design and implementation. Students will also work on a research or implementation project, based on cryptographic algorithms and/or authentication protocols. The applications of cryptography and authentication in the areas of computer networks and systems will also be investigated. This course requires prior knowledge in Discrete Mathematics. (Prerequisites: (MATH-190 and BS/MS students in Computing Security) or students matriculated in the COMPSEC-MS program.) **Lecture 3, Credits 3 (Fall)**

CSEC-620**Cyber Analytics and Machine Learning**

The course provides students an opportunity to explore methods and applications in cyber analytics with advanced machine learning algorithms including deep learning. Students will learn how to use machine learning methods to solve cybersecurity problems such as network security, anomaly detection, malware analysis, etc. Students will also learn basic concepts and algorithms in machine learning such as clustering, neural networks, adversarial machine learning, etc. A key component of the course will be an independent exploratory project to solve a security program with machine learning algorithms. Students taking this course should have knowledge in Discrete Math, Probability and Statistics, and Linear Algebra. Students should also be able to program in Python. **Lecture 3, Credits 3 (Fall)**

CSEC-630**Trusted Computing and Trusted Execution**

This course covers some of the foundational technologies for establishing trust in modern computing systems, including classic methods (e.g., boot chain-of-trust, secure boot, exception/privilege levels, and Trusted Platform Modules - TPMs) and more recent trusted computing architectures such as ARM TrustZone and Intel Secure Guard eXtensions (SGX), which are increasingly popular and widely adopted in both academic research and industry. The latter part of the course will touch upon more advanced and research-oriented aspects in the intersection of trusted computing and various realms of Computing Security & Privacy. A key component of the course will be an exploratory research project aiming to use trusted computing technologies to address a security/privacy problem. To be successful in this course students should be knowledgeable in applied cryptography and basic security technologies. (Prerequisite: CSEC-604 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

CSEC-659**Seminar in Computing Security**

This course offers an opportunity to learn about a specific seminar topic in more depth. The course description will be replaced by the specific instance of the seminar, as it is proposed by faculty. **Lecture 3, Credits 3 (Fall, Spring)**

CSEC-669**Wireless Security**

The goal of this course is to provide the students with an understanding of the concepts and principles of wireless communications and networks along with their vulnerabilities and security protocols. In addition, the students will gain practical experience via a series of attack/defense lab activities, a literature review on a selected topic, and a hands-on software-defined radio project to explore mechanisms for analyzing and/or securing modern wireless networks. The course begins with a primer on wireless security concepts from a physical-layer perspective. It then covers various generations of security protocols for IEEE 802.11 (Wi-Fi) systems, security of cellular networks, security of wireless protocols for Internet-of-Things (IoT), security of connected vehicles communications, and other selected trending topics. (Prerequisites: CSEC-600 and (CSCI-462 or CSEC-604 or CSCI-662) or equivalent courses.) **Lab 2, Credits 3 (Summer)**

CSEC-669**Wireless Security**

The goal of this course is to provide the students with an understanding of the concepts and principles of wireless communications and networks along with their vulnerabilities and security protocols. In addition, the students will gain practical experience via a series of attack/defense lab activities, a literature review on a selected topic, and a hands-on software-defined radio project to explore mechanisms for analyzing and/or securing modern wireless networks. The course begins with a primer on wireless security concepts from a physical-layer perspective. It then covers various generations of security protocols for IEEE 802.11 (Wi-Fi) systems, security of cellular networks, security of wireless protocols for Internet-of-Things (IoT), security of connected vehicles communications, and other selected trending topics. (Prerequisites: CSEC-600 and (CSCI-462 or CSEC-604 or CSCI-662) or equivalent courses.) **Lecture 2, Credits 3 (Summer)**

CSEC-699**Graduate Co-op**

Students perform professional work related to the field of computing security for which they are paid. Students work full-time during the term for which they are registered. Students must complete a student co-op work report for each term for which they are registered; students are also evaluated each term by their employer. A satisfactory grade is given for co-op when both the student's work report and the employer evaluation have been completed. Co-op is an optional part of the MS in Computing Security degree. (Enrollment in this course requires permission from the department offering the course.) **CO OP, Credits 0 (Fall, Spring, Summer)**

CSEC-720**Deep Learning Security**

This course covers the intersection of cybersecurity and deep learning technologies such as CNNs, LSTMs, and GANs. Topics include the application of deep learning to traffic analysis, Deepfake detection, malware classification, fooling deep learning classifiers with adversarial examples, network attack prediction and modeling, poisoning attacks, and privacy attacks like model inversion and membership inference. Students will present research papers, perform several exercises to apply attack and defense techniques, and complete a final research project. Prior experience with machine learning concepts and implementation is required, but necessary details on deep learning will be covered. (Prerequisites: CSEC-620 or CSCI-630 or CSCI-631 or CSCI-635 or CMPE-677 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

CSEC-730**Advanced Computer Forensics**

This course provides students with the latest techniques and methods needed for extracting, preserving and analyzing volatile and nonvolatile information from digital devices. Students will gain exposure to the spectrum of available computer forensics tools along with developing their own tools for "special need" 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 platforms, under multiple file systems. Therefore, students must possess a knowledge of available filesystems on both platforms. (Prerequisites: CSEC-600 or NSSA-221 or equivalent course. This course is restricted to BS/MS students in Computing Security and students in the COMPSEC-MS program.) **Lecture 3, Credits 3 (Fall)**

CSEC-731**Web Server and Application Security Audits**

This course discusses the processes and procedures to perform a technical security audit of web servers and web based applications. Students will not only explore Web Servers and Applications/Services threats, but also apply the latest auditing techniques to identify vulnerabilities existing in or stemming from web servers and applications. Students will write and present their findings and recommendations in audit reports on web servers and application vulnerabilities. To be successful in this course students should be knowledgeable in a scripting language and comfortable with the administration of both Linux and Windows platforms. (Prerequisites: CSEC-600 or equivalent course. This course is restricted to BS/MS students in Computing Security and students in the COMPSEC-MS program.) **Lecture 3, Credits 3 (Spring)**

CSEC-732**Mobile Device Forensics**

Techniques and limitations related to the seizure and interrogation of a variety of digital devices will be explored. Various mobile phone and tablet platforms will be interrogated with the intent of gaining better access and understanding of the organization of data in the devices. The infusion of digital storage and identification devices such as MP3 players, RFID and tokens into our everyday lives requires the study of their weaknesses and forensic exploit-ability. As personal information is frequently gathered and stored on these devices, the loss of a device could adversely affect individuals and organizations. The examination, collection, and removal of such information will be studied. To be successful in this course students should be knowledgeable in basic networking, systems, and security technologies. (Prerequisites: This course is restricted to BS/MS students in Computing Security and students in the COMPSEC-MS program.) **Lecture 3, Credits 3 (Spring)**

CSEC-733**Information Security Risk Management**

This course will provide students with an introduction to the principle of risk management and its three key elements: risk analysis, risk assessment and vulnerability assessment. Students will also learn the differences between quantitative and qualitative risk assessment, and details of how security metrics can be modeled/monitored/controlled and how various types of qualitative risk assessment can be applied to the overall assessment process. Several industry case studies will be studied and discussed. Students will work together in teams to conduct risk assessments based on selected case studies or hypothetical scenarios. Finally, they will write and present their risk assessment reports and findings. (Prerequisites: This course is restricted to BS/MS students in Computing Security and students in the COMPSEC-MS program.) **Lecture 3, Credits 3 (Spring)**

CSEC-741

Internet of Things Security

As the world becomes more and more connected as ever before via various kinds of devices and systems on the Internet, called the Internet of Things (IoT), the associated security and privacy-related issues also become increasingly challenging. This course is designed for students who wish to advance their knowledge in the Internet of Things security. It provides students opportunities to explore security and privacy-related issues manifested by various kinds of IoT devices and systems such as sensors, sensor networks, SCADA systems, vehicular systems, consumer IoT devices, etc. (Prerequisites: CSEC-600 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

CSEC-742

Computer System Security

The importance of effective security policies and procedures coupled with experience and practice is emphasized and reinforced through research and practical assignments. Organization and management of security discipline and response to threats is studied. Case studies of effective and failed security planning and implementation will be examined and analyzed. The issues influencing proper and appropriate planning for security and response to attacks will be studied. To be successful in this course students should be knowledgeable in networking, systems, and security technologies. (Prerequisites: CSEC-600 or equivalent course. This course is restricted to BS/MS students in Computing Security and students in the COMPSEC-MS program.) **Lab 2, Credits 3 (Fall)**

CSEC-742

Computer System Security

The importance of effective security policies and procedures coupled with experience and practice is emphasized and reinforced through research and practical assignments. Organization and management of security discipline and response to threats is studied. Case studies of effective and failed security planning and implementation will be examined and analyzed. The issues influencing proper and appropriate planning for security and response to attacks will be studied. To be successful in this course students should be knowledgeable in networking, systems, and security technologies. (Prerequisites: CSEC-600 or equivalent course. This course is restricted to BS/MS students in Computing Security and students in the COMPSEC-MS program.) **Lecture 3, Credits 3 (Fall)**

CSEC-743

Computer Viruses and Malicious Software

Computer malware is a computer program with malicious intent. In this course, students will study the history of computer malware, categorizations of malware such as computer viruses, worms, Trojan horses, spyware, etc. Other topics include, but are not limited to, basic structures and functions of malware, malware delivery mechanism, propagation models, anti-malware software, its methods and applications, reverse engineering techniques. Students will conduct research to understand the current state of the computer malware defense and offense. (Prerequisites: CSEC-600 or equivalent course. This course is restricted to BS/MS students in Computing Security and students in the COMPSEC-MS program.) **Lec/Lab 3, Credits 3 (Fall, Summer)**

CSEC-744

Network Security

Students will examine the areas of intrusion detection, evidence collection, network auditing, network security policy design and implementation as well as preparation for and defense against attacks. The issues and facilities available to both the intruder and data network administrator will be examined and evaluated with appropriate laboratory exercises to illustrate their effect. The students will be provided with an understanding of the principles and concepts of wired and wireless data network security. Students will perform a series of laboratory or homework experiments in order to explore various mechanisms for securing data networks including physical layer mechanisms, filters, applications and encryption. Students will engage in attack/defense scenarios to test their deployments against other teams. Students should be knowledgeable in networking technologies. (Prerequisites: CSEC-600 or equivalent course. This course is restricted to BS/MS students in Computing Security and students in the COMPSEC-MS program.) **Lecture 3, Credits 3 (Spring)**

CSEC-750

Covert Communications

Students will be introduced to the history, theory, methodology and implementation of various kinds of covert communications. Students will explore future techniques and uses of covert communications in the management of botnets. To be successful in this course students should be knowledgeable in networking, systems, and security technologies. (Prerequisites: This course is restricted to BS/MS students in Computing Security and students in the COMPSEC-MS program.) **Lecture 3, Credits 3 (Fall)**

CSEC-751

Information Security Policy and Law

This course explores Information Security Policy development and deployment as well as laws (US and International) that impact information security. Students in this class will develop policies and analyze how policy impacts an organization. Students will also determine how federal, state, and international laws impact the information security policies of an organization. (Prerequisites: This course is restricted to BS/MS students in Computing Security and students in the COMPSEC-MS program.) **Lecture 3, Credits 3 (Fall)**

CSEC-759

Graduate Seminar in Computing Security

This course explores current topics in Computing Security. It is intended as a place holder course for faculty to experiment new course offerings in Computing Security undergraduate program. Course specific details change with respect to each specific focal area proposed by faculty. **Lec/Lab 3, Credits 3 (Fall, Spring)**

CSEC-769

Emerging Topics Wireless Security

This course focuses on security in current and emerging systems and protocols of the modern wireless ecosystems, aiming at advancing students' understanding of these systems while providing an insight into state-of-the-art wireless security research trends. The course covers a primer on wireless communications and introduces prominent wireless systems and their security protocols. Along with reviewing research approaches in wireless security, students then study and discuss several recent papers on current topics, including Wi-Fi and cellular networks security; physical-layer security; security of wireless protocols for IoT, connected vehicles, and GPS; and other selected topics. Students will also practice the steps of a research process by completing a small project, from critically reviewing the literature to evaluating a novel idea on a hardware testbed, and finally presenting their findings. (Prerequisites: CSEC-569 or CSEC-669 or CSEC-741 or EEEE-707 or ENGR-707 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

CSEC-790

MS Thesis

This course is one of the capstone options in the MS in Computing Security program. It offers students the opportunity to investigate a selected topic and make an original contribution which extends knowledge within the computing security domain. Students must submit an acceptable proposal to a thesis committee (chair, reader, and observer) before they may be registered by the department for the MS Thesis. Students must defend their work in an open thesis defense and complete a written report of their work before a pass/fail grade is awarded. As part of their original work, students are expected to write and submit an article for publication in a peer reviewed journal or conference. (Enrollment in this course requires permission from the department offering the course.) **Thesis, Credits 1 - 6 (Fall, Spring, Summer)**

CSEC-791

MS Project

This course is one of the capstone options in the MS in Computing Security program. It offers students the opportunity to investigate a selected topic within the computing security domain. A project involves some type of practical development with a deliverable. This may include development with computer equipment, software packages, and programming/scripting languages. Alternately, it may be the development and demonstration of an innovative process that addresses a current computing security issue or problem. Students must submit an acceptable proposal to a project committee (chair, and reader) before they may be registered by the department for the MS in CSEC Project. Students must defend their work in an open project defense and complete a written report of their work before a letter grade is awarded. A well-written professional report is required that details current thinking on the topic in the professional literature, the design and implementation of development that was done, and a critical evaluation of the results. (Enrollment in this course requires permission from the department offering the course.) **Project, Credits 1 - 3 (Fall, Spring, Summer)**

CSEC-793

Capstone for Computing Security

This course is one of the capstone options in the MS in Computing Security program. Students will apply their knowledge to solve real-world problems in the areas of computing security. Students will work on an individual semester-long project involving some type of practical development with a deliverable. This may include development with computer equipment, software packages, and programming or scripting languages. Alternately, it may be the development and demonstration of an innovative process that addresses a current computing security issue or problem. A well-written professional report is required that details current thinking on the topic in the professional literature, the design and implementation of development that was done, and a critical evaluation of the results. The students will also present their findings in an open forum. Students are expected to submit a short proposal before they can be enrolled in the class. (Enrollment in this course requires permission from the department offering the course.) **Lecture 3, Credits 3 (Spring)**

CSEC-799

Independent Study

The graduate independent study offers students the opportunity to investigate a topic not covered in an available course in the MS program in conjunction with a faculty sponsor. Working cooperatively, the faculty sponsor and the student draft a proposal of the work to be completed, the deliverables expected from the student, the number of credits assigned, and the means by which the student's work will be evaluated. The proposal must be approved by the graduate program director before a student can be registered for independent study. (Enrollment in this course requires permission from the department offering the course.) **Ind Study, Credits 1 - 3 (Fall, Spring, Summer)**

CSEC-909

Proposal Development

This course is part of a capstone experience for graduate students who are beginning the capstone experience. Students will submit an accepted proposal as a prerequisite for the formal thesis. (Enrollment in this course requires permission from the department offering the course.) **Research, Credits 0 (Fall, Spring, Summer)**

Data Science

DSCI-601

Applied Data Science I

This is the first of a two course applied data science seminar series. Students will be introduced to the data science masters program along with potential projects which they will develop over the course of this series in conjunction with the applied data science directed studies. Students will select a project along with an advisor and sponsor, develop a written proposal for their work, and investigate and write a related work survey to refine this proposal with their findings. Students will begin preliminary design and implementation of their project. Work will be presented in class for peer review with an emphasis on developing data science communication skills. This course will keep students up to date with the broad range of data science applications. (Prerequisites: SWEN-601 and DSCI-633 and STAT-614 or equivalent courses.) **Lecture 3, Credits 3 (Fall)**

DSCI-602

Applied Data Science II

This is the second of a three course applied data science seminar series. Students will design an implementation plan and preliminary documentation for their selected applied data science project, along with an in class presentation of this work. At the end of the semester students will present preliminary demos of their project and write a preliminary project report. Writing and presentations will be peer reviewed to further enhance data science communication skills. This course will keep students up to date with the broad range of data science applications. (Prerequisite: DSCI-601 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

DSCI-603

Applied Data Science III

This is the final course in the three course applied data science seminar series. Students will complete the implementation of their projects under guidance of their advisor and sponsor. Students will present a mid-term and final demo, and participate in a project poster session. Students will complete their final project report or thesis in the case of thesis track students. Peer reviews will be made of presentations, posters and final reports/theses for mastery of data science communication skills. This course will keep students up to date with the broad range of data science applications. (Prerequisites: DSCI-602 or equivalent course. Co-requisites: DSCI-682 or equivalent course.) **Lecture 1, Credits 1 (Fall)**

DSCI-623

Introduction to Data Science: Management

This course introduces students to the problems and issues in managing large sets of data, focusing on modeling, storing, searching, and transforming large collections of data for analysis. The course will cover database management and information retrieval systems, including relational database systems, massively parallel/distributed computation models (e.g., MapReduce/Hadoop) and various NoSQL (e.g., key-value, document, column, and graph) systems that are designed to handle extremely large-scale and complex data collections. Emphasis is placed on the application of large-scale data management techniques to particular domains. Programming projects are required. (Graduate Computing and Information Sciences) **Lecture 3, Credits 3 (Fall or Spring)**

DSCI-633

Foundations of Data Science and Analytics

A foundations course in data science, emphasizing both concepts and techniques. The course provides an overview of data analysis tasks and the associated challenges, spanning data pre-processing, model building, model evaluation, and visualization. The major areas of machine learning, such as unsupervised, semi-supervised and supervised learning are covered by data analysis techniques including classification, clustering, association analysis, anomaly detection, and statistical testing. The course includes a series of assignments utilizing practical datasets from diverse application domains, which are designed to reinforce the concepts and techniques covered in lectures. A substantial project related to one or more data sets culminates the course. (This course is restricted to DATASCI-MS, INFOST-MS, SOFTENG-MS, COMPSCI-MS, or COMPIS-PHD Major students.) **Lecture 3, Credits 3 (Fall, Spring)**

DSCI-640

Neural Networks

This course will cover modern and deep neural networks with a focus on how they can be correctly implemented and applied to a wide range of data types. It will cover the backpropagation algorithm and how it is used and extended for deep feedforward, recurrent and convolutional neural networks. An emphasis will be placed on the implementation, design, testing and training of neural networks. The course will also include an introduction to using a modern neural network framework. (Prerequisites: SWEN-601 or equivalent course.) **Lec/Lab 3, Credits 3 (Spring)**

DSCI-644

Software Engineering for Data Science

This course focuses on the software engineering challenges of building scalable and highly available big data software systems. Software design and development methodologies and available technologies addressing the major software aspects of a big data system including software architectures, application design patterns, different types of data models and data management, and deployment architectures will be covered in this course. (Prerequisites: SWEN-601 and DSCI-633 or equivalent courses.) **Lecture 3, Credits 3 (Spring)**

DSCI-650

High Performance Data Science

This course will cover concurrent, parallel and distributed programming paradigms and methodologies with a focus on implementing them for use in applied data science or scientific computing tasks. In particular, the course will focus on developing software using graphical processing units (GPUs) and the message passing interface (MPI); with an emphasis on properly handling large-scale, real-world data as part of these applications. The course will also teach scalability and load balancing techniques for developing efficient distributed systems. Programming assignments are required. (Graduate Computing and Information Sciences) **Lecture 3, Credits 3 (Fall)**

DSCI-681

Applied Data Science Directed Study I

This course provides an opportunity for a student to perform a research and/or development of an applied data science project under the supervision of a data science advisor and project sponsor, which will have been proposed and selected during the Applied Data Science I course. Students will have regular meetings with the project advisor and sponsors who will guide the students initial project design and development. (Co-requisites: DSCI-602 or equivalent course.) **Lecture 1, Credits 1 (Spring)**

DSCI-682

Applied Data Science Directed Study II

This course provides will have a student complete a research and/or development of an applied data science project under the supervision of an data science advisor and project sponsor, which will have been begun during the Applied Data Science II and Applied Data Science Directed Study I courses. Students will have regular meetings with the project advisor sponsors who will guide the students final project design, development and provide feedback on the student's final report or thesis. (Prerequisites: DSCI-681 or equivalent course. Co-requisites: DSCI-603 or equivalent course.) **Lecture 2, Credits 2 (Fall)**

DSCI-689

Topics in Data Science

This course will cover specialized topics in data science. Such topics are often emerging and not covered in other existing courses or are not covered in a manner that is appropriate for the student in this program. Graduate program standing and specific prerequisites will be noted for a specific special topic. (This course is restricted to DATASCI-MS Major students.) **Lecture 3, Credits 1 - 3 (Fall, Spring, Summer)**

DSCI-699

Graduate Co-op Experience

The main goal of this course is to provide a mechanism for graduate students to participate in co-op education, consisting of full-time paid employment in the discipline of Data Science. Co-op education enriches the graduate experience for many students, especially those who are transitioning to software engineering from another discipline or another domain. (Enrollment in this course requires permission from the department offering the course.) **CO OP, Credits 0 (Fall, Spring, Summer)**

DSCI-770

Data Science Masters Thesis

This course provides the student with an opportunity to develop a thesis project, and analyze and document the project in thesis document form. An in-depth study of a data science topic will be research focused, having built upon the thesis proposal developed prior to this course. The student is advised by their primary faculty advisor and committee. The thesis and thesis defense is presented for approval by the thesis advisor and committee. **Thesis 3, Credits 3 (Fall, Spring, Summer)**

DSCI-771

Continuation of Data Science Masters Thesis

This course provides the student with an opportunity to complete their thesis project after having enrolled in the data science thesis course (DSCI-770), if extra time if needed. The student continues to work closely with his/her advisor and thesis committee. **Cont 3, Credits 0 - 1 (Fall, Spring, Summer)**

DSCI-781

Continuation of Capstone

This course provides the student with an opportunity to complete their capstone project, if extra time is needed after enrollment in the on campus capstone courses DSCI-601 and DSCI-602 (Applied Data Science I and II) or the online capstone course DSCI-799 (Graduate Capstone). The student continues to work closely with his/her advisor to complete their project. (Prerequisite: DSCI-602 or DSCI-799 or equivalent course.) **Project 1, Credits 0 - 1 (Fall, Spring, Summer)**

DSCI-789

Advanced Topics in Data Science

This course will cover advanced specialized topics data science. Such topics are may be emerging and advanced. Specific prerequisites will be noted for each specific special topic. (This course is restricted to DATASCI-MS Major students.) **Lecture 3, Credits 1 - 3 (Fall, Spring, Summer)**

DSCI-790

Independent Study

This course provides the graduate student an opportunity to explore an aspect of data science independently and in depth, under the direction of an advisor. The student selects a topic and then works with a faculty member to describe the value of the work and the deliverables. (This course is restricted to DATASCI-MS Major students.) **Ind Study, Credits 1 - 3 (Fall, Spring, Summer)**

DSCI-799

Graduate Capstone

This non-class-based experience provides the student with an individual opportunity to explore a project-based or a research-based project that advances knowledge in an area of data science. The student selects a problem, conducts background research, develops the system or devises a research approach, analyses the results, and builds a professional document and presentation that disseminates the project. The report must include a literature review. The final report structure is to be determined by the capstone advisor. **Ind Study, Credits 3 - 6 (Fall, Spring, Summer)**

Human Computer Interaction

HCIN-600

Research Methods

This course provides students with an introduction to the practical application of various research methods that can be used in human computer interaction. The course provides an overview of the research process and the literature review, and provides experience with qualitative, survey, and experimental research methods. Students will study existing research and design and conduct studies. Students will need to have taken a statistics course before registering for this class. (Prerequisites: DECS-782 or STAT-145 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

HCIN-610

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 human use and with the study of major phenomena surrounding them. This course surveys the scope of issues and foundations of the HCI field: cognitive psychology, human factors, interaction styles, user analysis, task analysis, interaction design methods and techniques, and evaluation. This course will focus on the users and their tasks. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall, Spring)**

HCIN-620

Information and Interaction Design

Designing meaningful relationships among people and the products they use is both an art and a science. This course will focus on the unique design practice of: representing and organizing information in such a way as to facilitate perception and understanding (information architecture); and, specifying the appropriate mechanisms for accessing and manipulating task information (interaction design). This course will also explore the various design patterns (design solutions to particular problems) that are appropriate for the HCI professional. Students will need prior knowledge of an interface prototyping tool. (Prerequisite: ISTE-200 or equivalent course.Co-requisite: HCIN-610 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

HCIN-630

Usability Testing

This project-based course will focus on the formal evaluation of products. 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. (Prerequisites: HCIN-600 and HCIN-610 or equivalent courses.) **Lecture 3, Credits 3 (Spring, Summer)**

HCIN-636

Interactive Programming

This course teaches students how to program interactive components to create user interfaces and information visualization systems. Students will work with data, information, animation, and digital media to create interactive applications. Students will be introduced to visual layout and design concepts. Programming is required. Students will need to have taken one year of programming in a high-level language to be successful in this course. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lec/Lab 3, Credits 3 (Fall)**

HCIN-660

Fundamentals of Instructional Technology

Instructional Technology encompasses the basic processes for developing and delivering instruction. Instructional Systems Design (ISD) is a well-established methodology for describing knowledge and skills and developing instructional systems to effectively conveying knowledge. This course enables the student to be able to plan, organize, and systematically develop instructional materials. The course uses an ISD model to analyze, design, deliver, and evaluate instruction. **Lecture 3, Credits 3 (Fall)**

HCIN-661

Interactive Courseware

Computer software that teaches is referred to as courseware. This course is a continuation of HCIN-660 that transitions from general instructional design into the actual application of these principles in a computer-based environment. Although the basic principles of instructional design hold true in all media environments, 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. Successful students should have one year of object-oriented programming. (Prerequisites: HCIN-660 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

HCIN-662

Research in Accessibility

Students will dive into cutting edge research in the field of computer accessibility and assistive technology; they will read, present, and discuss research literature from major conferences and journals in the field. Students will learn about recent developments and ongoing research efforts in accessibility, and they will learn how to synthesize the results from research publications. Students will learn how to identify high quality research and how to critique this work to identify areas for improvement or future research directions. Students will learn the elements of a high-quality research publication, and they will explore and gain expertise in a particular topic in the field of accessibility in depth. (Prerequisites: HCIN-600 or equivalent course.) **Lecture 3, Credits 3 (Biannual)**

HCIN-663

Access and Assistive Technology

Students will gain hands-on experience and knowledge about a wide variety of accessibility and assistive technology available for people with disabilities. Students will understand the design principles underlying this technology and how the features and capabilities of assistive technology can be tailored to a particular individual's needs and capabilities. Students will learn about how new technologies and research in accessibility can be made available for users, and they will learn how to design websites and software that work effectively with a user's own technology. Specific technologies discussed in the course may include, e.g.: alternative input devices, communication devices, and screen readers and magnifiers for people with visual impairments. (Prerequisites: HCIN-630 or equivalent course.) **Lecture 3, Credits 3 (Biannual)**

HCIN-700

Current Topics in HCI

Human-Computer Interaction (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. **Lecture 3, Credits 3 (Spring)**

HCIN-705

Topics in HCI for Biomedical Informatics

This course will provide a theoretical and case-based study of several areas of HCI, all considered within the application domain of biomedical informatics. 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. (Prerequisites: HCIN-610 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

HCIN-715

Agent-Based and Cognitive Modeling

This course is intended as an introduction to the emerging areas of agent-based modeling and cognitive modeling. Both modeling approaches are 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 and the development and testing of cognitive models. The role of visualization in 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. (Prerequisites: HCIN-600 or equivalent course.) **Lec/Lab 3, Credits 3 (Spring)**

HCIN-720

Prototyping Wearable and Internet of Things Devices

Wearable computers and Internet of Things devices involve both hardware and software. In order to design user experiences for these systems, professionals must understand how they are built. Students will learn how to rapidly prototype and evaluate wearable and IoT devices combining hardware and software. Experience in programming is helpful but not a prerequisite. **Lecture 3, Credits 3 (Fall)**

HCIN-722 Human-Computer Interaction with Mobile, Wearable, and Ubiquitous Devices

Mobile phones are now a major computing platform, and wearable and Internet of Things devices are emerging as major technologies. Each device offers different interaction opportunities and challenges. Students will learn about the research in interaction with these devices and how to design effective interactions for mobile, wearable, and ubiquitous devices. (Prerequisites: HCIN-610 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

HCIN-730

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, attributes and process of the major design methodologies. Software design projects will be required. (Prerequisites: HCIN-610 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

HCIN-735

Collaboration, Technology, and the Human Experience

Students will examine the role of technology and group collaboration in organizations. An overview of relevant theory, current and emergent technologies, and trends in collaborative science will provide the context for strategic implementation and development of collaborative environments. Group projects using collaborative technologies will be required. (Prerequisites: HCIN-600 and HCIN-610 or equivalent courses.) **Lecture 3, Credits 3 (Spring)**

HCIN-794**MS Human Computer Interaction Capstone Proposal**

In this course, students will design a proposal for a capstone project to apply the theories and methodologies to a problem in the HCI domain. Students working through the guidance of the instructor, will investigate a problem space, perform a literature review, develop the problem statement, write a proposal for how they intend to design and implement a solution, and communicate the proposal to potential capstone committee members. (Prerequisites: HCIN-600 and HCIN-610 or equivalent courses.) **Lecture 3, Credits 3 (Fall, Spring)**

HCIN-795**MS HCI Project**

In this course, students will apply the theories and methodologies to the investigation of a problem in the HCI domain. Students who have already prepared a proposal for their capstone project, will design and implement a solution to a problem, and communicate the results. (Prerequisites: HCIN-794 or equivalent course.) **Project 4, Credits 1 - 4 (Fall, Spring, Summer)**

HCIN-796**MS HCI Thesis**

Students electing a research capstone experience will work closely with an adviser on a current research project or one self-developed and guided by the adviser. Permission of the capstone committee and the graduate program director is required. (Enrollment in this course requires permission from the department offering the course.) **Thesis, Credits 1 - 6 (Fall, Spring, Summer)**

HCIN-797**MS HCI Directed Final Project**

This course provides students with the skills to develop a plan and execute a project in the field of human-computer interaction. Emphasis is placed on the student applying skills and knowledge gained previously throughout their HCI master's degree program. Students will select a topic from a set of recommendations provided by the instructor, formulate a detailed plan for the execution of this project, provide deliverables for key milestones throughout the semester, and present their work in a professionally appropriate manner, e.g. via a written report, video, or other forms that are suitable for dissemination in a professional user-experience portfolio. The goal of this course is for students to gain experience how to employ methodologies and skills from the field of human-computer interaction appropriately as part of an extended final project that serves as a culminating experience for their master's degree program. This course is only an option for students who are registered as online students. (Enrollment in this course requires permission from the department offering the course.) **Project 3, Credits 3 (Fall, Spring)**

HCIN-909**Proposal Development**

This course is part of a capstone experience for graduate students who are just beginning the thesis topic development process. Students must submit an accepted proposal as a prerequisite for formal thesis work. Requires permission of the program director for enrollment. (Enrollment in this course requires permission from the department offering the course.) **Research, Credits 0 (Fall, Spring, Summer)**

Information Sciences and Technologies

ISTE-600**Foundations of Data Mining**

This course provides students with exposure to foundational data mining techniques. Topics include analytical thinking techniques and methods, data/exploring data, classification algorithms, association rule mining, cluster analysis and anomaly detection. Students will work individually and in groups on assignments and case study analyses. (Prerequisite: ISTE-200 and (DECS-782 or STAT-145) or equivalent courses.) **Lec/Lab 3, Credits 3 (Fall, Spring)**

ISTE-605**Scholarship in Information Technology and Analytics**

ITA graduate students are expected to make a scholarly contribution as a requirement for the MS degree. The Scholarship in Information Technology and Analytics course provides students with the fundamental skills needed to define and conduct a program of scholarly investigation in the form of a capstone or thesis project. The course focuses on skills such as academic writing, searching the literature, identifying and articulating interesting and important topics and problems, scholarship ethics, developing capstone proposals, critical thinking, and effective oral and written communication and presentation of scholarship. (This course is restricted to INFOST-MS, INFOTEC-MS and NETSYS-MS students.) **Lecture 3, Credits 3 (Fall, Spring, Summer)**

ISTE-608**Database Design and Implementation**

An introduction to the theory and practice of designing and implementing database systems. Current software environments are used to explore effective database design and implementation concepts and strategies. Topics include conceptual data modeling, methodologies, logical/physical database design, normalization, relational algebra, schema creation and data manipulation, and transaction design. Database design and implementation projects are required. **Lec/Lab 4, Credits 3 (Fall, Spring)**

ISTE-610**Non-Relational Data Management**

This course provides students with exposure to foundational information sciences and technologies. Topics include an overview of data types, structuring and processing data and knowledge, data transformation, and data storage and warehousing. Students will work with non-traditional (noSQL) data stores to manage large datasets in the context of specific problem scenarios. (Prerequisites: ISTE-608 or DSCI-623 or CSCI-620 or equivalent course.) **Lec/Lab 3, Credits 3 (Fall, Spring)**

ISTE-612**Information Retrieval and Text Mining**

This is the second course in a two-course sequence that provides students with exposure to foundational information sciences and technologies. Topics include internet middleware technologies, data and text analytics, and information visualization. Note: One year of programming in an object-oriented language, a database theory course, a course in Web development, and a statistics course is needed. (Prerequisites: ISTE-608 and (DECS-782 or STAT-145 or STAT-614) or equivalent courses.) **Lec/Lab 3, Credits 3 (Fa/sp/su)**

ISTE-645**Foundations of Web Technologies I**

This class provides an introduction to internet and web technologies. Topics include an introduction to the internet and basic internet technologies (including, but not limited to: SSH, SFTP, UNIX, XHTML, CSS, Client-Side programming, and website publishing). **Lec/Lab 3, Credits 3 (Fall)**

ISTE-646**Foundations of Web Technologies II**

This course builds on the basic aspects of web page development that are presented in the first course and extends that knowledge to focus on issues and technologies related to the design and development of web sites. Topics include advanced internet technologies (including, but not limited to: AJAX, server-side programming, database use and access, client libraries, server frameworks, and creating and consuming information services). (Prerequisites: ISTE-645 or equivalent course.) **Lec/Lab 3, Credits 3 (Spring)**

ISTE-661**Data Analytics for Smart Cities**

Within the city framework, information technologies are a key for providing new services and applications that contribute to success. This course examines a cross-section of information and computing technologies that can best contribute to city sciences. Students will learn of the concept of the Internet of Things, geographic information systems (GIS), ubiquitous computing, and wearable interfaces as they relate to future cities. Additionally students will look at existing technologies in environmental sensing for monitoring and improving cities. This course is only offered at RIT Dubai campus. **Lecture 3, Credits 3 (Fall, Spring)**

ISTE-662**Technology Infrastructure for Smart Cities**

The thinking within modern cities has changed dramatically in the past decade with the emergence of information and communication technologies (ICT). Previously, the existence of useful infrastructure was considered to be a beneficial but not essential factor in influencing development. Presently, a modern, flexible infrastructure is considered to be a requirement for any modern city. Its absence is a sign of underdevelopment. This course presents current and future ICT development along with techno-economic deployment scenarios and provides breadth in understanding the limits and potential of information and communication technologies. This course is only offered at RIT Dubai campus. **Lecture 3, Credits 3 (Fall, Spring)**

ISTE-690**School of Information Graduate Seminar**

This iSchool seminar course provides an opportunity for special one-time offerings of graduate topics or allows faculty to pilot possible 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 seminar offering. (Graduate standing with topic-specific prerequisites as appropriate) (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture, Credits 1 - 4 (Fall, Spring, Summer)**

ISTE-699**Graduate Co-op**

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 is required. (Graduate standing with the IST department, and prerequisites plus at least 12 credits completed with a 3.0 GPA or better) (Enrollment in this course requires permission from the department offering the course.) **CO OP, Credits 0 (Fall, Spring, Summer)**

ISTE-721 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. The application of computing technologies, procedures and policies and the activities necessary to detect, document, and counter unauthorized data and system access will be explored. Effective implementation will be discussed and include topics from other fields such as management science, security engineering and criminology. A broad understanding of this subject is important for computing students who are involved in the architecting and creation of information and will include current software exploitation issues and techniques for information assurance. **Lec/Lab 3, Credits 3 (Spring)**

ISTE-722 Database Connectivity and Access

In this course, students will build applications that interact with databases. Through programming exercises, students will work with multiple databases and programmatically invoke the advanced database processing operations that are integral to contemporary computing applications. Students will examine and evaluate alternative approaches for each of these operations. Topics include the database drivers, the data layer, connectivity operations, security and integrity, and controlling database access. (Prerequisites: ISTE-608 or equivalent course.) **Lec/Lab 3, Credits 3 (Fall)**

ISTE-724 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 analysis, 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. (Prerequisites: ISTE-608 or equivalent course.) **Lec/Lab 3, Credits 3 (Fall, Spring)**

ISTE-726 Database Management and Access

Students will be introduced to issues in client/server database implementation and administration. Students will configure, test, and establish client-server communication and server-server communication with single and multiple database servers. Topics such as schema implementation, storage allocation and management, user creation and access security, backup and recovery, and performance measurement and enhancement will be presented in lecture and experienced in a laboratory environment. Students will configure and demonstrate successful communication between a database file server and multiple clients. (Prerequisites: ISTE-608 or equivalent course.) **Lec/Lab 3, Credits 3 (Spring)**

ISTE-728 Database Management and Access II

Students will explore the theory and application of advances database administration including database performance monitoring and tuning techniques. Standard topics in DBMS performance will be discussed including: physical and logical design issues, the hardware and software environment, SQL statement execution, indexes and front-end application issues. Techniques in performance monitoring and tuning will be investigated. In addition, advanced database backup and recovery, disaster recovery and other DBA topics will be explored. (Prerequisites: ISTE-726 or equivalent course.) **Lec/Lab 4, Credits 3 (Fall)**

ISTE-730 Foundations of IoT

Internet of Things (IoT) refers to physical and virtual objects that are connected to the Internet to provide intelligent services for energy management, logistics, retail, agriculture and many other domains. IoT leverages sensors, wireless communication, mobile devices, networking and cloud technologies to create many smart applications. In this course, the students learn about IoT design and development methodologies that enable the development of IoT applications. The students have hands-on opportunities to program and build IoT prototypes through lab assignments and a course project. The students should have some programming knowledge and required to purchase a IoT kit. (This course is restricted to students in INFOST-MS.) **Lecture 3, Credits 3 (Spring)**

ISTE-732 IoT Analytics

IoT is simply interconnected devices that generate and exchange data from observations, facts, and other data, making it available to anyone. This includes devices that generate data from sensors, smart phones, appliances, and home network devices. IoT solutions are designed to make our knowledge of the world around us more aware and relevant, making it possible to get data about anything from anywhere at any time. This course teaches how IoT data could help and execute data driven operational and business decisions. The students learn how IoT analytics can create adaptive business and operational decisions in intelligent, effective and efficient ways. First, this course provides students with an understanding of different types of IoT data and the knowledge of how to handle the data relate to IoT. Then, the students learn how to create and setup a cloud analytic environment, exploring IoT data. The course also teaches how to apply analytics and statistics to extract value from the data. Lastly, the course explores different use-cases for IoT data. Purchasing a IoT kit is required. (This course is restricted to INFOST-MS or HUMCOMP-MS or DATASCI-MS students.) **Lec/Lab 3, Credits 3 (Fall)**

ISTE-740 Geographic Information Science and Technology

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 & 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 & T theory, concepts, and research trends such as spatial reasoning, spatio-temporal data representation, and spatial analysis. **Lec/Lab 3, Credits 3 (Fall)**

ISTE-742 Introduction To Geographic Information Systems

This course introduces students to the world of Geographic Information Systems (GIS). Course lectures, reading assignments, and practical lab experiences will cover a mix of conceptual, practical and technical GIS topics. Topics include GIS data models, basic cartography, geodatabases, spatial analysis, GIS software, and theory and concepts from the Geographic Information Science and Technology domain. **Lec/Lab 3, Credits 3 (Spring)**

ISTE-744 Thematic Cartography and Geographic Visualization

This course examines concepts and techniques associated with dynamic map construction, usage, and assessment. Specific topics include thematic cartography, geographic information visualization, sources of dynamic geographic information, developing animated and interactive maps, mapping mashup development, using maps as a means to support group work, usability of dynamic maps, and current geovisualization research areas. Development of a visualization prototype and an associated scholarly paper in an area related to thematic cartography and geographic visualization are required. **Lec/Lab 3, Credits 3 (Spring)**

ISTE-750 Internet Middleware Design and Implementation

This course provides students with an introduction to the design and implementation of Internet middleware application programming interfaces (APIs) and services. Topics include the blending of interactive and dynamic content from multiple servers and services utilizing data from heterogeneous sources, with a strong design focus on the needs of client software and human users which will utilize those services. Provides a practical and theoretical basis for the design and implementation of APIs and middleware, and for the design and development of custom servers and services built on top of existing frameworks (such as Apache/PHP). Emphasis is placed on fundamentals, concepts and standards. Exercises, programming, and projects are required. (Prerequisites: ISTE-612 or equivalent course and graduate standing in INFOST-MS or INFOTEC-MS.) **Lec/Lab 3, Credits 3 (Fall)**

ISTE-754 Client Design and Development

This course will explore the analysis, design, development, and implementation of client-side programming in the context of Internet technologies, mobile devices, and Web-based client systems. Students will learn to design and build usable and effective interactive systems, clients, and interfaces. Key features addressed will include browser and platform compatibility, object reusability, bandwidth and communications issues, development environments, privacy and security, and related technologies and APIs. Programming is required. (Prerequisites: ISTE-200 and ISTE-140 or equivalent courses.) **Lec/Lab 3, Credits 3 (Fall, Spring)**

ISTE-756 Server Design and Development

This course provides students with advanced work in the design and implementation of highly-scalable server-side applications, and application programming interfaces (APIs). Topics include the effects of client requirements upon design, creating and blending heterogeneous data for analysis and visualization, and approaches to building highly-scalable services. Students will develop dynamic, data centric web systems, as well as building information services systems that are independent of the technologies that use them. Students will implement their own servers and services using programming languages. Exercises, programming, and projects are required. (Prerequisites: ISTE-754 or equivalent course.) **Lec/Lab 3, Credits 3 (Spring)**

ISTE-758 Semantic Web Technologies

This course provides students with an in-depth introduction to Semantic Web technologies, utilizing ontologies and relationship metadata. Topics include the creation of data linkage through metadata, practical approaches to the design and implementation of ontologies, server- and client-side parsing and transformation of data and ontologies, and machine interpretation of relationships. Emphasis is placed on fundamentals, concepts and standards. Exercises, programming, and projects are required. (Prerequisites: ISTE-610 and ISTE-612 or equivalent courses and graduate standing in the INFOTEC-MS program.) **Lec/Lab 3, Credits 3 (Fall)**

ISTE-759 Secure Web Application Development

When building larger-scale web applications, there are a myriad of concerns that range from technology, security, framework, and architecture selection to runtime performance optimization. This course focuses on the development of secure integrated web applications that consume information served from one or many sources. Trends in web application development are identified and assessed. Programming projects are required. (Prerequisites: ISTE-756 or equivalent course.) **Lec/Lab 3, Credits 3 (Fall)**

ISTE-760**Design, Development, and Deployment of Applications**

What's the difference between writing an application for a school project and writing an application for mass marketing? What makes an application production-ready? In this course we will look at several factors that must be considered including help systems, installation routines, code design, and error handling. Students will need to have had one year of programming in a high-level language to be successful in this course. **Lec/Lab 3, Credits 3 (Fall)**

ISTE-762**Software Economics**

In addition to developing software using an organization's own software development staff, new approaches for the acquisition of software systems continue to emerge and to be adopted. This course provides students with the necessary foundational knowledge to compare, evaluate, and assess, from financial and economic perspectives, the alternatives for developing or acquiring software systems. Topics include motivations for studying software economics, basic financial and economic concepts, measurements of software development productivity and software quality, software development cost estimation models, modeling software development and deployment activities, and acquisition alternatives such as open source, purchase, lease, cloud, and outsourcing. (This course is restricted to students in INFOST-MS or INFOTEC-MS.) **Lecture 3, Credits 3 (Spring)**

ISTE-764**Project Management**

Information technology projects require the application of sound project management principles in order to be developed on time, on budget, and on specification. This course takes students through the nine knowledge areas of modern project management and the utilization of project management principles in both traditional and agile environments. **Lecture 3, Credits 3 (Fall)**

ISTE-773**XML Transformation and Presentation**

This course will explore techniques and technologies for transforming XML documents using XSLT and XSL-FO or other frameworks. 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 XSLT. Students will implement projects to present XML data using a variety of transformation tools and technologies. (Prerequisites: ISTE-610 or equivalent course.) **Lec/Lab 3, Credits 3 (Fall, Spring)**

ISTE-774**Mobile Application Development I**

This course extends the material covered in the Foundations of Mobile Design course and provides students with individual and team-based experience of creating interesting native applications for small-size form factor mobile devices such as smartphones using one of the major platforms. These devices are exceptionally portable, have unique sets of hardware and communications capabilities, incorporate novel interfaces, are location aware, and provide persistent connectivity. Students are encouraged to make creative use of these unique device characteristics and operating properties to develop innovative applications including inter-device communications. Programming projects are required. (Prerequisites: IGME-770 or equivalent course.) **Lec/Lab 3, Credits 3 (Spring)**

ISTE-776**Mobile Application Development II**

This course extends the Foundations of Mobile Design course in that students will learn to apply mobile design skills to develop applications in the Android platform. Students will design, develop, and test mobile applications using the Android Studio IDE. This course covers the major components such as activities, receivers, content providers, permissions, intents, fragments, data storage, and security. Programming projects are required. (Prerequisites: IGME-770 or equivalent course.) **Lec/Lab 3, Credits 3 (Fall)**

ISTE-780**Data Driven Knowledge Discovery**

Rapidly expanding collections of data from all areas of society are becoming available in digital form. Computer-based methods are available to facilitate discovering new information and knowledge that is embedded in these collections of data. This course provides students with an introduction to the use of these data analytic methods, with a focus on statistical learning models, within the context of the data-driven knowledge discovery process. Topics include motivations for data-driven discovery, sources of discoverable knowledge (e.g., data, text, the web, maps), data selection and retrieval, data transformation, computer-based methods for data-driven discovery, and interpretation of results. Emphasis is placed on the application of knowledge discovery methods to specific domains. (Prerequisite: DSCI-633 or equivalent course.) **Lec/Lab 3, Credits 3 (Fall, Summer)**

ISTE-782**Visual Analytics**

This course introduces students to Visual Analytics, or the science of analytical reasoning facilitated by interactive visual interfaces. Course lectures, reading assignments, and practical lab experiences will cover a mix of theoretical and technical Visual Analytics topics. Topics include analytical reasoning, human cognition and perception of visual information, visual representation and interaction technologies, data representation and transformation, production, presentation, and dissemination of analytic process results, and Visual Analytic case studies and applications. Furthermore, students will learn relevant Visual Analytics research trends such as Space, Time, and Multivariate Analytics and Extreme Scale Visual Analytics. **Lec/Lab 3, Credits 3 (Spring)**

ISTE-790**Thesis in Information Technology and Analytics**

The thesis capstone experience for the Master of Science in Information Technology and Analytics program. Students must submit an approved capstone proposal in order to enroll. (Permission of capstone committee and graduate coordinator). (Enrollment in this course requires permission from the department offering the course.) **Thesis, Credits 1 - 6 (Fall, Spring, Summer)**

ISTE-791**Project in Information Technology and Analytics**

The project-based culminating experience for the Master of Science in Information Technology and Analytics program. A MS project will typically include a software system development component requiring a substantial and sustained level of effort. Students must submit an approved project proposal in order to enroll. (Permission of project committee and graduate program director). (Enrollment in this course requires permission from the department offering the course.) **Project, Credits 1 - 4 (Fall, Spring, Summer)**

ISTE-792**Capstone Guidance Colloquium**

This course supports the proposal development process for graduate students enrolled in the MS in information sciences and technologies, the MS in networking and system administration, or the MS in human-computer interaction program who are beginning the project or thesis experience and require additional structure and support. Students begin the development of an acceptable proposal and through weekly meetings students are guided toward the completion of the proposal, which is a prerequisite for formal thesis or project registration. Note: Students must have completed all their course work prior to enrollment which is by permission of the graduate program director. **Lecture 1, Credits 1 (Fall, Spring)**

ISTE-795**Capstone in Information Sciences and Technologies**

This is the project-based capstone course for the master of science in information sciences and technologies program. Students work in teams to complete a substantial, integrative large scale system development projects. Submission of a project proposal, a formal set of development artifacts, a final project report, and a public defense with system demonstration are required. (Enrollment in this course requires permission from the department offering the course.) **Lec/Lab 2, Credits 3 (Fall, Spring)**

ISTE-798**Graduate Seminar in Information Sciences and Technologies**

This IST seminar course provides an opportunity for special one-time offerings of graduate topics or allows faculty to pilot possible 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 seminar offering. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lec/Lab 3, Credits 3 (Fall, Spring, Summer)**

ISTE-799**Independent Study**

The student will work independently, under the supervision of one or more faculty advisers, on a topic of mutual interest that is beyond the depth of or not covered in other courses. (Enrollment in this course requires permission from the department offering the course.) **Ind Study, Credits 3 (Fall, Spring, Summer)**

ISTE-909**Proposal Development**

This course supports the proposal development process for graduate students who are beginning the thesis experience. Students begin the development of an accepted proposal as a prerequisite for formal thesis registration. (Enrollment in this course requires permission from the department offering the course.) **Research, Credits 0 (Fall, Spring, Summer)**

Interactive Games and Media

IGME-601**Game Development Processes**

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 technical development, content development, testing, deployment, and maintenance. Students will explore the design process through the deconstruction of the game industry's software lifecycle model. (This course is restricted to students in the GAMEDES-MS program.) **Lec/Lab 3, Credits 3 (Fall)**

IGME-602**Game Design**

This course presents students with core theories of game design, informed by research results from media theory, narrative methods and models, theories of ideation, and the nature of games, play and fun. Specific emphasis is placed on the examination of historical successes and failures, along with presentation of ethical and cultural issues related to the design of interactive software. Students will engage in formal critique and analysis of media designs and their formal elements. (This course is restricted to students in the GAMEDES-MS program.) **Lec/Lab 3, Credits 3 (Fall)**

IGME-603

Gameplay and Prototyping

This course explores the pragmatic issues of creative concept development through story-boarding, pitching, prototyping and play-testing. Students will use various tools and techniques to build game prototypes that they will evaluate through play-testing in an incremental design process informed by market research and analysis. (This course is restricted to students in the GAMEDES-MS program.) **Lec/Lab 3, Credits 3 (Fall)**

IGME-609

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. (Prerequisites: VCDE-709 or equivalent course and graduate standing in VISCOM-MFA.) **Lec/Lab 3, Credits 3 (Spring)**

IGME-621

Board and Card Game Design and Development

This course explores issues pertaining to design, mechanics, development, and production of analog, tabletop "hobby" games, which include board games, card games, wargames, and other non-digital games catering to multiple players. Students will analyze and apply concepts and mechanics of modern tabletop game design, and build and test both competitive and cooperative tabletop games, designed specifically for a global audience. Students will work with development and prototyping tools, explore component design and art direction, and work with desktop publishing technologies. In addition, they will work directly with board game publishing and manufacturing technologies and services, and study factors pertaining to the business of tabletop games, and produce a professional, polished tabletop game. (Prerequisites: (IGME-602 and student is matriculated in GAMEDES-MS); or (IGME-220 and student is matriculated in GAMEDES-BS/NWMEDID-BS)) **Lecture 3, Credits 3 (Spring)**

IGME-622

Game Balance

This course is an in-depth exploration of the sub-field of game design known as balance. Topics include: transitive mechanics and cost/power curves; economic systems in games; probability and the psychology of randomness; pseudorandom numbers; situational balance; level/XP curves, advancement and pacing; tuning; statistics, metrics, and analytics; intransitive mechanics, game theory, and payoff matrices; and the applied use of spreadsheets. (This course is restricted to students in the GAMEDES-MS program.) **Lecture 3, Credits 3 (Fall)**

IGME-623

Theory and Design of Role Play and Interactive Narrative

Role playing games (RPGs) are among the most popular game forms. RPG design incorporates elements from most game genre. This course will address all aspects of design relevant to role play, both digital and analog, and the course will focus on the underlying theory of role play as a practice. We will talk about popular games, but will also spend time on experimental and innovative role play. Students should expect to study playing styles, RPG structure, and to both study and produce effective interactive narrative. **Lab 3, Credits 3 (Spring)**

IGME-624

Tabletop Role-Playing Game Design and Development

This course explores the concepts and mechanics of analog role-playing games, such as tabletop "pencil-and-paper" and live-action role-playing games, from a practical, hands-on perspective. In this project-based course, students will develop their own rule systems to facilitate various facets of role-playing and associated game mechanics, then playtest and publish their games. Students will also use desktop publishing tools to produce game rules and supplemental materials suitable for publication. Note that this course assumes that students have extensive experience in playing tabletop role-playing games. (Prerequisites: (IGME-602 and student is matriculated in GAMEDES-MS); or (IGME-220 and student is matriculated in GAMEDES-BS/NWMEDID-BS)) **Lecture 3, Credits 3 (Fall, Spring)**

IGME-670

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, synthesis techniques, real-time performance issues, and the application of digital audio to multimedia and Web production. (Students must be in GAMEDES-MS or GAMEDES-BS and have taken IGME-202. Undergraduate students may not take and receive credit for this course if they have already taken IGME-570.) **Lec/Lab 3, Credits 3 (Fall)**

IGME-671

Interactive Game and Audio

This course provides 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. (Students must be in GAMEDES-MS or GAMEDES-BS and have taken IGME-202. Undergraduate students may not take and receive credit for this course if they have already taken IGME-571.) **Lec/Lab 3, Credits 3 (Spring)**

IGME-680

IGM Production Studio

This course will allow students to work as domain specialists on teams completing one or more large projects over the course of the semester. The projects will be relevant to experiences of the interactive games and media programs, but they 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. (Prerequisites: IGME-601 or equivalent courses.) **Lec/Lab 3, Credits 3 (Fall, Spring)**

IGME-689

IGM Graduate Research Studio

This course will allow students to work as domain specialists on teams completing one or more faculty-led research projects over the course of the semester. The faculty member teaching the class will provide the research topic(s). Students will learn about research methodology to implement, test, and evaluate results of projects. Students will complete research reports and final assessments of themselves and their teammates in addition to completing their assigned responsibilities on the main projects. (Prerequisites: This course is restricted to students in the GAMEDES-BS or GAMEDES-MS programs.) **Lab 3, Credits 3 (Fall or Spring)**

IGME-690

IGM Seminar

This is intended to allow for special one-time offerings of graduate topics. 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 seminar offering. (Varies) (This course is restricted to GAMEDES-MS students or (GAMEDES-BS or NWMEDID-BS students with at least 3rd year standing).) **Lecture, Credits 1 - 6 (Fall, Spring, Summer)**

IGME-695

Colloquium in Game Design and Development

This required colloquium will introduce students to a range of emerging topics and themes in the field of game design and development. Students will attend lectures by and discussions with RIT faculty and visitors, complete related readings, and offer both oral and written responses to readings and presentations. (This course is restricted to students in the GAMEDES-MS program.) **Lec/Lab 2, Credits 1 (Fall, Spring)**

IGME-699

Graduate Co-op

Cooperative education is a work experience designed to supplement the educational process. Students may select from a range of activities designated as cooperative education, including relevant industrial experience, internships, entrepreneurial activities, as well as faculty supervised research and innovation opportunities. (Enrollment in this course requires permission from the department offering the course.) **CO OP, Credits 0 (Fall, Spring, Summer)**

IGME-720

Social and Pervasive Game Design

This course presents students with core theories of sociology, psychology, economics, law, and politics in the context of social and pervasive (or "alternate reality") games. Students will engage in formal critique and analysis of media designs and their formal elements. (Prerequisites: IGME-602 or equivalent course and graduate standing in GAMEDES-MS.) **Lec/Lab 3, Credits 3 (Fall)**

IGME-730

Game Design and Development for Casual and Mobile Platforms

This course explores the design and development of casual and mobile game applications. Students will begin by exploring the design practices relevant to casual and mobile games, including hardware constraints, player expectations, play experiences, mechanics for casual and mobile experiences, as well as the aesthetics and presentation of casual and mobile game elements. As students learn the theoretical concepts, they will also learn the development process for casual and mobile games. Development topics will include technology platforms, physical and logical interface control, graphics and interaction, tools and APIs, connectivity, data management, data persistence, delivery mechanisms, and systems integration with desktop and web-based platforms. (This course is restricted to students in the GAMEDES-MS program.) **Lec/Lab 3, Credits 3 (Spring)**

IGME-740

Game Graphics Programming

Students will explore the use of an advanced graphics API to access hardware-accelerated graphics in a real-time graphics engine context. The course will involve discussion of scene graphs, optimizations, and integration with the API object structure, as well as input schemes, content pipelines, and 2D and 3D rendering techniques. Students will also explore the advanced use of the API calls in production code to construct environments capable of real-time performance. Students will construct from scratch a fully functional graphics engine, with library construction for game development. Advanced topics will be explored, including real-time special effects, custom shading pipelines, and advanced deferred rendering techniques. (Prerequisites: IGME-601 or equivalent courses.) **Lec/Lab 3, Credits 3 (Spring)**

IGME-742**Level Design**

This course introduces level design theory and best practice through game level analysis, evaluation, and creation. Students will explore the history of various game genres and the design of their levels, analyze game levels from existing games, and discuss what made those levels successful or unsuccessful. Through their analysis and hands-on experience, students will gain an understanding of overall level design including layout, flow, pacing, narrative, and balance. They will enhance their understanding of level design principles by creating their own game levels. (Prerequisites: IGME-602 or equivalent courses.) **Lab 3, Credits 3 (Fall, Spring)**

IGME-750**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 involved in game engine design, scene graph construction and maintenance, texture and materials management, collision systems, physics systems, 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. (This course is restricted to students in the GAMEDES-MS program.) **Lec/Lab 3, Credits 3 (Fall)**

IGME-753**Console Development**

This course explores the history and modern implementation of software for game consoles. Cross-platform development will be emphasized along with software concepts such as memory management, scheduling, parallelization, graphics, and virtual reality. Programming projects are required. (Prerequisite: IGME-740 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

IGME-760**Artificial Intelligence for Gameplay**

This course explores artificial intelligence concepts and research through both a theoretical perspective and a practical application to game development. In particular the course focuses on AI concepts and paradigms such as search and representation, reasoning under uncertainty, intelligent agents, biologically inspired computing and machine learning to real-time situations and applications as relevant to the field of entertainment technology and simulation. (This course is restricted to students in the GAMEDES-MS program.) **Lec/Lab 3, Credits 3 (Fall)**

IGME-770**Geographic Information Science and Technology**

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 & T). Students will gain hands-on experience with technologies such as Global Positioning Systems (GPSs), Geographic Information Systems (GISs), remote sensing, spatial data science and analysis, and web mapping. Furthermore, students will learn relevant GIS & T theory, concepts, and research trends such as spatial reasoning, spatiotemporal data representation, and spatial analysis. **Lec/Lab 3, Credits 3 (Fall)**

IGME-771**Introduction To Geographic Information Systems**

This online course introduces students to the world of Geographic Information Systems (GIS). Course lectures, reading assignments, and practical lab experiences will cover a mix of conceptual, practical and technical GIS topics. Topics include GIS data models, basic cartography, geodatabases, spatial analysis, GIS software, and theory and concepts from the Geographic Information Science and Technology domain. **Lec/Lab 3, Credits 3 (Fall)**

IGME-772**Geographic Visualization**

This course examines concepts and techniques associated with dynamic map construction, usage, and assessment. Specific topics include thematic cartography, geographic information visualization, sources of dynamic geographic information, developing animated and interactive maps, mapping mashup development, using maps as a means to support group work, usability of dynamic maps, and current geovisualization research areas. Development of a visualization prototype and an associated scholarly paper in an area related to thematic cartography and geographic visualization are required. **Lec/Lab 3, Credits 3 (Spring)**

IGME-788**Capstone Design**

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, it defines the group and individual responsibilities for the cohort capstone project experience. (Prerequisites: IGME-601 and IGME-602 and IGME-603 or equivalent courses.) **Lecture 5, Credits 3 (Fall)**

IGME-789**Capstone Development**

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. (Prerequisites: IGME-788 or equivalent course.) **Lec/Lab 5, Credits 3 (Spring)**

IGME-790**Graduate Seminar in IGM**

This is intended to allow for special one-time offerings of graduate topics. 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 seminar offering. (This course is restricted to students in the GAMEDES-MS program.) **Lec/Lab, Credits 1 - 6 (Fall, Spring, Summer)**

IGME-795**Game Industry Themes and Perspectives**

This required course prepares students for a career in the field of game design and development. Students will attend lectures by and discussions with RIT faculty and visitors and produce material to assist in their career preparation. (This course is restricted to students in the GAMEDES-MS program.) **Lec/Lab 2, Credits 1 (Fall)**

IGME-796**Advanced Topics in Game Design**

This course examines current topics in game design. Specific course details (such as prerequisites, course topics, format, learning outcomes, assessment methods, and resource needs) will be determined by the faculty member(s) who propose a specific topics course in this area. (This course is restricted to students in the GAMEDES-MS program.) **Lec/Lab 3, Credits 3 (Fall, Spring, Summer)**

IGME-797**Advanced Topics in Game Development**

This course examines current topics in game development. Specific course details (such as prerequisites, course topics, format, learning outcomes, assessment methods, and resource needs) will be determined by the faculty member(s) who propose a specific topics course in this area. (This course is restricted to students in the GAMEDES-MS program.) **Lec/Lab 3, Credits 3 (Fall, Spring, Summer)**

IGME-799**Independent Study**

The student will work independently under the supervision of a faculty adviser on a topic not covered in other courses. (Enrollment in this course requires permission from the department offering the course.) **Ind Study, Credits 1 - 6 (Fall, Spring, Summer)**

Medical Informatics

MEDI-610**Scripting Fundamentals**

This course is an introductory scripting course. Students will learn to design software solutions using the procedural approach, to implement software solutions using a contemporary programming language, and to test these software solutions. Topics include problem definitions, designing solutions, implementing solutions using a contemporary programming language, implementing a contemporary library/framework, and testing software solutions. Programming projects will be required. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lec/Lab 3, Credits 3 (Spring)**

MEDI-701**Introduction to Health Informatics**

This course provides a rigorous introduction to the principles of medical informatics. The focus of this course is on the study of the nature of medical information and its use in clinical practice and clinical quality improvement. Key topics include: the electronic medical record (EMR) and its impact on health care delivery, the Internet and mobile computing as sources of medical information, Health care information systems, the software development lifecycle, the importance of the informatics specialists in medicine and the various roles they can play, and government economic incentives and policy issues in healthcare such as privacy, confidentiality, including health care regulatory and accreditation issues and the Health Insurance Portability and Accountability Act (HIPAA). Students will participate in online discussion of medical informatics. They will also investigate several topics of interest in the field and provide presentations. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall)**

MEDI-702**Perspectives of Health Informatics**

The health care industry is composed of many different disciplines, specialties, and professions. Designing and developing informatics solutions requires an understanding of the roles, approaches and information needs of the many diverse user groups in delivering health care services for patients and health populations. This course will focus on the overlapping and divergent requirements of a comprehensive electronic health record from the perspectives of patients, health care providers (physicians, nurses, pharmacists, etc), health care payers, public health structures, biotechnology firms and researchers. Group projects will be required. (Prerequisites: MEDI-701 or equivalent course and graduate standing in the MEDINFO-MS program.) **Lecture 3, Credits 3 (Fall)**

MEDI-704

Practice of Health Care

This course is an introduction to clinical practice for graduate students in medical informatics. It consists of the study of six medical specialties including shadowing of clinicians in these areas. Students in this course will be part of a team of health care professionals in the selected specialties. They will round with providers, assist with information gathering and dissemination, and observe specialty specific disease process, diagnosis and treatment. They will observe and note clinical workflow and technology usage. They will interact with team members and assist with the acquisition of reference knowledge as appropriate. They will keep a log of cases during the rotation and use this as the basis for their research project and case presentation. (Prerequisites: MEDI-701 or equivalent course and graduate student standing.) **Lecture 3, Credits 3 (Fall, Spring, Summer)**

MEDI-705

Medical Knowledge Structures

This course presents concepts related to organization and retrieval of knowledge-based information in the health sciences. It includes a study of classification schemes, controlled vocabularies and thesauri, metadata, and ontologies. Major schemes and systems examined, for example, include MeSH, UMLS, and PubMed. Also covered are the topics of knowledge retrieval at the point of care, and knowledge discovery. (Prerequisites: MEDI-701 or equivalent course and graduate student standing.) **Lecture 3, Credits 3 (Fall)**

MEDI-707

Clinical Decision Support

This course provides a rigorous introduction to the principles of modeling and implementing decision support systems. It begins with an overview of how to frame a clinical or health care management question, develop a decision support model, and find appropriate evidence for model calibration. The major decision categories covered in the course for clinical practice include those regarding treatment, diagnosis, harm (etiology), and prognosis. The major decision categories covered in the course for health care management include service provision, resource allocation, and cost-effectiveness. The course will identify the best types of evidence to answer questions, and how to find and apply that evidence. The decision support modeling techniques include game theory, Bayesian theory, decision trees, planning models, systems dynamics models, and queuing models. The course concludes with a section on summarizing evidence (e.g., through systematic reviews and meta-analysis), putting evidence into practice (e.g., implementing clinical practice guidelines), and the limitations of the approaches covered in the course. Students will apply decision support techniques in addressing real world problems using appropriate software and participate in online discussion of decision analysis in the medical literature. (Prerequisites: MEDI-701 or equivalent course and graduate standing in the MEDINFO-MS program.) **Lecture 3, Credits 3 (Fall)**

MEDI-710

American Health Policy and Politics

This course examines the formation and evolution of American Health policy from an historical perspective. Concentrating on developments from the early twentieth century to the present, the focus will be political forces and institutions and historical and cultural contexts. Among the topics covered are periodic campaigns for national health insurance, the creation of Medicare and Medicaid and the further evolution of these programs, the rise to dominance of economists in the shaping of health policy, incremental and state-based vs. universal and federal initiatives, the formation and failure of the Clinton administration's health reform agenda, and national health reform during the Obama administration. (Enrollment in this course requires permission from the department offering the course.) **Lecture 3, Credits 3 (Fall)**

MEDI-711

Introduction to US Health Care System

In this course, we examine the organization, financing, delivery, and performance of the U.S. health care system. The inherent tradeoffs between access to care, cost, quality, and outcomes are considered from the perspective of the main actors in the system, i.e. patients, providers (physicians, hospitals, etc.), health plans, insurers and payers. Topics include: need and access to care; health care insurance and financing; Medicare and Medicaid; managed care; service delivery; long-term care; public health; quality of care, and others. The aim of the course is to help students deepen their understanding of the health care system, strengthen their ability to synthesize the literature and assess key current policy issues, and to further develop their critical thinking skills. (Enrollment in this course requires permission from the department offering the course.) **Lecture 3, Credits 3 (Fall)**

MEDI-730

Medical Application Integration

A typical hospital information system architecture contains a variety of best of breed applications running on different hardware and software platforms. Exchange of information between these applications can be a significant problem. In this course, students will learn how to leverage the loose coupling of service-oriented architectures and message oriented middleware to address the issues of data integration between these types of computer programs when executing across domains. Programming projects will be required. (Students will need a database theory course, and one year of object-oriented programming to be successful in this course) (Prerequisites: MEDI-701 and ISTE-608 and ISTE-200 or equivalent courses and graduate student standing.) **Lecture 3, Credits 3 (Fall)**

MEDI-731

System Integration Concepts

This course will provide students with an understanding of application integration concepts in healthcare. Students will also learn medical business processes and how they impact data integration within a healthcare setting. Middleware message brokers will be examined along with the use of the HL7 messaging standard. Web services and other forms of data integration will be studied. Students will develop integration solutions to support healthcare information systems exchange and validation procedures and solutions to ensure the quality of information exchanged between healthcare systems. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Spring)**

MEDI-735

Clinical Information Systems

A study of the component approach to clinical information systems. Students will learn about the evolution of Health Information Systems, and the variety of systems offered by vendors at the present time. The importance of the Electronic Health Record (EHR), the Computerized Physician Order Entry (CPOE) and Clinical Decision Support will be stressed as they become the focal points in clinical information systems. The following components will be studied in detail: patient, activity, health record, knowledge, and security components. The role of imaging management and integration will also be reviewed. (Prerequisites: MEDI-701 or equivalent course and graduate student standing.) **Lecture 3, Credits 3 (Spring)**

MEDI-766

Building the Electronic 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. (Prerequisites: HCIN-610 and MEDI-705 or equivalent courses and graduate student standing.) **Lec/Lab 3, Credits 3 (Spring)**

MEDI-788

Capstone in Health Informatics

This team-based course provides students with the opportunity to apply the knowledge and skills learned in coursework to design, develop, and implement a solution to a real problem in the medical informatics domain. Project teams also will be responsible for submitting a final project report, and for making a final presentation to project stakeholders. (Completion of first year courses) (Prerequisite: MEDI-701 and MEDI-705 and MEDI-735 and MEDI-704 and HCIN-610 and Graduate standing.) **Lecture 3, Credits 3 (Summer)**

MEDI-909

Proposal Development

This course is part of a capstone experience for graduate students who are beginning the capstone experience. Students will submit an accepted proposal as a prerequisite for the formal thesis. Permission of the graduate adviser is required. (Enrollment in this course requires permission from the department offering the course.) **Research, Credits 0 (Fall, Spring, Summer)**

Networking, Security and Systems Administration

NSSA-602

Enterprise Computing

This course explores enterprise systems (clouds, server farms, mainframes, and clusters/grids) from the environment, networking, storage, security, and system administration perspectives. Students in this course gain an understanding of the knowledge and concepts needed to manage, perform research in, and administrate those architectures. **Lecture 3, Credits 3 (Fall, Spring)**

NSSA-605

Principles of System Admin

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 web services hosting. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall, Spring)**

NSSA-606

Wired and Wireless Networking

This course is a bridge course focused on an introduction to wired and wireless network infrastructures, topologies, technologies and protocols required for effective end-to-end communication. Basic security concepts are also introduced at the local area network communication level. Networking layers 1, 2 and 3 are examined in-depth using the International Standards Organization's Open Systems Interconnection and TCP/IP models. Topics focus on the TCP/IP protocol suite, the Ethernet LAN protocol, IEEE 802.11 Wireless LAN protocol, and routed and routing protocols common in local area networks. Labs will cover the various aspects of communication, management and security on equipment found in industry. **Lab 2, Credits 3 (Fall, Spring)**

NSSA-606**Wired and Wireless Networking**

This course is a bridge course focused on an introduction to wired and wireless network infrastructures, topologies, technologies and protocols required for effective end-to-end communication. Basic security concepts are also introduced at the local area network communication level. Networking layers 1, 2 and 3 are examined in-depth using the International Standards Organization's Open Systems Interconnection and TCP/IP models. Topics focus on the TCP/IP protocol suite, the Ethernet LAN protocol, IEEE 802.11 Wireless LAN protocol, and routed and routing protocols common in local area networks. Labs will cover the various aspects of communication, management and security on equipment found in industry. **Lecture 2, Credits 3 (Fall, Spring)**

NSSA-607**Network Systems and Services**

This course will introduce students to LAN and routed network infrastructures, topologies, technologies and protocols required for effective end-to-end communication. Using the Open Systems Interconnection model as defined by the International Organization of Standards and the TCP/IP model as a guide, network functionality at layers 1, 2, 3, and 4 are examined in-depth. This includes the IEEE 802.3 Ethernet LAN protocol, routed and routing protocols common data networks, the TCP/IP Version 4 and Version 6 protocol suite, as well as network services such as DHCP, DNS, and SSH. The conceptual and theoretical content of the course will be reinforced through hands-on or simulated lab exercises that will include deployment in both Linux and Windows internetworking environments. Construction of virtual networks, observation and analysis of the implemented data communications protocols, and basic security techniques will be included. Students completing this course will have a strong understanding of the TCP/IP protocol suite and experience in administering, monitoring, securing and troubleshooting an internetwork of TCP/IP based systems. **Lec/Lab 4, Credits 3 (Fall, Spring)**

NSSA-610**Advanced Wired Networking Concepts**

This course covers advanced networking technologies available to enterprises. Protocol options and their evolutions over the years, the growth in complexity and its impacts are explored in depth. Topics include: VLANs and VLAN Hierarchies, Loop-Avoidance in customer, provider and provider backbone networks such as RSTP and Shortest Path Bridging, IPv4 and IPv6 coexistence issues, Routing protocols with IPv4 and IPv6 for inter and intra-AS routing, MobileIP, queuing and Quality of service routing and congestion control in the Internet, MultiProtocol Label Switching, Routing and Switching in wireless networks (Prerequisite: NSSA-606 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

NSSA-611**Advanced Topics in Wireless Networks and Technologies**

The course is designed to provide comprehensive exposition to the challenges faced in wireless networks and technologies in the different protocol layers. Leading work conducted to address the challenges faced in the new techniques such as cross layered and integrated approaches will be covered. From the challenges perspective, case studies based on several upcoming wireless technologies and networks will be presented. In most cases, the standards efforts follow the deployment, which lags the research effort. Some of the standardization efforts and their impacts in industry deployment and the effect of research on standardization will be covered. This study will be based on case studies. Students will need one statistics course to be successful in this class. (This course is restricted to NETSYS-MS Major students.) **Lecture 3, Credits 3 (Spring)**

NSSA-612**Network Modeling and Analysis**

The course provides comprehensive exposition of the core concepts in network modeling and simulation. It will cover both graph theoretical and statistical models of complex networks such as the Internet and social networks. It also introduces different types of modeling techniques and simulation tools. The course also systematically addresses some practical and theoretical considerations for developing complex modeling. It offers real world examples to illustrate the process of modeling to address specific problems. (Prerequisites: NSSA-606 and DECS-782 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

NSSA-613**Wireless Access and IoT Technologies**

The networking industry has experienced phenomenal changes in the areas of wireless access networks, including the Internet of Things (IoT) that leverages sensors, wireless communication, mobile devices, networking and cloud technologies to provide intelligent services for energy management, logistics, retail, agriculture and many other domains. This course explores the various types of wireless access networks, including related applications, architecture, technologies, and performance topologies. Additionally, students will learn about IoT protocols, platforms, physical devices and security. Both wireless access networks and IoT will be explored through a series of lab assignments either hands-on or simulated and a course project. (Prerequisites: NSSA-607 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

NSSA-615**Advanced OOP for Networking and Systems Admins**

This is a course in Object Oriented Programming. Students must have completed one year of OO programming prerequisite, as the course will presume that level of knowledge and will build from there. Multiple languages will be studied in this course. The languages chosen will have direct and immediate applicability to the field of Networking and Systems Administration program and will be chosen for their use in the topic areas of that degree program. Students will be quickly led through the primitive types and control structures of each language and immersed in significant projects using advanced language features. Note: Student must have one year of programming in an object oriented programming language. (Prerequisite: ISTE-200 or equivalent course.) **Lec/Lab 4, Credits 3 (Fall, Spring)**

NSSA-616**Task Automation Techniques**

In this course, students will use programming and scripting techniques to automate tasks and solve problems. The course will explore scripting concepts including but not limited to process substitution, list constructs, functions, and arrays. The student will explore the techniques and methods used to analyze and address network and system problems by writing complex scripts and programs. The scripts will be used to analyze network traces, configure routers and switches, monitor network activity, troubleshoot problems, implement security processes, and address other operational requirements. Requires at least one year programming experience. **Lecture 4, Credits 3 (Fall, Spring)**

NSSA-620**Emerging Computing and Networking Technologies**

Computer networking and computer system technologies have dramatically changed the way that businesses operate and how they accomplish their organizational goals. Most of the current technologies used today have their roots in the early days of the internet and computing. The changes that have occurred since then have been largely at the margins, rather than developed in a wholesale fashion. As our discipline moves forward there are a substantial number of emerging technologies in development to address the inadequacies of the currently deployed technologies. If widely adopted, these technologies will change how technologies support organizations and individuals creating a whole new paradigm for computing, networking, and the security of our computing environment. Students will be researching the current state of several of the most significant emerging technologies. The course will consist of a combination of lectures where technologies will be presented and explained; independent labs, modeling and simulation exercises that will reinforce the students' understanding of the technologies by allowing them to work with them in a hands-on fashion; and independent literature research do serve as a foundation for future work in this degree program. (Prerequisite: NSSA-606 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

NSSA-621**Design and Deployment of Wireless Networks**

This course will take students through large scale wireless systems. It will also cover the significant access wireless networks. Important areas of concern will be contemporary and emerging Wireless Local Area Network (WLAN) standards, cellular communication and other forms of wireless access such as wireless INTERNET service provision. Focal points for these areas will be protocol operation, network architecture, and security issues and solutions. (Prerequisites: NSSA-606 and DECS-782 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

NSSA-622**Carrier Networking**

This course is primarily concerned with the issues associated with carrier networks in the WAN. Major protocols such as BGP, MPLS, T carriers, Metro Ethernet and SONET will form the backbone of the content. In addition to protocol architecture and operation, the course will also examine the integrated nature of these protocols as they support contemporary communication applications. (This course is restricted to NETSYS-MS Major students.) **Lecture 3, Credits 3 (Spring)**

NSSA-710**Network Management**

This course provides an introduction to network management concepts with hands-on laboratory sessions in developing network management applications and using it to study and analyze the performance of networks, data communications hardware and software, and use of these components in computer networks. Topics include but are not limited to introduction to network management concepts, the five basic network management functions namely fault management, configuration management, performance management, accounting management and security management, introduction to Simple Network Management Protocol (SNMP) and its versions, Remote monitoring and different network management architectures. (Prerequisite: NSSA-606 or equivalent course.) **Lec/Lab 3, Credits 3 (Spring)**

NSSA-711**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 wired and wireless routing protocols will also be discussed. Knowledge of networking, systems, and security technologies is necessary. (This course is restricted to NETSYS-MS Major students.) **Lecture 3, Credits 3 (Fall)**

NSSA-712 **Advanced Storage Technologies**
Data storage is an integral and essential component of every computer system and controlling access to storage resources is the basis for many security efforts. This course explores the spectrum of storage technologies and file and record management systems ranging from Direct Access Storage to Storage Area Networks (SAN) and cloud based object and record storage. We will also explore the impact of software defined storage on organization's storage plans and implementation strategies. All storage systems present an abstracted version of the data blocks that reside on spinning disks and SSD cards. In this course we will look at the ways that abstraction can be used to create storage systems that meet the needs of modern organizations for resilient large scale storage systems. (Prerequisite: NSSA-605 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

NSSA-713 **Enterprise Service Provisioning**
The distributed architectures used to support the highly variable workloads typical of web scale applications can only be maintained by converting configuration of those architectures to software. This course will explore some of the architectures, technologies and theories of service provision used to support software defined infrastructure and modern web scale applications. Some of the technologies discussed include containers, content versioning systems, and software testing as applied to configuration management and security as reflected in more reliable availability. The course will also include a discussion of promise theory and its application to large scale architectures. The course is a combination of hands-on labs and lectures. (Prerequisites: NSSA-602 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

NSSA-714 **Advanced Large-Scale Computing**
Large organizations are dependent on the availability and reliability of computing services. The provisioning challenge is to cost-effectively manage the deployment of different kinds of software services in enterprise scale environments. This course explores systems architectures and deployment strategies for large-scale systems. Technologies discussed include public and private clouds, hybrid architectures, service oriented architectures, configuration management, virtualization, service discovery, load balancing, and system elasticity. The course is a combination of hands-on labs and lectures. (Prerequisite: NSSA-605 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

NSSA-715 **Network Design and Performance**
This course will examine the design and performance of networks based on the top down approach. Students will learn to design networks based on identified business needs through a phased approach starting with requirements gathering and analysis, technical goals study, logical design, physical design followed by simulating the network and assessing the performance and optimizing the design. The designs include site, campus, and enterprise networks. Wide Area Network (WAN) technologies will be combined with Local Area Network (LAN) technologies in the design of enterprise networks. Students will learn to assess the business goals and their application to the network goals. Given the serious security threat faced in networks today, this course will provide a modular approach to designing security strategies for the network ground up in the design. The significance of network management to a design of a secure and manageable network will be discussed. (Prerequisites: NSSA-602 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

NSSA-716 **Enterprise Mobile Computing**
This course will cover technologies for web-based mobile cloud computing especially for business solutions. The course covers enterprise mobile computing architecture, emerging mobile computing technologies, operating system, and security. Also, the course discusses different applications of mobile computing in mobile ad hoc and sensor networks. (Prerequisites: NSSA-605 and NSSA-606 or equivalent courses.) **Lecture 3, Credits 3 (Spring)**

NSSA-720 **Virtual Systems Architecture and Deployment**
This class will take the students through the evolution of virtualization including various host-based virtualization, bare metal hypervisors and server virtualization. Elements of software defined networking and cloud computing will also be discussed. This course also explores the architectures and operational techniques that support the operation of web scale applications including service oriented architectures, micro-service architectures and hybrid public/private cloud architectures. The course also deals with modern storage architectures as they support web scale applications. (Prerequisite: NSSA-605 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

NSSA-789 **GraduateSeminarInNetworkingandSystemAdministration**
This IST seminar course provides an opportunity for special one-time offerings of graduate topics or allows faculty to pilot possible 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 seminar offering. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lec/Lab 3, Credits 3 (Fall, Spring, Summer)**

NSSA-790 **MS Thesis**
This course is a capstone course in the MS in computing security program. It offers students the opportunity to investigate a selected topic and make an original contribution which extends knowledge within the computing security domain. As part of their original work students will write and submit for publication an article to a peer reviewed journal or conference. Students must submit an acceptable proposal to a thesis committee (chair, reader, and observer) before they may be registered by the department for the MS Thesis. Students must defend their work in an open thesis defense and complete a written report of their work before a pass/fail grade is awarded. **Thesis 6, Credits 1 - 6 (Fall, Spring, Summer)**

NSSA-791 **MS NSSA Project**
This course is a capstone course in the MS NSA and MS IAF (Information Assurance and Forensics) programs. It offers students the opportunity to investigate a selected topic within the NSSA domain. The student will do this using an applied laboratory approach. Students must submit an acceptable proposal to a project committee (chair, and reader) before they may be registered by the department for the MS NSSA Project. Students must defend their work in an open project defense and complete a written report of their work before a letter grade is awarded. **Project 3, Credits 1 - 4 (Fall, Spring, Summer)**

NSSA-900 **Continuation of Thesis**
Cont, Credits 0 (Fall, Spring, Summer)

NSSA-901 **Continuation of Project**
Cont, Credits 0 (Fall, Spring, Summer)

NSSA-909 **Proposal Development**
This course is part of a capstone experience for graduate students who are beginning the capstone experience. Students will submit an accepted proposal as a prerequisite for the formal thesis. (Permission of the graduate advisor.) (Enrollment in this course requires permission from the department offering the course.) **Research, Credits 0 (Fall, Spring, Summer)**

Software Engineering

SWEN-601 **Software Construction**
This is a programming based course to enhance individual, technical engineering knowledge and skills as preparation for masters level graduate work in computing. Students will be introduced to programming language syntax, object oriented concepts, data structures and foundational algorithms. An emphasis will be placed on obtaining practical programming skills, through regular programming assignments and practicum. (Corequisites: SWEN-610 and SWEN-746 or equivalent courses.) **Lecture 3, Credits 3 (Fall)**

SWEN-610 **Foundations of Software Engineering**
An overview course in software engineering emphasizing software design and software development projects. The course will focus on object-oriented (OO) analysis, design principles and techniques. Students will be introduced to OO modeling, design patterns and design/code refactoring techniques. While there is a significant emphasis on product development, students will be required to use a rigorous process in a team-based product development project. Major topics include analysis and specification of software, subsystem modeling using patterns, and software testing. A term-long, team-based project is used to reinforce concepts presented in class. Programming is required. (Co-requisites: SWEN-601 or equivalent courses.) **Lecture 3, Credits 3 (Fall)**

SWEN-614 **Engineering Cloud Software Systems**
The course focuses on designing and implementing applications using cloud software systems infrastructure and technologies. The course introduces the basic concept and knowledge on cloud computing systems and application infrastructure. It also contains brief introductions on key technologies and paradigms related to developing big data applications in the cloud. The course also includes student-led case studies of cloud computing applications in different application domains, e.g., healthcare, financial, IoT (Internet of Things), and so on. The course contains a set of related topics which are covered via hands-on class instruction, application development in teams, course materials, and class discussions. Programming projects and demo presentations are required. (Prerequisites: SWEN-601 and SWEN-610 or equivalent courses.) **Lec/Lab 3, Credits 3 (Fall)**

SWEN-640**Research Methods**

Overview of the academic research methodologies used in graduate level work. Topics include: Writing style, Audience analysis, Research Planning, Experiment design and result analysis, Document structure, Research validation, and the process for submission and review to conferences and journals. In this course the student will identify and develop a detailed thesis or capstone proposal that may be continued in a subsequent course. An in-depth study of a software engineering topic will be research focused. The student selects a research problem, conducts background research, and selects appropriate technology and methodologies needed to fully conduct the project. The topic is selected by the student and is in agreement with the student's advisor and committee. The proposal is presented in a scholarly format for approval by the advisor and committee. (Graduate Computing and Information Sciences) **Lecture 3, Credits 3 (Spring)**

SWEN-660**Graduate Affinity Research Group**

This course is a project-based, research-focused course that supports teamwork, collaboration, and both professional and technical skill building. Students will work in teams that consist of both students and professor. Topics include research methods, technical communication, and technical topics that are relevant to the project(s). This course requires permission of the instructor to enroll. (This course requires permission of the Instructor to enroll.) **Studio 3, Credits 3 (Fall, Spring, Summer)**

SWEN-699**Graduate Co-op Experience**

One block of full-time, paid employment in software engineering. See the software engineering graduate program coordinator or RIT's Office of Career Services and Cooperative Education for further details. Completion of all bridge courses and 17 semester hours of graduate courses are required for enrollment. (Enrollment in this course requires permission from the department offering the course.) **CO OP, Credits 0 (Fall, Spring, Summer)**

SWEN-701**Practicum I**

A project course where students practice what they have learned or are learning in class, through directed study. Teams work with contemporary tools, technologies, and methodologies. 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. **Lec/Lab 3, Credits 3 (Fall, Spring, Summer)**

SWEN-702**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 senior engineers in a specific role in accordance to individual levels of expertise and profile. (Prerequisites: SWEN-701 or equivalent course.) **Lec/Lab 3, Credits 3 (Fall, Spring, Summer)**

SWEN-711**Engineering Self-Adaptive Software Systems**

This course introduces beginning graduate students to key concepts and techniques underlying the engineering of self-adaptive and autonomic software systems. Such software systems are capable of self-management, self-healing, self-tuning, self-configuration and self-protection. The course content includes an introduction of self-adaptive software systems and defines their characteristics. This will be followed by foundational engineering principles and methodology for achieving self-adaptive systems – feedback control, modeling, machine learning, and systems concepts. Selected seminal research paper reading and a term-long project will also be covered in the class. (Prerequisites: This course is restricted to students with graduate standing in Software Engineering program or GCCIS graduate programs who have completed SWEN-601 or equivalent courses.) **Lecture 3, Credits 3 (Fall)**

SWEN-712**Engineering Accessible Software**

This course introduces software accessibility principles, which are relevant to the Software Engineering approach of software development. The course will survey assistive technologies, accessibility standards and their applications to new and existing software, and how to incorporate accessibility principles at the various phases of the software development life cycle. Students will deliver software based on software engineering approach to users with different abilities e.g. people with visual impairments, and older users. Other topics include mobile accessibility, accessibility testing, validation technologies, and tools. (Prerequisites: SWEN-601 and SWEN-610 or equivalent courses.) **Lecture 3, Credits 3 (Spring)**

SWEN-722**Process Engineering**

In this course, students will study various lifecycle models for developing software systems. They 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. Students will also study software process assessment models, including the Capability Maturity Models, and learn how to identify specific recommendations for an organization to improve their processes. Students will apply their learning to engineer software engineering processes, tools, and methods appropriate for their graduate projects, course projects, and projects for organizations they have worked for. **Lec/Lab 3, Credits 3 (Spring)**

SWEN-732**Collaborative Software Development**

This course covers processes, tools, and techniques for software development, in general, and collaborative, distributed software development, in particular. Students will learn how to design a process specific to their organization and development project needs. This includes how to select a software development life-cycle model, how to select and sequence the development and management activities of a collaborative, distributed software development team structure and dynamics, and how to define the work products, tools, and methods used to perform those activities. The Software Process Engineering Metamodel (SPEM, an Object Management Group standard) will serve to graphically describe, analyze, discuss, and improve software development processes. Special attention will be given to collaboration needs and approaches for small and large teams that may be globally distributed. (Prerequisites: This course is restricted to students with graduate standing in Software Engineering program or GCCIS graduate programs who have completed SWEN-601 and SWEN-610 or equivalent courses.) **Lecture 3, Credits 3 (Fall)**

SWEN-745**Software Modeling**

Modeling plays a pivotal role during the software lifecycle during the pre-construction and post-construction activities of the software lifecycle. During the pre-construction stage, models help software engineers understand, specify, and analyze software requirements and designs. During the post-construction stage, 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. (Department approval) (This course is restricted to students with graduate standing in Software Engineering program or GCCIS PHD program.) **Lec/Lab 3, Credits 3 (Fall)**

SWEN-746**Model-Driven Development**

Software models help the software engineer to understand, specify, and analyze software requirements, designs, and implementations (code components, databases, support files, etc.). Model-driven development is a software engineering practice that uses tool-enabled transformation of requirements models to design models and then to code and associated implementation artifacts. Students will use the Unified Modeling Language (UML) and other modeling techniques to capture software requirements, designs, and implementations. Students will also use formal modeling methods to semi-automatically transform among the various models and to study the quality attributes of the modeled software, such as performance, reliability, security, and other qualities. (Co-requisites: SWEN-601 and SWEN-610 or equivalent courses.) **Lecture 3, Credits 3 (Fall)**

SWEN-749**Software Evolution and Reengineering**

This course explores the concepts of software evolution and reengineering 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. (Prerequisites: SWEN-745 or equivalent course.) **Lec/Lab 3, Credits 3 (Spring)**

SWEN-755**Software Architecture**

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 trade-offs among conflicting constraints, the documentation of architecture for use over a product's life cycle, and the role of architecture during coding activities. (Prerequisites: SWEN-601 and SWEN-610 and SWEN-746 or equivalent courses.) **Lecture 3, Credits 3 (Fall)**

SWEN-772 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, and discuss the application and analysis of its evaluation experimentation as a means of improving the quality aspects of subject project/organizational situation. (This course is restricted to students with graduate standing in Software Engineering program or GCCIS PHD program.) **Lec/Lab 3, Credits 3 (Fall, Spring)**

SWEN-777 Software Quality Assurance

This course explores the concepts of process and product quality assurance and introduces approaches and support tools used to extract the information needed to assess and evaluate the quality of existing software systems. Major maintenance activities are detailed including unit and regression testing, test case generation, software refactoring, API migrations, bug localization and triage, and predicting technical debt. Students will participate in an active learning approach by exercising and practicing code reviews, software testing tools, and quality frameworks. (Prerequisites: SWEN-601 and SWEN-610 or equivalent courses.) **Lecture 3, Credits 3 (Spring)**

SWEN-780 Capstone Research Project

This course provides the student with an opportunity to explore a project-based research experience that advances knowledge in that area. The student selects a research problem, conducts background research, develops the system, analyses the results, and builds a professional document and presentation that disseminates the project. The report must include an in-depth research report on a topic selected by the student and in agreement with the student's adviser. The report must be structured as a conference paper, and must be submitted to a conference selected by the student and his/her adviser. (Enrollment in this course requires permission from the department offering the course.) **Lec/Lab 6, Credits 3 - 6 (Fall, Spring, Summer)**

SWEN-781 Continuation of Capstone

This course provides the student with an opportunity to complete their capstone project, if extra time is needed after enrollment in SWEN-790. The student continues to work closely with his/her adviser. (Enrollment in this course requires permission from the department offering the course.) **Cont, Credits 0 (Fall, Spring, Summer)**

SWEN-789 Graduate Special Topics

This course will cover specialized topics in software engineering. Such topics are often considered emerging and advanced. Graduate standing and specific prerequisites will be noted upon specific proposal of a course. (Prerequisites: SWEN-610 or equivalent course.) **Lec/Lab 3, Credits 3 (Fall, Spring, Summer)**

SWEN-790 Thesis

This course provides the student with an opportunity to execute a thesis project, analyze and document the project in thesis document form. An in-depth study of a software engineering topic will be research focused, having built upon the thesis proposal developed prior to this course. The student is advised by their primary faculty adviser and committee. The thesis and thesis defense is presented for approval by the thesis adviser and committee. (Enrollment requires completion of all core courses and permission from the department offering the course.) **Thesis 6, Credits 6 (Fall, Spring, Summer)**

SWEN-791 Continuation of Thesis

This course provides the student with an opportunity to complete their thesis project once having enrolled in both thesis courses (SWEN-794, SWEN-795) if extra time is needed. The student continues to work closely with his/her adviser and thesis committee. (Enrollment in this course requires permission from the department offering the course.) **Cont, Credits 0 (Fall, Spring, Summer)**

SWEN-799 Independent Study

This course provides the graduate student an opportunity to explore an aspect of software engineering in depth, under the direction of an adviser. The student selects a topic, conducts background research, develops the system, analyses results, and disseminates the project work. The report explains the topic/problem, the student's approach and the results. (Completion of 9 semester hours is needed for enrollment) (Enrollment in this course requires permission from the department offering the course.) **Ind Study, Credits 3 - 6 (Fall, Spring, Summer)**

Kate Gleason College of Engineering

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Course numbering: RIT courses are generally referred to by their alphanumeric registration label. The four alpha characters indicate the discipline within the college. The final three digits are unique to each course and identify whether the course is noncredit (less than 099), lower division (100-299), upper division (300-599), or graduate level (600 and above).

Unless otherwise noted, the following courses are offered annually. Specific times and dates can be found in each semester's schedule of courses. Prerequisites/corequisites are noted in parentheses near the end of the course description.

Biomedical Engineering

BIME-607

Graduate Biodesign

This course is a graduate-level introduction to the biodesign process used for innovating medical technologies. Student teams will apply a needs-based assessment strategy to identify opportunities in a biomedical related field such as assistive technologies and rehabilitation engineering. Incorporating CAD will culminate in a virtual medical device prototype. Concepts of intellectual property, regulatory considerations, and reimbursement and business models will be introduced. (This course is restricted to Graduate students.) **Lecture 3, Credits 3 (Fall)**

BIME-610

Bioanalytical Microfluidics

This course is focused on the analysis and separation of high value biological products employing microfluidic devices. The course will cover miniaturization, microfabrication, microfluidics and electrohydrodynamic flow; as well as the most common separation techniques employed in bio-analytical microdevices: chromatography, electrophoresis, dielectrophoresis, cytometry and electrochemistry. Students will be able to apply the fundamentals of these techniques for the solution of a variety of microfluidics problems. Students will also become familiar with the recent literature on bioanalytical applications in microfluidics devices. Students will review journal articles on novel microfluidics methods and they will present their finding to the rest of the group. The course also includes three "hands on" laboratory modules. Students will fabricate microfluidic devices and then use these devices to perform experiments with electroosmotic flow and dielectrophoresis. (Prerequisite: CHME-321 or BIME-320 or MECE-210 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

BIME-617

Principals of Biomedical Device Regulations

This course will present the principles and fundamentals of medical device and in vitro diagnostic regulation. The course will cover the history of the FDA and the regulations around food, drug and cosmetic products. An overview of regulatory pathways, clinical trials, good manufacturing practices and quality system design will be covered. Comparisons between US, EU and other international regulatory bodies will also be discussed. The course will culminate with students developing a clinical trial and regulatory strategy for a new hypothetical medical device. (This course is restricted to Graduate students.) **Lecture 3, Credits 3 (Fall)**

BIME-620

Hemodynamics

This course will focus on the application of fluid mechanics principles to vascular blood flow and flow dynamics. It will cover concepts such as the vascular system and flow patterns in different segments (i.e., blood, heart, arteries and veins), parameters and measures of flow dynamics, including pressure, flow rate, and vascular resistance; fully developed laminar flow (Poiseuille's Law), applications of electrical analogous and optimality for modeling vascular flow using Poiseuille's Law; equations of fluid flow (Continuity, Bernoulli, Navier-Stokes). In addition, the course will also cover the principles of microcirculation briefly, as well as the principles of pulsatile flow and wave propagation in both rigid and elastic vessels. Lastly, we will briefly cover the concepts of large artery hemodynamics and its effect on the vascular disease and medical imaging and blood flow (i.e., Doppler flow imaging, phase-contrast MRI and arterial spin labeling) techniques. (Prerequisite: BIME-320 or MECE-210 or CHME-321 or equivalent course and graduate student standing.) **Lecture 3, Credits 3 (Fall)**

BIME-670

Tissue Engineering

This course is intended to provide an overview of how replacement organs and tissues can be engineered using both natural and synthetic biomaterials that direct cellular differentiation and integration. The objectives of the course are to present how tissues can be engineered using the physical and chemical properties of biomaterials and targeted differentiation of multi- and pluripotent stem cells. Topics include the adhesion, migration, growth and differentiation of cells as well as the optimization and modeling of molecular and cellular transport within and across engineered tissues. Additionally, the course will investigate the engineering parameters and necessary functionality of artificial tissues. There is no laboratory component to this course. Graduate students will work in pairs to present one of the engineering fundamentals lectures listed in section 6.3 as it applies to tissue engineering. Additionally, graduate students will also be responsible for independently researching and presenting a case study on the use of stem cells in tissue engineering at the conclusion of the course. (Prerequisite: BIME-370 and MECE-557 or MECE-657 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

BIME-675

Practical Methods in Tissue Engineering

This hands-on course gives engineering students experience with advanced, state of the art production and application of biomaterials, cell culture methods and analysis techniques used in the area of tissue engineering. In this project-based course, students will work on experiments relating to current literature and will learn how to critically analyze and scientifically summarize the obtained results. Students will use their knowledge and experience to finally design and conduct their independent experiment related to broadly defined topics in the area of tissue engineering. (Prerequisites: BIME-470 or equivalent course.) **Lab 3, Credits 3 (Fall)**

BIME-675

Practical Methods in Tissue Engineering

This hands-on course gives engineering students experience with advanced, state of the art production and application of biomaterials, cell culture methods and analysis techniques used in the area of tissue engineering. In this project-based course, students will work on experiments relating to current literature and will learn how to critically analyze and scientifically summarize the obtained results. Students will use their knowledge and experience to finally design and conduct their independent experiment related to broadly defined topics in the area of tissue engineering. (Prerequisites: BIME-470 or equivalent course.) **Lecture 2, Credits 3 (Fall)**

BIME-689

Special Topics

Topics and subject areas that are not regularly offered are provided under this course. Such courses are offered in a normal format; that is, regularly scheduled class sessions with an instructor. The level of complexity is commensurate with a graduate technical course. **Lecture 3, Credits 3 (Fall or Spring)**

BIME-697

Graduate Research Practicum

This course will give students supervised practical training within academic research laboratories prior to conducting their own dissertation research. Students will identify a laboratory or laboratories to conduct the research with the permission of the graduate director and principal investigator. For each practicum, students will complete a brief critical literature review in the sub-field of the particular laboratory with the principal investigator. Students will then be trained on experimental or computational methods and learn relevant applied data analysis techniques. The practicum will conclude with a written summary and oral presentation. A typical 2 credit practicum is 120 hours of research training in a laboratory. Students will typically enroll in either 2 or 4 credits per semester (1 or 2 practicums) with a maximum of 6 credits earned during the degree program. (This course is available to RIT degree-seeking graduate students.) **Project 10, Credits 2 - 6 (Fall, Spring, Summer)**

BIME-699

Graduate Co-op

One term of experiential learning or work experience in biomedical engineering. **CO OP, Credits 0 (Fall, Spring, Summer)**

BIME-749

Graduate Literature Review

This course will introduce students to the methods involved in conducting a review of existing research. Students will also review current journal articles within a specific research domain identified by the course instructor that will vary between offerings. The course will allow flexibility for students to select and critically review articles that align with their research interests within this domain. It will culminate with a synthesis of a detailed outline connecting the ideas across the reviews that could be used for a topical review or research proposal. (This course is available to RIT degree-seeking graduate students.) **Lecture 3, Credits 3 (Fall, Spring)**

BIME-750

Statistical Analysis and Modeling of Biomedical Data

This course will expose student to the basic properties of data collected from biological systems and issues involved in the statistical analysis of such data. Specifically, this course will review the motivations and rationale behind conventional regression models, issues that arise in applying these methods to biological data, and specific extensions of these methods required to obtain meaningful results. Specific examples of these approaches and their application will be given at different levels of biology. The analysis of such problems will require the use of advanced regression techniques directed at resolving the partial confounding that is typical of living (closed loop regulated) systems, applied under statistical software packages (e.g., spreadsheets, graphing, Matlab, SPSS, Simca). (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lab 3, Credits 3 (Biannual)**

BIME-770

Engineering Cell-Substrate Interactions

Students will be introduced to both the material and cellular aspects that control and regulate cell-substrate interactions and the resulting cellular behavior including spreading, adhesion, migration and differentiation. Key material physical and surface chemistry properties will be explored as well as cellular adhesion molecules and cytoskeletal structures. In addition, cellular signaling pathways related to mechanobiology including YAP/TAZ will be discussed using current peer-review journal articles. Students will also design and propose a cell-substrate interaction study and execute feasibility experiments. (Prerequisite: BIME 470 or BIME 570 or BIME 670 or MECE 557 or MECE 657 or equivalent courses.) **Lecture 3, Credits 3 (Spring)**

BIME-791

Graduate Biomedical Laboratory

This course provides students with a variety of lab experiences across many specialties of biomedical engineering. Experiments emphasize proper data collection and analysis as well as critical reading and scientific writing. (This course is available to RIT degree-seeking graduate students.) **Lab 6, Credits 4 (Fall)**

BIME-791

Graduate Biomedical Laboratory

This course provides students with a variety of lab experiences across many specialties of biomedical engineering. Experiments emphasize proper data collection and analysis as well as critical reading and scientific writing. (This course is available to RIT degree-seeking graduate students.) **Lecture 2, Credits 4 (Fall)**

BIME-792

Project with Paper

This course is used by students in the Biomedical Engineering MS degree program as a capstone experience following completion of BIME 607 Graduate Bidesign. Students will learn and apply advanced Bidesign strategies related to intellectual property, regulatory approval, and potential commercialization, completing a series of modules with specific learning goals. The course will include the design and fabrication of product concepts using rapid prototyping tools. Students completing an internship may use that experience as motivation for their project in this course. Students must work with a faculty advisor who will approve their topic and review their progress throughout the completion of this capstone experience. A written paper and presentation of the work as well as a prototype are required. (Prereq: BIME-607) **Ind Study 6, Credits 6 (Fall, Spring, Summer)**

BIME-799

Graduate Independent Study

Allows graduate students an opportunity to independently investigate, under faculty supervision, aspects of the field of biomedical engineering that are not sufficiently covered in existing courses. Proposals for independent study activities must be approved by both the faculty member supervising and the graduate program director. (This course is available to RIT degree-seeking graduate students.) **Ind Study 3, Credits 1 - 3 (Fall, Spring, Summer)**

Chemical Engineering

CHME-610

Advanced Thermodynamics

This course extends the concepts of energy, entropy, phase equilibrium and multi-component mixtures from ideal to real fluids via the introduction of state functions, fluid models and generalized conditions for equilibrium of solutions and phases. Models for real-fluid behavior are implemented in the context of actual chemical processes. Additionally, real-fluid behavior is linked to molecular properties in order to introduce predictive approaches to fluid behavior. **Lecture 3, Credits 3 (Fall, Spring)**

CHME-611

Statistical Thermodynamics

This course draws a connection between molecular scale phenomena and concepts in undergraduate chemical engineering thermodynamics. The ideal gas law is derived from first principles, entropy is defined from a molecular perspective, and chemical potential (and fugacity) is viewed as a derivative of the partition function rather than an "ad-hoc" correction parameter for vapor-liquid equilibrium. Using the thermodynamic ensembles and multivariable calculus, a unified approach to convert between all thermodynamic variables is presented. A special emphasis is provided on the phase separation of gas-mixtures and liquid-mixtures to enable the design of solvents for applications. **Lecture 3, Credits 3 (Fall, Spring)**

CHME-620

Transport Phenomena

Fundamentals of fluid flow are examined on a differential scale. Local differential equations governing fluid flow are derived from their corresponding integral forms using classical integral theorems. The form of these equations in various coordinate systems is examined. Exact solutions of differential equations are considered under both steady state and transient conditions, as are typical approximations to those equations such as creeping, potential, lubrication, and boundary layer flows. The theoretical basis of these approximations are unified via asymptotic theory. Forces on surfaces are determined by coupling differential velocity and pressure fields with appropriate integral representations. **Lecture 3, Credits 3 (Fall, Spring)**

CHME-640

Advanced Reaction Engineering

The application of ideal reactor concepts and analyses is extended to the design, modeling and performance evaluation of reactors used in manufacturing processes. Catalytic reactions are discussed in terms of mechanisms and kinetics, and used to design, model and evaluate the performance of fixed bed, suspended bed and other types of catalytic reactors. Concepts of mass transport limitations and non-ideal flows are introduced to provide the framework for the analysis of deviations from ideal behavior experienced by real reactors. **Lecture 3, Credits 3 (Fall, Spring)**

CHME-650

Electrochemical Engineering

The course focuses on applications of electrochemical phenomena with examples of practical materials and processes. Fundamental considerations will include charge transfer at electrode/electrolyte interphases, surface modification by electrodeposition and etching, and corrosion. Electroanalytical techniques will be described including potentiometry, voltammetry, and electrochemical impedance analysis. Applications of electrochemical engineering will be summarized in detail for batteries, capacitors, and fuel cells; including conventional materials and fabrication techniques. A special emphasis on the use of nanomaterials in electrochemical engineering will be investigated. **Lecture 3, Credits 3 (Fall, Spring)**

CHME-689

Special Topics

Topics and subject areas that are not regularly offered are provided under this course. Such courses are offered in a normal format; that is, regularly scheduled class sessions with an instructor. The level of complexity is commensurate with an upper-level undergraduate technical course. **Lecture 3, Credits 3 (Fall, Spring)**

CHME-699

Graduate Co-op

Up to six months of full-time, paid employment in the chemical engineering field. See the Department Graduate Program Director or RIT's Office of Career Services and Cooperative Education for further details. (Prerequisites: Graduate standing in Chemical Engineering, completed at least 18 credits and students with at least a 3.0 cumulative GPA.) **CO OP, Credits 0 (Fall, Spring, Summer)**

CHME-709

Advanced Engineering Mathematics

The course begins with a pertinent review of linear and nonlinear ordinary differential equations and Laplace transforms and their applications to solving engineering problems. It then continues with an in-depth study of vector calculus, complex analysis/integration, and partial differential equations; and their applications in analyzing and solving a variety of engineering problems. Topics include: ordinary and partial differential equations, Laplace transforms, vector calculus, complex functions/analysis, complex integration. Chemical engineering applications will be discussed throughout the course. (Prerequisites: Graduate standing in Chemical Engineering.) **Lecture 3, Credits 3 (Fall)**

CHME-777

Graduate Internship

This course is used by students as a qualifying capstone experience to their M.S. degree. Students must submit a 1-page proposal for the internship, to be approved by an employing supervisor and the Chemical Engineering department prior to enrolling. The work may involve research and/or design project with demonstration of acquired knowledge. The project scope should be developed with the intent of being completed in a single academic semester. In all instances, an evaluation report submitted to the employing supervisor of the work is required to satisfy the capstone experience. (Prerequisites: Graduate standing in Chemical Engineering.) **Internship 3, Credits 3 (Fall, Spring, Summer)**

CHME-789

Special Topics

The chemical engineering curriculum are provided under the title of Special Topics. Such courses are offered in a normal format; that is, regularly scheduled class sessions with an instructor. **Lecture 3, Credits 3 (Fall, Spring)**

CHME-792

Project with Paper

This course is used by students as a qualifying capstone experience to their M.S. degree. The student must demonstrate an acquired competence in a topic that is chosen in conference with a faculty advisor. The work may involve a research and/or design project with demonstration of acquired knowledge. The project scope should be designed with the intent of being completed in a single academic semester. In all instances, a final report determined by the faculty advisor/ supervisor of the work are required to satisfy the capstone experience. (Prerequisites: Graduate standing in Chemical Engineering.) **Ind Study 3, Credits 3 (Fall, Spring, Summer)**

CHME-799**Independent Study**

Allows graduate students an opportunity to independently investigate, under faculty supervision, aspects of the field of chemical engineering that are not sufficiently covered in existing courses. Proposals for independent study activities are subject to approval by both the faculty member supervising the independent study and the department head. **Ind Study, Credits 1 -4 (Fall, Spring, Summer)**

Computer Engineering

CMPE-610**Analytical Topics in Computer Engineering**

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. Other topics include symbolic logic and optimization techniques. (Prerequisites: CMPE-480 and (MATH-251 or 1016-345) or graduate standing in the CMPE-MS program.) **Lecture 3, Credits 3 (Fall, Spring)**

CMPE-630**Digital Integrated Circuit Design**

This course will cover the basic theory and techniques of Digital Integrated Circuit Design in CMOS technology. Topics include CMOS transistor theory and operation, design and implementation of CMOS circuits, fabrication process, layout and physical design, delay and power models, static and dynamic logic families, testing and verification, memory and nanoscale technologies. Laboratory assignments and project facilitate in hands-on learning of circuit-level design and simulation, layout and parasitic extractions, pre and post-layout verification and validation, full-custom flow and Synthesis based flow, using industry standard CAD tools. (Prerequisites: CMPE-260 and EEEE-282 and (EEEE-380 or EEEE-381) or equivalent courses.) **Lab 2, Credits 3 (Fall, Spring)**

CMPE-630**Digital Integrated Circuit Design**

This course will cover the basic theory and techniques of Digital Integrated Circuit Design in CMOS technology. Topics include CMOS transistor theory and operation, design and implementation of CMOS circuits, fabrication process, layout and physical design, delay and power models, static and dynamic logic families, testing and verification, memory and nanoscale technologies. Laboratory assignments and project facilitate in hands-on learning of circuit-level design and simulation, layout and parasitic extractions, pre and post-layout verification and validation, full-custom flow and Synthesis based flow, using industry standard CAD tools. (Prerequisites: CMPE-260 and EEEE-282 and (EEEE-380 or EEEE-381) or equivalent courses.) **Lecture 3, Credits 3 (Fall, Spring)**

CMPE-640**Control Systems**

This course introduces students to the study of linear control systems, their behavior and design and use in augmenting engineering system performance. This is accomplished through classical control methods that employ the use of Laplace transforms, block diagrams, root locus, and frequency domain diagrams. Topics include: Laplace transform review, system modeling for control, fundamentals of time response behavior, stability analysis, steady-state error and design, feedback control properties, PID control, root locus analysis and design, and frequency response design. **Lecture 3, Credits 3 (Spring)**

CMPE-655**Multiple Processor Systems**

The course 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 typology of interconnection networks used in the design. The suitability of various architectures in meeting demands is studied in depth including the study of representative examples of current commercial machines. Students will complete programming assignments on a parallel computer illustrating practical issues. A review and analysis of a commercial parallel processor system or an active research area is required; written review presented in class. (Prerequisite: CMPE-550 or equivalent course or graduate standing in the CMPE-MS program.) **Lecture 3, Credits 3 (Fall, Spring)**

CMPE-660**Reconfigurable Computing**

The objective of this course is to present the foundations of reconfigurable computing methodologies from both hardware and software perspectives. Topics covered are: architectures of modern field programmable gate arrays (FPGAs), digital system design methodologies using FPGAs, hardware-software co-design with embedded processors, hardware optimization techniques, system level integration under operating system, dynamic reconfiguration. Laboratory projects in which students will acquire a solid capability of Xilinx CAD tools and FPGA devices are required. The projects include the whole design flow: design of the system, VHDL modeling, software and hardware development, FPGA verification. (Prerequisites: CMPE-260 or equivalent course or graduate standing in the CMPE-MS program.) **Studio 3, Credits 3 (Fall)**

CMPE-661**Hardware and Software Design for Cryptographic Applications**

The objective of this course is to build knowledge and skills necessary for efficient implementations of cryptographic primitives on reconfigurable hardware. The implementation platform will be a field programmable gate array (FPGA) containing a general purpose processor and additional reconfigurable fabric for implementations of custom hardware accelerators. In the studio format, team projects require design of selected cryptographic primitives followed by comparison and contrast of various implementation alternatives, such as software, custom FPGA hardware, and hybrid hardware-software co-design. Project teams are ideally composed of one Computer Engineering student and one Software Engineering or Computer Science student. Computer Engineering students lead the hardware design portions of each project, and Software Engineering and Computer Science students lead the software development portions. Topics may include binary finite field arithmetic, block ciphers, hash functions, counter mode of operation for block ciphers, public key cryptosystems, hardware/software co-design methodologies with FPGAs, software development and profiling, high level synthesis, on-chip buses, hardware/software interfaces, custom hardware accelerators and side channel attacks. (Prerequisites: CMPE-260 or CMPE-240 or equivalent course or graduate standing in the CMPE-MS program.) **Studio 2, Credits 3 (Spring)**

CMPE-663**Real-time and Embedded Systems**

This first course in a graduate elective sequence will begin by presenting a general road map of real-time and embedded systems. The course will be conducted in a studio class/lab format with lecture material interspersed with laboratory work. This course will introduce a representative family of microcontrollers that will exemplify unique positive features as well as limitations of microcontrollers in embedded and real-time systems. These microcontrollers will then be used as external, independent performance monitors of more complex real-time systems. The majority of the course will present material on a commercial real-time operating system and using it for programming projects on development systems and embedded target systems. Some fundamental material on real-time operating systems and multiprocessor considerations for real-time systems will also be presented. Examples include scheduling algorithms, priority inversion, and hardware-software co-design. (Prerequisites: CMPE-380 or SWEN-220 or graduate standing in the CMPE-MS program.) **Lecture 3, Credits 3 (Fall)**

CMPE-664**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 system models 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. (Prerequisite: SWEN-220 or CSCI-251 or CMPE-380 or graduate standing in the CMPE-MS program.) **Lecture 3, Credits 3 (Spring)**

CMPE-665**Performance Engineering of Real-Time and Embedded Systems**

This course discusses issues of performance in real-time and embedded systems. Techniques for profiling the resource usage of a system and for measuring the effect of increasing system requirements will be covered. The control of physical systems will motivate the need for performance tuning of a real-time system. Students will write programs running under a real-time operating system that can maintain control of a physical system. The course will discuss and experiment with performance trade-offs that can be made using hardware-software co-design. (Prerequisite: SWEN-220 or CSCI-251 or CMPE-380 or graduate standing in the CMPE-MS program.) **Lecture 3, Credits 3 (Fall)**

CMPE-670**Data and Communication Networks**

This course will give an overview of the technologies, architectures and protocols used to build various types of computer and communication networks - wired or wireless. The emphasis will be placed on discussions of various network design problems and solution approaches. Specific issues covered in this course include: framing and coding, error detection, multiple access control, addressing, routing, flow and congestion control, scheduling and switching. (Prerequisite: MATH-251 or 1016-345 or graduate standing in the CMPE-MS program.) **Lecture 3, Credits 3 (Fall, Spring)**

CMPE-675**Robotics: Embedded and Autonomous Systems**

This course covers an overview of robotics topics with an AI influence. Includes hands-on laboratory with low level microcontroller programming driving a Lynxmotion 4WD chassis. Course has a strong emphasis on robotics related input and output device inter-facing. Course topics include microcontrollers, control systems, vision, path planning localization, and machine learning. Term project of student choosing emphasizes a specific robotic topic. (Prerequisites: CMPE-380, CMPE-460 and CMPE-480 or equivalent courses or graduate standing in the CMPE-MS program.) **Lab 2, Credits 3 (Summer)**

CMPE-675

Robotics: Embedded and Autonomous Systems

This course covers an overview of robotics topics with an AI influence. Includes hands-on laboratory with low level microcontroller programming driving a Lynxmotion 4WD chassis. Course has a strong emphasis on robotics related input and output device inter-facing. Course topics include microcontrollers, control systems, vision, path planning localization, and machine learning. Term project of student choosing emphasizes a specific robotic topic. (Prerequisites: CMPE-380, CMPE-460 and CMPE-480 or equivalent courses or graduate standing in the CMPE-MS program.) **Lecture 3, Credits 3 (Summer)**

CMPE-677

Machine Intelligence

Machine intelligence teaches devices how to learn a task without explicitly programming them how to do it. Example applications include voice recognition, automatic route planning, recommender systems, medical diagnosis, robot control, and even Web searches. This course covers an overview of machine learning topics with a computer engineering influence. Includes Matlab programming. Course topics include unsupervised and supervised methods, regression vs. classification, principal component analysis vs. manifold learning, feature selection and normalization, and multiple classification methods (logistic regression, regression trees, Bayes nets, support vector machines, artificial neural networks, sparse representations, and deep learning). (Prerequisites: CMPE-380 and CMPE-480 and MATH-251 or graduate standing in the CMPE-MS, CMPE-BS/MS program.) **Lecture 3, Credits 3 (Fall)**

CMPE-679

Deep Learning

Deep learning has been revolutionizing the fields of object detection, classification, speech recognition, natural language processing, action recognition, scene understanding, and general pattern recognition. In some cases, results are on par with and even surpass the abilities of humans. Activity in this space is pervasive, ranging from academic institutions to small startups to large corporations. This course emphasizes convolutional neural networks (CNNs) and recurrent neural networks (RNNs), but additionally covers reinforcement learning and generative adversarial networks. In addition to achieving a comprehensive theoretical understanding, students will understand current state-of-the-art methods, and get hands-on experience at training custom models using popular deep learning frameworks. (Prerequisites: CMPE-677 or equivalent course and students in CMPE-BS or CMPE-MS programs.) **Lecture 3, Credits 3 (Spring)**

CMPE-680

Digital Image Processing Algorithms

Emphasizes both theory and implementation of image processing algorithms. Two-dimensional filtering, sampling, and transforms 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. (Prerequisites: CMPE-480 or equivalent course or graduate standing in the CMPE-MS program.) **Lecture 4, Credits 3 (Fall)**

CMPE-685

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. (Prerequisites: CMPE-480 or equivalent course or graduate standing in the CMPE-MS program.) **Lecture 3, Credits 3 (Spring)**

CMPE-699

Graduate Co-op

Graduate co-op aims to enhance the educational experience of graduate students through full-time paid employment during an academic term at positions in the Computer Engineering field. Registration is optional and is recommended for summer term only after the completion of all course work. **CO OP, Credits 0 (Fall, Spring, Summer)**

CMPE-730

Advanced Digital Integrated Circuit Design

This course covers techniques for high-performance, low power and reliability in digital integrated circuit design from a systems perspective. Emphasis will be on the most important design challenges, being the impact of scaling, interconnect, signal integrity, power and timing. Presentation and term paper based on current research articles is required. Laboratory assignments are based on real time applications. Design process starting from logic synthesis down to layout synthesis will be covered in the laboratory, with industry standard CAD tools. (Prerequisites: CMPE-530 or CMPE-630 or equivalent course.) **Lab 2, Credits 3 (Spring)**

CMPE-730

Advanced Digital Integrated Circuit Design

This course covers techniques for high-performance, low power and reliability in digital integrated circuit design from a systems perspective. Emphasis will be on the most important design challenges, being the impact of scaling, interconnect, signal integrity, power and timing. Presentation and term paper based on current research articles is required. Laboratory assignments are based on real time applications. Design process starting from logic synthesis down to layout synthesis will be covered in the laboratory, with industry standard CAD tools. (Prerequisites: CMPE-530 or CMPE-630 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

CMPE-731

Design and Test of Multi-Core Chips

Massive levels of integration following Moore's Law is making modern multi-core chips all-pervasive in several domains ranging from scientific applications like weather forecasting, astronomical data analysis, bioinformatics applications to even consumer electronics. This course introduces students to current and future trends in IC Design. Students learn to identify bottlenecks in designing state-of-the-art multicore System-on-Chips (SoCs) and propose solutions to such design challenges from a cross-layer perspective spanning multiple levels of abstraction in the design process. Low-power and high-speed testing of multicore chips is an important design issue in Design for Testability (DFT) of such massive multicore systems. In this course students learn various issues and solutions to ongoing challenges in SoC testing. The instruction will rely on lectures, textbooks, seminal and cutting edge publication articles and term projects. Students will be evaluated based on homework assignments, class presentations, examinations and projects. (Prerequisites: CMPE-530 or CMPE-630 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

CMPE-750

Advanced Computer Architecture

The goal of this course is to acquire a good understanding of important current and emerging design techniques, machine structures, technology factors, and evaluation methods that will determine the form of high-performance advanced programmable processor architectures in the 21st Century. The topics covered include Simultaneous Multithreading (SMT), Vector Processing, Digital Signal Processing (DSP), Media Architectures and Processors, Re-Configurable Computing and Processors, Advanced Branch Prediction Techniques, and Redundant Arrays of Disks (RAID). The course also provides an introduction to the main concepts of parallelism including single-chip multiprocessors. (Prerequisite: CMPE-550 or equivalent course or graduate standing in the CMPE-MS program.) **Lecture 4, Credits 3 (Fall)**

CMPE-755

High Performance Architectures

This course will focus on learning and understanding the available hardware options to satisfy the needs of high performance and computational intensive applications. Special attention will be paid to single platform massively parallel devices, their programming and efficient use of the hardware resources. The course will include hands on work with the actual device, lab work, and technical reports and conference paper reading as a relevant source information. (Prerequisite: CMPE-350 or equivalent course or graduate standing in the CMPE-MS program.) **Lecture 3, Credits 3 (Fall)**

CMPE-765

Brain Inspired Computing

This course is primarily designed for graduate students and will expose them to theoretical and practical aspects of brain-inspired computing. It will offer students the opportunity to understand how the human brain computes to achieve intelligent behavior and how this understanding guides the development of new neural algorithms. We will identify the key developments and large issues at stake, and study brain inspired systems in the context of pragmatic applications. At the end of the course the students are expected to have expanded their knowledge of how the brain processes information, and how one can develop neuro-morphic algorithms to tackle emergent spatio-temporal problems. (Prerequisites: CMPE-260 and MATH-251 or equivalent course or graduate standing in CMPE-MS.) **Lecture 3, Credits 3 (Spring)**

CMPE-770

Wireless Networks

This course will give an overview of the technologies, architectures and protocols used to build various types of computer and communication networks - wired or wireless. The emphasis will be placed on discussions of various network design problems and solution approaches. Specific issues covered in this course include: framing and coding, error detection, multiple access control, addressing, routing, flow and congestion control, scheduling and switching. (Prerequisites: CMPE-570 or CMPE-670 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

CMPE-784

Cognitive Radios and Networks

This course studies multiple aspects of cognitive radios and their operation in a cognitive network. Cognitive radios are an artificial intelligence agent that, instead of operating in the more common three-dimensional physical space that surround us, it learns and operates in the "virtual" space of the radio spectrum. Topics to be covered include an overview of wireless channels and wireless communications, cognitive radios network paradigms, spectrum sensing and dynamic spectrum access, spectrum exploration and exploitation through game theory and machine learning, cross-layer cognitive radios and cognitive networking. (Prerequisite: CMPE-570 or CMPE-670 or equivalent course or graduate standing in the CMPE-MS program.) **Lecture 3, Credits 3 (Fall)**

CMPE-788

Machine Learning for Cybersecurity Analytics

This course is a semester-long project-based course, where students learn to select and apply machine learning and data science (ML/DS) techniques to solve cybersecurity problems. Through learning-by-doing, students will discover cybersecurity challenges and how ML/DS can help overcome the challenges as well as the limitations of ML/DS. Students will explore and choose appropriate ML/DS approaches, design and conduct experiments with open-domain cybersecurity data, and deduce and present findings to practice analytical and critical thinking skills. The course will progress in tightly guided and coupled stages: data and feature analysis, literature review and problem discovery, ML technique exploration, experimental design, result interpretation and analysis, professional project dissemination, and constructive peer reviews. (Prerequisites: CSEC-520 or EEET-520 or CMPE-610 or equivalent courses.) **Lecture 3, Credits 3 (Spring)**

CMPE-789

Special Topics

Graduate level topics and subject areas that are not among the courses typically offered are provided under the title of Special Topics. Such courses are offered in a normal format; that is, regularly scheduled class sessions with an instructor. (This class is restricted to students in the CMPE-BS, CMPE-MS or CMPE-BS/MS programs.) **Lecture 3, Credits 3 (Fall, Spring)**

CMPE-790

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. (Enrollment in this course requires permission from the department offering the course.) **Thesis, Credits 1 - 9 (Fall, Spring, Summer)**

CMPE-792

Graduate Project

Graduate Project is a scholarly undertaking that addresses an immediate and practical problem with tangible outcomes. A formal report, presentation, or demonstration is required. The student must obtain the approval of an appropriate faculty adviser to guide the project before registering. (This class is restricted to students in the CMPE-MS, CMPE-BS/MS program.) **Project, Credits 3 (Fall, Spring, Summer)**

CMPE-795

Graduate Seminar

The graduate seminar prepares graduate students to effectively conduct their thesis research and expose them to current research in various areas of computer engineering. Current literature topics are reviewed through interactive presentations and discussions. (This class is restricted to students in the CMPE-MS, CMPE-BS/MS program.) **Seminar, Credits 0 (Fall, Spring)**

CMPE-796

Thesis and Project Initiation Seminar

The objective of this seminar is to engage the students in the preparation and completion of their thesis Proposal. The students will learn about the resources available at RIT to support their work as well as general guidelines and practices that should lead to a good thesis proposal. (Prerequisites: CMPE-795 or equivalent course.) **Seminar 1, Credits 0 (Fall, Spring)**

CMPE-799

Independent Study

Allows graduate students an opportunity to independently investigate, under faculty supervision, aspects of the field of computer engineering that are not sufficiently covered in existing courses. Proposals for independent study activities are subject to approval by both the faculty member supervising the independent study and the department head. (Enrollment in this course requires permission from the department offering the course.) **Ind Study, Credits 1 - 3 (Fall, Spring, Summer)**

Electrical Engineering

EEEE-602

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 theory, random processes, stationarity and ergodicity, auto correlation, cross-correlation and power spectrum density, response of linear prediction, Wiener filtering, elements of detection, matched filters. (Prerequisites: This course is restricted to graduate students in the EEEE-MS, EEEE-BS/MS program.) **Lecture 3, Credits 3 (Fall, Spring)**

EEEE-605

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 optical fiber communications, image processing, super-resolution imaging, optical properties of materials, and novel optical materials. Topics covered: geometrical optics, propagation of light, diffraction, interferometry, Fourier optics, optical properties of materials, polarization and liquid crystals, and fiber optics. In all topics, light will be viewed as signals that carry information (data) in the time or spatial domain. After taking this course, the students should have a firm foundation in classical optics. (Prerequisite: EEEE-374 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

EEEE-610

Analog Electronics Design

This is a foundation course in analog integrated electronic circuit design and is a prerequisite for the graduate courses in analog integrated circuit design EEEE-726 and EEEE-730. The course covers the following topics: (1)CMOS Technology (2) CMOS active and passive element models (3) Noise mechanisms and circuit noise analysis (4) Current mirrors (5) Differential amplifiers, cascade amplifiers (6) Multistage amps and common mode feedback (7) Stability analysis of feedback amplifiers; (8) Advanced current mirrors, amplifiers, and comparators (9) Band gap and translinear cells (10) Matching. (Prerequisites: EEEE-480 or equivalent course or graduate standing in EEEE-MS.) **Lecture 3, Credits 3 (Fall)**

EEEE-615

Embedded Systems for Mechatronics

This course introduces the principles of Matlab, Simulink and Embedded Systems through the use of examples, problems, and a hands-on learning approach. Matlab topics include: Matlab basic function usage, matrix manipulation, polynomials, programming loops, operators, logical operations, conditional flow control, m-files, data import/export, plotting, data analysis, custom functions, differential equation solvers, Fourier transforms, systems modeling, and introduction to external interfaces. Simulink topics include: creating a model file, basic block manipulation, interfacing with Matlab, modeling and solutions of systems, creating subsystems, S-functions, and custom blocks. This course introduces embedded systems programming with microprocessors focusing on measuring input, manipulating data, and controlling output. Several systems-level examples are presented. (Enrollment in this course requires permission from the department offering the course.) **Lecture 3, Credits 3 (Spring)**

EEEE-617

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, microwave resonators and filters. Microwave circuit design projects will be performed using Ansoft's Designer software. (Prerequisites: EEEE-374 or equivalent course or graduate standing in EEEE-MS.) **Lecture 3, Credits 3 (Spring)**

EEEE-620

Design of Digital Systems

The purpose of this course is to expose students to complete, custom design of a CMOS digital system. It emphasizes equally analytical and CAD based design methodologies, starting at the highest level of abstraction (RTL, front-end)), and down to the physical implementation level (back-end). In the lab students learn how to capture a design using both schematic and hardware description languages, how to synthesize a design, and how to custom layout a design. Testing, debugging, and verification strategies are formally introduced in the lecture, and practically applied in the lab projects. Students are further required to choose a research topic in the area of digital systems, perform bibliographic research, and write a research paper following a prescribed format. (Prerequisites: EEEE-420 and EEEE-480 or equivalent courses or graduate standing in EEEE-MS.) **Lab 3, Credits 3 (Fall, Spring)**

EEEE-620

Design of Digital Systems

The purpose of this course is to expose students to complete, custom design of a CMOS digital system. It emphasizes equally analytical and CAD based design methodologies, starting at the highest level of abstraction (RTL, front-end)), and down to the physical implementation level (back-end). In the lab students learn how to capture a design using both schematic and hardware description languages, how to synthesize a design, and how to custom layout a design. Testing, debugging, and verification strategies are formally introduced in the lecture, and practically applied in the lab projects. Students are further required to choose a research topic in the area of digital systems, perform bibliographic research, and write a research paper following a prescribed format. (Prerequisites: EEEE-420 and EEEE-480 or equivalent courses or graduate standing in EEEE-MS.) **Lecture 3, Credits 3 (Fall, Spring)**

EEEE-621

Design of Computer Systems

The purpose of this course is to expose students to the design of single and multicore computer systems. The lectures cover the design principles of instructions set architectures, non-pipelined data paths, control unit, pipelined data paths, hierarchical memory (cache), and multicore processors. The design constraints and the interdependencies of computer systems building blocks are being presented. The operation of single core, multicore, vector, VLIW, and EPIC processors is explained. In the first half of the semester, the lab projects enforce the material presented in the lectures through the design and physical emulation of a pipelined, single core processor. This is then being used in the second half of the semester to create a multicore computer system. The importance of hardware/software co-design is emphasized throughout the course. Students are further required to choose a research topic in the area of computer systems, perform bibliographic research, and write a research paper following a prescribed format. (Prerequisites: EEEE-420 or equivalent course or graduate standing in EEEE-MS.) **Lab 2, Credits 3 (Fall)**

EEEE-621

Design of Computer Systems

The purpose of this course is to expose students to the design of single and multicore computer systems. The lectures cover the design principles of instructions set architectures, non-pipelined data paths, control unit, pipelined data paths, hierarchical memory (cache), and multicore processors. The design constraints and the interdependencies of computer systems building blocks are being presented. The operation of single core, multicore, vector, VLIW, and EPIC processors is explained. In the first half of the semester, the lab projects enforce the material presented in the lectures through the design and physical emulation of a pipelined, single core processor. This is then being used in the second half of the semester to create a multicore computer system. The importance of hardware/software co-design is emphasized throughout the course. Students are further required to choose a research topic in the area of computer systems, perform bibliographic research, and write a research paper following a prescribed format. (Prerequisites: EEEE-420 or equivalent course or graduate standing in EEEE-MS.) **Lecture 3, Credits 3 (Fall)**

EEEE-622

Electric Power Transmission and Distribution

This course deals with the topics related to electric power transmission and distribution. Topics covered in this course include: Three Phase System – Wye and Delta connections, Transformers – equivalent circuit –performance characteristics, Balanced and Unbalanced System Analysis, Transmission and Distribution Line Design Considerations, Transmission Line Protection, Transmission Line Faults and Fault Analysis. (Prerequisites: EEEE-321 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

EEEE-624

Advances in Power Systems

This course will introduce the details of electric power markets and the techniques to better use the available resources. Topics include the description of steam generation and renewable energy sources. Formulation of the cost associated with the generation and the optimization methods to minimize this cost in the economic dispatch problem. Unit commitment. Optimal power flow formulation and its solution methods. Introduction to smart grid technologies and challenges. (Prerequisite: EEEE-622 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

EEEE-625

Lab Applications in Mechatronics

This course provides a culminating experience for the mechatronics engineering certificate, relying upon the completed course work and culminating in development of laboratory experiences related to mechatronics. Students enrolled in the course will design and prepare a novel lab experiment and complete lab experiments created by peers. (BS in Engineering) (Prerequisites: EEEE-451 or equivalent course.) **Lab 1, Credits 3**

EEEE-625

Lab Applications in Mechatronics

This course provides a culminating experience for the mechatronics engineering certificate, relying upon the completed course work and culminating in development of laboratory experiences related to mechatronics. Students enrolled in the course will design and prepare a novel lab experiment and complete lab experiments created by peers. (BS in Engineering) (Prerequisites: EEEE-451 or equivalent course.) **Lecture 2, Credits 3**

EEEE-629

Antenna Theory

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, antenna synthesis, aperture antennas and reflector antennas. A significant portion of the course involves design projects using some commercial EM software such as Ansoft Designer, Ansoft HFSS and SONNET and developing Matlab codes from theory for antenna synthesis and antenna array design. The measurement of antenna input and radiation characteristics will be demonstrated with the use of network analyzers, and spectrum analyzers in an anechoic chamber. (Prerequisites: EEEE-374 or equivalent course or graduate standing in EEEE-MS.) **Lecture 3, Credits 3 (Fall)**

EEEE-630

Biomedical Instrumentation

Study of fundamental principles of electronic instrumentation and design consideration associated with biomedical measurements and monitoring. Topics to be covered include biomedical signals and transducer principles, instrumentation system fundamentals and electrical safety considerations, amplifier circuits and design for analog signal processing and conditioning of physiological voltages and currents as well as basic data conversion and processing technology. Laboratory experiments involving instrumentation circuit design and test will be conducted. (Prerequisites: EEEE-380 or equivalent course. Corequisites: EEEE-480 or equivalent course.) **Lab 3, Credits 3 (Fall)**

EEEE-630

Biomedical Instrumentation

Study of fundamental principles of electronic instrumentation and design consideration associated with biomedical measurements and monitoring. Topics to be covered include biomedical signals and transducer principles, instrumentation system fundamentals and electrical safety considerations, amplifier circuits and design for analog signal processing and conditioning of physiological voltages and currents as well as basic data conversion and processing technology. Laboratory experiments involving instrumentation circuit design and test will be conducted. (Prerequisites: EEEE-380 or equivalent course. Corequisites: EEEE-480 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

EEEE-631

Biomed Sensors and Transducers I

Biological entities represent one of the most difficult environments in which to obtain or generate accurate and reliable signals. This course will discuss the techniques, mechanisms and methods necessary to transfer accurate and reliable information or signals with a biological target. Various biomedical sensor and transducer types including their characteristics, advantages, disadvantages and signal conditioning will be covered. Discussions will include the challenges associated with providing a reliable and reproducible interface to a biological entity, the nature and characteristics of the associated signals, the types of applicable sensors and transducers and the circuitry necessary to drive them. (Prerequisite: EEEE-480 and EEEE-353 or equivalent course.) **Lab 3, Credits 3 (Spring)**

EEEE-631

Biomed Sensors and Transducers I

Biological entities represent one of the most difficult environments in which to obtain or generate accurate and reliable signals. This course will discuss the techniques, mechanisms and methods necessary to transfer accurate and reliable information or signals with a biological target. Various biomedical sensor and transducer types including their characteristics, advantages, disadvantages and signal conditioning will be covered. Discussions will include the challenges associated with providing a reliable and reproducible interface to a biological entity, the nature and characteristics of the associated signals, the types of applicable sensors and transducers and the circuitry necessary to drive them. (Prerequisite: EEEE-480 and EEEE-353 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

EEEE-632

Fundamental Electrophysiology

Investigation and study of the concepts and underlying mechanisms associated with electrical signals in mammalian biology and physiology with a significant emphasis on methods, techniques and understanding of electrical potential distribution and current flow derived from circuit analysis. Intended to provide engineers with insight into the relationship between the study of electricity and its applicability to a wide variety of physiological mechanisms ranging from intracellular communication and control to cognitive function and bodily movement. Successful completion of the course will require generation of a significantly in-depth analysis report on some electrophysiological phenomenon or mechanism. (Prerequisites: EEEE-281 and MEDS-251 and EEEE-374 and MATH-221 or equivalent courses.) **Lab 3, Credits 3 (Fall)**

EEEE-632

Fundamental Electrophysiology

Investigation and study of the concepts and underlying mechanisms associated with electrical signals in mammalian biology and physiology with a significant emphasis on methods, techniques and understanding of electrical potential distribution and current flow derived from circuit analysis. Intended to provide engineers with insight into the relationship between the study of electricity and its applicability to a wide variety of physiological mechanisms ranging from intracellular communication and control to cognitive function and bodily movement. Successful completion of the course will require generation of a significantly in-depth analysis report on some electrophysiological phenomenon or mechanism. (Prerequisites: EEEE-281 and MEDS-251 and EEEE-374 and MATH-221 or equivalent courses.) **Lecture 3, Credits 3 (Fall)**

EEEE-633

Biomedical Signal Processing

Discussion and study of the methods and techniques that may be optimally employed for the fixed and adaptive processing of information with biological and physiological origin. The challenges and unique features of these types of signals will be discussed and application of known signal processing techniques that accommodate linear, non-linear and stochastic signals for the purpose of analysis, detection and estimation, monitoring and control will be studied. Successful participation in the course will entail completion of a project involving incorporation of these techniques in a biomedical application. (Permission of instructor or graduate standing) (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Spring)**

EEEE-636

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. Students are required to write an IEEE conference paper on their projects. (Prerequisites: This course is restricted to graduate students in the EEEE-MS, EEEE-BS/MS program.) **Lecture 3, Credits 3 (Spring)**

EEEE-636

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. Students are required to write an IEEE conference paper on their projects. (Prerequisites: This course is restricted to graduate students in the EEEE-MS, EEEE-BS/MS program.) **Lecture 3, Credits 3 (Spring)**

EEEE-646

Power Electronics

The course involves the study of the circuits and devices used in the control and conversion of power. Devices include diodes, BJTs, power MOSFETs, IGBTs and thyristors. Power conversion includes rectifiers (ac-dc), dc-dc, ac-ac and inverters (dc-ac). DC circuit topologies include Buck Converter, Boost Converter, Buck-Boost Converter, and the Cuk converter. (Prerequisites: EEEE-282 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

EEEE-646

Power Electronics

The course involves the study of the circuits and devices used in the control and conversion of power. Devices include diodes, BJTs, power MOSFETs, IGBTs and thyristors. Power conversion includes rectifiers (ac-dc), dc-dc, ac-ac and inverters (dc-ac). DC circuit topologies include Buck Converter, Boost Converter, Buck-Boost Converter, and the Cuk converter. (Prerequisites: EEEE-282 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

EEEE-647

Artificial Intelligence Explorations

The course will start with the history of artificial intelligence (AI) and its development over the years. There have been many attempts to define and generate artificial intelligence. As a result of these attempts, many AI techniques have been developed and applied to solve real life problems. This course will explore a variety of AI techniques and their applications and limitations. Some of the AI topics to be covered in this course are intelligent agents, problem-solving, knowledge and reasoning, uncertainty, decision making, machine learning, reinforcement learning, and real-world applications of AI. Students are expected to have solid programming skills, understanding of probability and linear algebra, and statistics. Students will write a conference-style paper based on a research project. (Prerequisites: This course is restricted to graduate students in the EEEE-MS, EEEE-BS/MS program.) **Lecture 3, Credits 3 (Fall)**

EEEE-661

Modern Control Theory

This course deals with a complete description of physical systems its analysis and design of controllers to achieve desired performance. The emphasis in the course will be on continuous linear systems. Major topics are: state space representation of physical systems, similarities/differences between input-output representation (transfer function) and state space representations, conversion of one form to the other, minimal realization, solution of state equations, controllability, observability, design of control systems for desired performance, state feedback, observers and their realizations. (Co-requisites: EEEE-707 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

EEEE-663

Real-Time and Embedded Systems

This first course in a graduate elective sequence will begin by presenting a general road map of real-time and embedded systems. The course will be conducted in a studio class/lab format with lecture material interspersed with laboratory work. This course will introduce a representative family of microcontrollers that will exemplify unique positive features as well as limitations of microcontrollers in embedded and real-time systems. These microcontrollers will then be used as external, independent performance monitors of more complex real-time systems. The majority of the course will present material on a commercial real-time operating system and using it for programming projects on development systems and embedded target systems. Some fundamental material on real-time operating systems and multiprocessor considerations for real-time systems will also be presented. Examples include scheduling algorithms, priority inversion, and hardware-software co-design. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall)**

EEEE-664

Performance Engineering of Real Time and Embedded Systems

This course discusses issues of performance in real-time and embedded systems. Techniques for profiling the resource usage of a system and for measuring the effect of increasing system requirements will be covered. The control of physical systems will motivate the need for performance tuning of a real-time system. Students will write programs running under a real-time operating system that can maintain control of a physical system. The course will discuss and experiment with performance trade-offs that can be made using hardware-software co-design. (Prerequisites: EEEE-663 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

EEEE-665

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 system models 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. (Prerequisites: EEEE-663 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

EEEE-669

Fuzzy Logic and Applications

In this course students are introduced to fuzzy systems and their applications in areas like control systems, signal and image processing, communications etc. Major topics are: Fuzzy sets and set operations, Evaluations of the rule sets using different implications, composition, aggregation and defuzzification methods. Applications in control systems: Development of fuzzy logic controllers for both linear and nonlinear systems & analysis and simulation studies of the designed systems. Function approximation using fuzzy systems. Students are also required to search published research works in other application areas like signal/image processing, communication, pattern recognition etc. and present their results to the class. (Prerequisites: This course is restricted to graduate students in the EEEE-MS, EEEE-BS/MS program.) **Lecture 3, Credits 3 (Fall)**

EEEE-670

Pattern Recognition

This course provides a rigorous introduction to the principles and applications of pattern recognition. The topics covered include maximum likelihood, maximum a posteriori probability, Bayesian decision theory, nearest-neighbor techniques, linear discriminant functions, and clustering. Parameter estimation and supervised learning as well as principles of feature selection, generation and extraction techniques, and utilization of neural nets are included. Applications to face recognition, classification, segmentation, etc. are discussed throughout the course. (Prerequisites: EEEE-602 and EEEE-707 and EEEE-709 or equivalent courses.) **Lecture 3, Credits 3 (Spring)**

EEEE-678

Digital Signal Processing

In this course, the student is introduced to the concept of multi rate signal processing, Poly phase Decomposition, Transform Analysis, Filter Design with emphasis on Linear Phase Response, and Discrete Fourier Transforms. Topics covered are: Z- Transforms, Sampling, Transform Analysis of Linear Time Invariant Systems, Filter Design Techniques, Discrete Fourier Transforms (DFT), Fast Algorithms for implementing the DFT including Radix 2, Radix 4 and Mixed Radix Algorithms, Quantization Effects in Discrete Systems and Fourier Analysis of Signals. (Prerequisites: EEEE-707 or equivalent course.) **Lecture 3, Credits 3 (Fall, Summer)**

EEEE-679

Analog Filter Design

A study of the various techniques for the design of filters to meet the given specifications. The emphasis is on the design of active filters using op amps. The following topics are discussed in detail: Review of transfer functions, Bode diagrams and the analysis of op amp circuits; ideal filter characteristics, approximations to the ideal filter using Butterworth, Chebyshev and Bessel-Thompson polynomials; standard filter stages; magnitude and frequency scaling; low-pass filter design; design of high-pass, band-pass and band-reject filters; passive ladder filter network design; frequency dependent negative resistance networks; switched capacitor filters. (Prerequisite: EEEE-480 and EEEE-353 or equivalent course.) **Lecture 3, Credits 3 (Biannual)**

EEEE-683

Mechatronics

The advanced topics on analysis, control and optimization of high-performance electromechanical systems are covered. Studies and learning are focused on electromechanical motion devices, amplifiers, controllers-drivers, multi-degree-of-freedom sensors, data acquisition, and, control systems. High-fidelity modeling, data-intensive simulations and experimental studies are pertinent to industrial control systems as well as supervisory control and data acquisition systems. Novel sensing technologies, analog and digital control algorithms, and optimal design schemes are considered with applications to industrial platforms. Case studies include aerial, automotive, energy, robotic and servo systems. (Prerequisites: EEEE-353 or MECE-320 or equivalent courses.) **Lecture 3, Credits 3 (Fall)**

EEEE-685

Principles of Robotics

An introduction to a wide range of robotics-related topics, including but not limited to sensors, interface design, robot devices applications, mobile robots, intelligent navigation, task planning, coordinate systems and positioning image processing, digital signal processing applications on robots, and controller circuitry design. Pre-requisite for the class is a 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 hardware design of an industrial or mobile robot. There will be a two-hour lab additional to the lectures. Students are required to write an IEEE conference paper on their projects. (Prerequisites: This course is restricted to graduate students in the EEEE-MS, EEEE-BS/MS program.) **Lab 3, Credits 3 (Fall)**

EEEE-685

Principles of Robotics

An introduction to a wide range of robotics-related topics, including but not limited to sensors, interface design, robot devices applications, mobile robots, intelligent navigation, task planning, coordinate systems and positioning image processing, digital signal processing applications on robots, and controller circuitry design. Pre-requisite for the class is a 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 hardware design of an industrial or mobile robot. There will be a two-hour lab additional to the lectures. Students are required to write an IEEE conference paper on their projects. (Prerequisites: This course is restricted to graduate students in the EEEE-MS, EEEE-BS/MS program.) **Lecture 3, Credits 3 (Fall)**

EEEE-689

Fundamentals of MEMS

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 which satisfy the requirements and specifications imposed. Integrated approaches must be applied to design and optimized MEMS, which integrate microelectromechanical motion devices, ICs, and microensors. This course covers synthesis, design, modeling, simulation, analysis, control and fabrication of MEMS. Synthesis, design and analysis of MEMS will be covered including CAD. (Prerequisites: This course is restricted to graduate students in the EEEE-MS, EEEE-BS/MS program.) **Lecture 3, Credits 3 (Fall)**

EEEE-692

Communication Networks

This course covers communication networks in general and the internet in particular. Topics include layers service models, circuit and packet switching, queuing, pipelining, routing, packet loss and more. A five-layer model is assumed and the top four levels are covered in a top-down approach: starting with the application layer, going down through the transport layer to the network layer and finally the data link layer. Emphasis is placed on wireless networks and network security. Students would perform a basic research assignment consisting of a literature survey, performance analysis and dissemination of results in written and oral presentation. (Prerequisites: This course is restricted to graduate students in the EEEE-MS, EEEE-BS/MS program.) **Lecture 3, Credits 3 (Spring)**

EEEE-693

Digital Data Communication

Principles and practices of modern digital data communication systems. Topics include pulse code transmission and error probabilities, M-ary signaling and performance, AWGN channels, band-limited and distorting channels, filter design, equalizers, optimal detection for channels with memory, synchronization methods, non-linear modulation, and introduction to multipath fading channels, spread spectrum and OFDM. Students would perform a basic research assignment consisting of a literature survey, performance analysis and dissemination of results in written and oral presentation. (Prerequisites: EEEE-602 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

EEEE-694

Sensor Array Processing for Wireless Communications

This course offers a broad overview of sensor-array processing, with a focus on wireless communications. It aims at providing the students with essential and advanced theoretical and technical knowledge that finds direct application in modern wireless communication systems that employ multi-sensor arrays and/or apply user-multiplexing in the code domain (CDMA). Theory and practices covered in this course can be extended in fields such as radar, sonar, hyperspectral image processing, and biomedical signal processing. Topics covered: uniform linear antenna arrays (inter-element spacing and Nyquist sampling in space); linear beamforming, array beam patterns, array gain, and spatial diversity; interference suppression in the absence of noise (null-steering beamforming); optimal beamforming in AWGN (matched filter); optimal beamforming in the presence of colored interference; estimation of filters from finite measurements and adaptive beamforming (SMI and variants, RLS, LMS and variants, CMA, and AV); BPSK demodulation with antenna arrays (multiple users and AWGN); BPSK demodulation in CDMA (multiple users and AWGN); ML and subspace methods (MUSIC, root MUSIC, Minimum-norm, Linear Predictor, Pisarenko) for Direction-of-arrival estimation; BPSK demodulation with antenna arrays in CDMA systems (space-time processing). (Prerequisites: This course is restricted to graduate students in the EEEE-MS, EEEE-BS/MS program.) **Lecture 3, Credits 3 (Spring)**

EEEE-695

Optimization Methods for Engineers

This course is designed to help the interested engineering students to develop working knowledge of optimization and, specifically, to develop the skills and background needed to recognize, formulate, and solve convex optimization problems. Convex optimization problems emerge naturally in the design and analysis of systems across the entire engineering spectrum. First, the course will briefly review basic concepts of linear algebra and calculus. Second, students will be introduced to optimization (problem formulation, feasibility sets, etc.) and principles of convexity, including convex functions, convex sets, convex problems and properties thereof. Then, an array of algorithmic numerical methods will be studied for the solution of convex problems, covering, among other topics, gradient methods, coordinate descent, Lagrangian duality, saddle points, optimality conditions etc. Last, the course will focus on how to formulate and solve convex problems in engineering, including convex approximation of non-convex problems and regularization. Many practical application examples will be studied from diverse areas of engineering. Through a series of assignments and in-class examples, students will learn how to practically solve optimization problems in MATLAB, using state-of-the-art toolboxes. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall)**

EEEE-699

Graduate Co-op

One semester of full-time, paid employment in the electrical engineering field. See the graduate program coordinator or RIT's Office of Cooperative Education for further details. **CO OP, Credits 0 (Fall, Spring, Summer)**

EEEE-707

Engineering Analysis

The course trains students to utilize mathematical techniques from an engineering perspective, and provides essential background for success in graduate level studies. The course begins with a pertinent review of matrices, transformations, partitions, determinants and various techniques to solve linear equations. It then transitions to linear vector spaces, basis definitions, normed and inner vector spaces, orthogonality, eigenvalues/eigenvectors, diagonalization, state space solutions and optimization. Applications of linear algebra to engineering problems are examined throughout the course. Topics include: Matrix algebra and elementary matrix operations, special matrices, determinants, matrix inversion, null and column spaces, linear vector spaces and subspaces, span, basis/change of basis, normed and inner vector spaces, projections, Gram-Schmidt/QR factorizations, eigenvalues and eigenvectors, matrix diagonalization, Jordan canonical forms, singular value decomposition, functions of matrices, matrix polynomials and Cayley-Hamilton theorem, state-space modeling, optimization techniques, least squares technique, total least squares, and numerical techniques. Electrical engineering applications will be discussed throughout the course. (Prerequisites: This course is restricted to graduate students in the EEEE-MS, EEEE-BS/MS program.) **Lecture 3, Credits 3 (Fall, Spring)**

EEEE-709

Advanced Engineering Mathematics

The course begins with a pertinent review of linear and nonlinear ordinary differential equations and Laplace transforms and their applications to solving engineering problems. It then continues with an in-depth study of vector calculus, complex analysis/integration, and partial differential equations; and their applications in analyzing and solving a variety of engineering problems especially in the areas of control, circuit analysis, communication, and signal/image processing. Topics include: ordinary and partial differential equations, Laplace transforms, vector calculus, complex functions/analysis, complex integration, and numerical techniques. Electrical engineering applications will be discussed throughout the course. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall, Spring, Summer)**

EEEE-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 included: electromagnetic theorems and principles, scattering and radiation integrals, TE and TM in rectangular and circular waveguides, hybrid LSE and LSM modes in partially filled guides, dielectric waveguides, the Green's function. The course will also include projects using advanced EM modeling software tools. (Prerequisites: EEEE-617 and EEEE-629 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

EEEE-711

Advanced Carrier Injection Devices

A graduate course in the fundamental principles and operating characteristics of carrier-injection-based semiconductor devices. Advanced treatments of pn junction diodes, metal-semiconductor contacts, and bipolar junction transistors form the basis for subsequent examination of more complex carrier-injection devices, including tunnel devices, transferred-electron devices, thyristors and power devices, light-emitting diodes (LEDs), and photodetectors. Topics include heterojunction physics and heterojunction bipolar transistors (HBT). (Prerequisites: This course is restricted to graduate students in the EEEE-MS, EEEE-BS/MS program.) **Lecture 3, Credits 3 (Spring)**

EEEE-712

Advanced Field Effect Devices

An advanced-level course on MOSFETs and submicron MOS devices. Topics include MOS capacitors, gated diodes, long-channel MOSFETs, subthreshold conduction and off-state leakage, short-channel effects, hot-carrier effects, MOS scaling and advanced MOS technologies. (Prerequisites: This course is restricted to graduate students in the EEEE-MS, EEEE-BS/MS program.) **Lecture 3, Credits 3 (Spring)**

EEEE-713

Solid State Physics

An advanced-level course on solid-state physics, with particular emphasis on the electronic properties of semiconductor materials. Topics include crystal structure, wave propagation in crystalline solids, lattice vibrations, elements of quantum mechanics, elements of statistical mechanics, free-electron theory of metals, Boltzmann transport equation, quantum-mechanical theory of carriers in crystals, energy band theory, equilibrium carrier statistics, excess carriers in semiconductors, carrier transport. (Prerequisites: This course is restricted to graduate students in the EEEE-MS, EEEE-BS/MS program.) **Lecture 3, Credits 3 (Fall)**

EEEE-715

Photonic Integrated Circuits

This course focuses on photonic integrated circuits (PICs) - an emerging technology where photonic chips (consisting of waveguides, lasers, detectors, modulators and more) are manufactured using integrated circuit technology and closely integrated with microelectronics. The circuits are finding applications in high performance communication, computing and sensing systems. The technology is rapidly growing in complexity and demand, and as the advantages of using photons are realized and the manufacturing hurdles are overcome, photonic circuits will become ubiquitous in future microsystems. Course topics include, fundamental concepts (waveguides, interference, light-matter interaction), PIC component modeling, schematic and layout driven design, PIC fabrication techniques, and PIC testing to round out the students understanding of integrated photonics. (Prerequisite: EEEE-374 or MCEE-320 or equivalent course or graduate standing in MCSE-PHD or ENGR-PHD or EEEE-MS or CMPE-MS or MCEE-MS.) **Lecture 2, Credits 3 (Spring)**

EEEE-718

Design and Characterization of Microwave Systems

There are two primary course objectives. Design of experiments to characterize or measure specific quantities, working with the constraints of measurable quantities using the vector network analyzer, and in conjunction with the development of closed form analytical expressions. Design, construction and characterization of microstrip circuitry and antennas for specified design criteria obtaining analytical models, using software tools and developing measurement techniques. Microwave measurement 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. (Prerequisites: EEEE-617 and EEEE-629 or equivalent courses. Co-requisite: EEEE-790 or EEEE-792 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

EEEE-720

Advanced Topics in Digital Systems Design

In this course the student is introduced to a multitude of advanced topics in digital systems design. It is expected that the student is already familiar with the design of synchronous digital systems. The lecture introduces the operation and design principles of asynchronous digital systems, synchronous and asynchronous, pipelined and wave pipelined digital systems. Alternative digital processing paradigms are then presented: data flow, systolic arrays, networks-on-chip, cellular automata, neural networks, and fuzzy logic. Finally, digital computer arithmetic algorithms and their hardware implementation are covered. The projects reinforce the lectures material by offering a hands-on development and system level simulation experience. (Prerequisites: EEEE-520 or EEEE-620 or equivalent courses.) **Lecture 3, Credits 3 (Spring)**

EEEE-721

Advanced Topics in Computer System Design

In this course the student is introduced to advanced topics in computer systems design. It is expected that the student is already familiar with the design of a non-pipelined, single core processor. The lectures cover instruction level parallelism, limits of the former, thread level parallelism, multicore processors, optimized hierarchical memory design, storage systems, and large-scale multiprocessors for scientific applications. The projects reinforce the lectures material, by offering a hands-on development and system level simulation experience. (Prerequisites: EEEE-521 or EEEE-621 or equivalent courses.) **Lecture 3, Credits 3 (Spring)**

EEEE-722

Complex Digital Systems Verification

Due to continually rising system complexity, verification has become the critical infection point for complex digital system success or failure. In this course students will study various concepts and technologies related to complex digital system verification with an emphasis on functional verification, top down design flows and advanced methodologies. The class projects reinforce the lectures material by offering hands-on development of a verification environment for a complex digital system. (Prerequisite: This course is restricted to students with graduate standing in EEEE-MS.) **Lecture 3, Credits 3 (Fall)**

EEEE-726

Mixed-Signal IC Design

This is the first course in the graduate course sequence in analog integrated circuit design EEEE-726 and EEEE-730. This course covers the following topics: (1) Fundamentals of data conversion (2) Nyquist rate digital-to-analog converters (3) Quantization noise and analysis (4) Nyquist rate analog-to-digital converters (5) Sample and hold circuits (6) Voltage references (7) Static and dynamic testing of digital-to-analog converters (8) Cell based design strategies for integrated circuits (9) Advanced topics in data conversion. (Prerequisites: EEEE-510 or EEEE-610 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

EEEE-730

Advanced Analog IC Design

This is the second course in the graduate course sequence in analog integrated circuit design EEEE-726 and EEEE-730. This course covers the following topics: (1) Fundamentals of Filter Design (2) Filter Approximations (3) Frequency and Impedance Scaling (4) Delay Equalization (5) Sensitivity Analysis (6) Sampled Data Theory (7) CMOS Integrated Filters including Switched Capacitor and gm-C Filters (8) Phase Locked Loops (Prerequisites: EEEE-726 or equivalent course.) **Lecture 4, Credits 3 (Fall)**

EEEE-731

Integrated Optical Devices and Systems

This course discusses basic goals, principles and techniques of integrated optical devices and systems, and explains how the various optoelectronic devices of an integrated optical system operate and how they are integrated into a system. Emphasis in this course will be on planar passive optical devices. Topics include optical waveguides, optical couplers, micro-optical resonators, surface plasmons, photonic crystals, modulators, design tools and 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. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall)**

EEEE-733

Robust Control

This course will provide an introduction to the analysis and design of robust feedback control systems. Topics covered: overview of linear algebra and linear systems, H₂ and H_∞ (spaces, modeling and paradigms for robust control; internal stability; nominal performance (asymptotic tracking); balanced model reduction; uncertainty and robustness; H₂ optimal control; H_∞ control; H_∞ loop shaping; controller reduction; and design for robust stability and performance. (Prerequisites: EEEE-661 or equivalent course.) **Lecture 4, Credits 3 (Spring)**

EEEE-743

Digital Controls

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 of signals and systems is 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. Various discrete-time controller designs are implemented. Topics for the class include: continuous to digital control conversion using finite difference solutions; continuous to digital control conversion using state equation approach; stability of discrete systems; PID control design for digital systems; frequency domain control system design methods for continuous systems (PID, lead, lag, lead-lag compensation design); frequency domain control system design methods for digital systems (PID, lead, lag, lead-lag compensation design) using phase loss methods and bilinear transformation; z-transforms for discrete systems; digital control system design using root locus; and deadbeat control design. Students will be required to do computer projects using Matlab and program Arduinos. There will be two exams and several homework assignments (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall)**

EEEE-765

Optimal Control

The course covers different optimization techniques, as applied to feedback control systems. The main emphasis will be 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 - Optimal controllers for discrete and continuous systems - Systems with magnitude constraints on inputs and states. (Prerequisites: EEEE-661 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

EEEE-766

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, creating frequency-response models from time-domain measurements, creating state-space models from frequency-response data, 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. (Prerequisites: EEEE-707 and EEEE-709 or equivalent courses.) **Lecture 3, Credits 3 (Spring)**

EEEE-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 misadjustments. Applications will include system identification, deconvolution and equalization, adaptive arrays and multipath communication channels. (Prerequisites: EEEE-602 and EEEE-707 and EEEE-709 or equivalent courses.) **Lecture 3, Credits 3 (Spring)**

EEEE-771

Optoelectronics

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 optical resonators, quantum states of light, semiconductor optics, fundamental of lasers, light-emitting diodes, laser diodes, semiconductor photon detectors, optical modulators, quantum wells, and optical fiber communication systems. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Spring)**

EEEE-779

Digital Image Processing

This is an introductory course in digital image processing. The course begins with a study of two dimensional (2D) signal processing and transform methods with applications to images. Image sampling is discussed extensively followed by gray level description of images and methods of contrast manipulation including linear/nonlinear transformations, histogram equalization and specification. Image smoothing techniques are considered including spatial and frequency domain low pass filtering, AD-HOC methods of noise removal and median filtering. Following this, methods of image sharpening are studied including derivatives and high pass filtering. Edge and line detection algorithms are discussed using masks and Hough transforms. Finally, methods of image segmentation, restoration, compression and reconstruction are also discussed. Several extensive computer lab assignments are required. (Co-requisites: EEEE-678 equivalent course.) **Lecture 3, Credits 3 (Fall)**

EEEE-780

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-recursive methods, Bayesian methods based on Gibbs Random Fields; Three-dimensional motion estimation and segmentation including methods using point correspondences, optical flow & direct methods, motion segmentation, and stereo and motion tracking. (Prerequisites: EEEE-779 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

EEEE-781

Image and Video Compression

This course studies the fundamental technologies used in image and video compression techniques and international standards such as JPEG and MPEG. At the highest level, all visual data compression techniques can be reduced to three fundamental building blocks: transformation or decomposition (examples are discrete cosine transform or DCT, wavelets, differential pulse code modulation or DPCM and motion compensation), quantization (strategies include scalar vs. vector quantization, uniform vs. nonuniform, Lloyd-Max and entropy-constrained quantization) and symbol modeling and encoding (the concept of Markov source and its entropy, context modeling, variable length coding techniques such as Huffman and arithmetic coding and Golomb-Rice coding). This course studies all of these fundamental concepts in great detail in addition to their practical applications in leading image and video coding standards. The study cases include a comprehensive review of the JPEG lossless compression standard (based on pixel prediction and Huffman coding), the JPEG lossy compression standard (based on DCT and Huffman coding), a detailed study of wavelet decomposition and a brief overview of the MPEG family of standards (employing motion compensation in addition to aforementioned techniques). (Prerequisites: EEEE-779 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

EEEE-784

Advanced Robotics

This course explores advance 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 pre-requisite for this course is Principles of Robotics. However, students would have better understanding of the topics if they had Control Systems and Mechatronics courses as well. The course will be a project based course requiring exploration of a novel area in Robotics and writing an IEEE conference level paper. (Prerequisites: EEEE-585 or EEEE-685 or equivalent course.) **Lab 2, Credits 3 (Spring)**

EEEE-784

Advanced Robotics

This course explores advance 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 pre-requisite for this course is Principles of Robotics. However, students would have better understanding of the topics if they had Control Systems and Mechatronics courses as well. The course will be a project based course requiring exploration of a novel area in Robotics and writing an IEEE conference level paper. (Prerequisites: EEEE-585 or EEEE-685 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

EEEE-785

Comprehensive Exam

(This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Comp Exam, Credits 0 (Fall, Spring, Summer)**

EEEE-787

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. (Prerequisites: This course is restricted to graduate students in the EEEE-MS, EEEE-BS/MS program.) **Lecture 3, Credits 3 (Spring)**

EEEE-789

Special Topics

Topics and subject areas that are not regularly offered are provided under this course. Such courses are offered in a normal format; that is, regularly scheduled class sessions with an instructor. (Prerequisites: This course is restricted to graduate students in the EEEE-MS, EEEE-BS/MS program.) **Lecture 3, Credits 3 (Fall, Spring)**

EEEE-790

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 6 credits. **Thesis, Credits 1 - 6 (Fall, Spring, Summer)**

EEEE-792

Graduate Paper

This course 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. **Project, Credits 3 (Fall, Spring, Summer)**

EEEE-793

Error Detection and Error Correction

This course covers linear algebraic block codes, convolutional codes, turbo codes, and low-density parity-check codes. The fundamental structure of linear block code will be developed and applied to performance calculations. The structure of cyclic codes will be developed and applied to encoders and decoders. The major error correction methods, including error trapping, majority logic decoding and the BCH encoder and decoder algorithms will be developed. The Viterbi and sequential decoding algorithms will be studied. Questions of system performance, speed and complexity will be examined. **Lecture 3, Credits 3 (Fall)**

EEEE-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. (Prerequisites: EEEE-602 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

EEEE-795

Graduate Seminar

The objective of this course is to introduce full time Electrical Engineering BS/MS and incoming graduate students to the graduate programs, campus resources to support research. 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 two semesters of this seminar. **Seminar 3, Credits 0 (Fall, Spring)**

EEEE-797

Wireless Communication

The course will cover topics in wireless communications, including: wireless propagation channels (propagation mechanisms, statistical description, channel characterization and modeling), modulation and demodulation, slow-flat fading channels, frequency selective channels, diversity methods, OFDM, spread spectrum, CDMA and channel coding. Applications of these systems, including wireless sensor networks would be discussed as well. (Prerequisites: EEEE-602 or equivalent course.Co-requisites: EEEE-593 or EEEE-693 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

EEEE-798

Software Defined Digital Radio Communications

Learn the principles and practices of how to engineer and implement software digital radio signal processing systems. Technology advances have brought us into the age of completely programmable full radio systems on a chip. ADC/DAC and high speed low power digital circuitry advances allow engineers to utilize digital signal processing techniques at RF and IF frequencies. By end of course students will understand how to statistically simulate receive and transmit fundamental digital radio modulations utilizing Matlab. As long as it is available by the time of the course and students/RIT can obtain equipment, exercises will be planned to implement some algorithms on a low cost educational digital radio kit (Analog Devices Educational Pluto Radio). Topics covered: OFDM, QAM, I/Q demod/mod, IF frequencies, encryption, channel interleavers, OSI Networking Layers 1 and 2. How to use iterative and non-iterative forward error correction (FEC) schemes. Efficient and proper utilization of RF spectrum, synchronization, radio channel equalization, understanding practical receive and transmit limitations, multipath channel models and an introduction to fixed point signal processing. The course will require much outside of class programming. (Prerequisites: EEEE-602 and EEEE-693 or equivalent course.Co-requisites: EEEE-797 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

EEEE-799

Independent Study

This course is 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. **Ind Study, Credits 1 - 3 (Fall, Spring, Summer)**

Industrial and Systems Engineering

ISEE-601

Systems Modeling and Optimization

An introductory course in operations research focusing on modeling and optimization techniques used in solving problems encountered in industrial and service systems. Topics include deterministic and stochastic modeling methodologies (e.g., linear and integer programming, Markov chains, and queuing models) in addition to decision analysis and optimization tools. These techniques will be applied to application areas such as production systems, supply chains, logistics, scheduling, healthcare, and service systems. (This course is restricted to students in the ISEE-MS, SUSTAIN-MS, ENGMGT-ME or MIE-PHD programs.) **Lecture 3, Credits 3 (Fall)**

ISEE-610

Systems Simulation

Computer-based simulation of dynamic and stochastic systems. Simulation modeling and analysis methods are the focus of this course. A high-level simulation language such as Simio, ARENA, etc., will be used to model systems and examine system performance. Model validation, design of simulation experiments, and random number generation will be introduced. (Prerequisites: ISEE-200 and ISEE-301 and (ISEE-325 or STAT-252) or degree-seeking graduate students.) **Lecture 3, Credits 3 (Fall, Spring)**

ISEE-626

Contemporary Production Systems

The focus of this course is Lean. Lean is about doing more with less - less human effort, less equipment, less time, less space. In other words, lean is about the application of industrial engineering principles and tools to the entire supply chain or value stream. The focus of this course will be learning and applying the principles and tools of lean such as value, value stream mapping, takt, flow, pull, kaizen, standard work, line design, and others, all in the context of continuous process improvement. By the end of this course, the student will possess the essential tools and skills to apply lean in their production system from either a line (supervisor or manager) or staff role. (This course is restricted to students in the ISEE-BS/MS, ISEE-BS/ME, ISEE-MS, SUSTAIN-MS, ENGMGT-ME, or MIE-PHD programs or those with 5th year standing in ISEE-BS or ISEEDU-BS.) **Lecture 3, Credits 3 (Fall)**

ISEE-640

Computer-Aided Design and Mfg

This course provides an introduction to computer-aided design and manufacturing (CAD/CAM) using Solidworks and MasterCAM. Students will learn how to model individual parts and assemblies. These skills will then be applied in a manufacturing context to produce CAD models of molds, jigs, and fixtures. Lastly, students will learn to generate CNC toolpaths from their CAD models. Students may not take this course for credit if they have already taken another Solidworks modeling course. (Prerequisites: ISEE-140 or MECE-104 or equivalent course or students in ISEE-MS, SUSTAIN-MS, ENGMGT-ME, MECE-MS, MECE-ME, or MIE-PHD programs.) **Lecture 3, Credits 3 (Fall)**

ISEE-660

Applied Statistical Quality Control

An applied approach to statistical quality control utilizing theoretical tools acquired in other math and statistics courses. Heavy emphasis on understanding and applying statistical analysis methods in real-world quality control situations in engineering. Topics include process capability analysis, acceptance sampling, hypothesis testing and control charts. Contemporary topics such as six-sigma are included within the context of the course. (This course is restricted to students in the ISEE-MS, SUSTAIN-MS, ENGMGT-ME, STAQL-ACT, or MIE-PHD programs.) **Lecture 3, Credits 3 (Fall)**

ISEE-661

Linear Regression Analysis

In any system where parameters of interest change, it may be of interest to examine the effects that some variables exert (or appear to exert) on others. "Regression analysis" actually describes a variety of data analysis techniques that can be used to describe the interrelationships among such variables. In this course we will examine in detail the use of one popular analytic technique: least squares linear regression. Cases illustrating the use of regression techniques in engineering applications will be developed and analyzed throughout the course. (This course is restricted to students in the ISEE-MS, SUSTAIN-MS, ENGMGT-ME or MIE-PHD programs.) **Lecture 3, Credits 3 (Fall)**

ISEE-682

Lean Six Sigma Fundamentals

This course presents the philosophy and methods that enable participants to develop quality strategies and drive process improvements. The fundamental elements of Lean Six Sigma are covered along with many problem solving and statistical tools that are valuable in driving process improvements in a broad range of business environments and industries. Successful completion of this course is accompanied by "yellow belt" certification and provides a solid foundation for those who also wish to pursue a "green belt." (Green belt certification requires completion of an approved project which is beyond the scope of this course). (This course is restricted to degree-seeking graduate students and dual degree BS/MS or BS/ME students in KGCOE.) **Lecture 3, Credits 3 (Fall, Spring, Summer)**

ISEE-684

Engineering and the Developing World

This course helps students develop a system of holistic thinking about engineering pursuits which includes the natural environment, humans as individuals, economics, culture, institutions, policies, and civil society. Topics include research, design, dissemination, and evaluation techniques of the Human Centered Design Methodology (also called Design Thinking), Systems Practice tools for understanding complex problems, comparison of competing economic viewpoints, and evaluation of project case studies for triple bottom line sustainability. The course will include an extensive community engaged experiential learning component with a community partner in the city of Rochester which requires periodic travel to the partner's site for interviews and activities. The course project is intended to lead to ideas that can be continued into social impact design capstone projects for implementation. **Lecture 3, Credits 3 (Spring)**

ISEE-689

Special Topics

Topics and subject areas that are not regularly offered are provided under this course. Such courses are offered in a normal format; that is, regularly scheduled class sessions with an instructor. **Lecture 3, Credits 3 (Fall, Spring)**

ISEE-698

Part-time Graduate Co-op

One semester of paid part-time work experience in the field of industrial engineering or sustainable engineering. See the graduate program coordinator or RIT's Office of Cooperative Education for further details. (This course is restricted to students in the ISEE-MS, SUSTAIN-MS, ENGMGT-ME, MFLEAD-MS, or PRODDEV-MS programs.) **CO OP, Credits 0 (Fall, Spring, Summer)**

ISEE-699

Graduate Co-op

One semester of paid full-time work experience in the field of industrial engineering or sustainable engineering. See the graduate program coordinator or RIT's Office of Cooperative Education for further details. (This course is restricted to students in the ISEE-MS, SUSTAIN-MS, ENGMGT-ME, MFLEAD-MS, or PRODDEV-MS programs.) **CO OP, Credits 0 (Fall, Spring, Summer)**

ISEE-701

Linear Programming

Computational techniques for solving constrained optimization problems. Linear programming, the Simplex method and variations, duality and sensitivity testing. (Prerequisites: ISEE-601 or ISEE-301 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

ISEE-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. (Prerequisite: ISEE-301 or ISEE-601 or equivalent course.) **Lecture 3, Credits 3**

ISEE-703

Supply Chain Management

Supply chain management is unique in that it is one of the oldest business activities and yet has been recently discovered as a potentially powerful source of competitive advantage. Supply chain system activities, such as planning production levels, forecasting demand, managing inventory, warehousing, transportation, and locating facilities have been performed since the start of commercial activity. It is difficult to visualize any product that could reach a customer without a consciously designed supply chain. Yet it is only recently that many firms have started focusing on supply chain management. There is a realization that no company can do any better than its supply chain and logistics systems. This becomes even more important given that product life cycles are shrinking and competition is intense. Logistics and supply chain management today represents a great challenge as well as a tremendous opportunity for most firms. (This course is restricted to degree-seeking graduate students or ISE department dual degree students.) **Lecture 3, Credits 3 (Spring)**

ISEE-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. (Prerequisites: ISEE-420 or ISEE-720 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

ISEE-708

Simulation Analysis

Simulation Analysis focuses on simulation design, analysis, and applied research methods for industrial and service systems. In particular, the course covers discrete-event, agent-based, and continuous simulation modeling approaches; data driven simulation models; design and analysis of simulation experiments and optimization; artificial intelligence (AI) simulation methods; and Industry 4.0/Digital Twin simulation. (Prerequisites: ISEE-510 or equivalent course or students in ISEE-MS, SUSTAIN-MS, ENGMGT-ME, MIE-PHD, MMSI-MS programs or MMSI-MS dual degree students) **Lecture 3, Credits 3 (Spring)**

ISEE-711

Advanced Simulation

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. (Prerequisites: ISEE-510 or ISEE-610 or ISEE-708 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

ISEE-720

Production Control

This course covers the process and the analysis methods used to produce goods and services to 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 mathematical optimization to support production planning. The course emphasizes how a production process can be characterized by a process that requires answering a sequence of decision-making problems. The course will show how the production functions integrate with each other and how their coordination can be automated through mathematical programming. Identifying opportunities for improvement through optimization is also highlighted. (Prerequisites: ISEE-601 or (ISEE-301 and (STAT-251 or MATH-251)) or equivalent courses.) **Lecture 3, Credits 3 (Spring)**

ISEE-723

Global Facilities Planning

Facilities planning determines how an activity's tangible fixed assets best support achieving the activity's objective. This course will provide knowledge of the principles and practices of facility layout, material handling, storage and warehousing, and facility location for manufacturing and support facilities. Tools for sizing the resources needed, planning, design, evaluation, selection, and implementation will be covered. The focus of the course will cover both management and design aspects, with the focus being more heavily on the management aspects. (This course is available to RIT degree-seeking graduate students.) **Lecture 3, Credits 3 (Fall)**

ISEE-728

Production Systems Management

The focus of this course is Lean. Students who take this course should be interested in building on their basic knowledge of (lean) 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 beyond manufacturing - specifically logistics. This course should enable the student to practice the application of lean concepts in the context of systems design at the enterprise level. (Prerequisites: ISEE-420 or ISEE-626 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

ISEE-730

Biomechanics of Human Movement

Topics include musculoskeletal anatomy and mechanics, theory and application of electromyography, motion and force measuring equipment and techniques, human locomotion, balance and falls, inverse dynamics modeling of the human body, and current topics in musculoskeletal biomechanics research. Students collect data in the lab and conduct the data analysis using MATLAB software or Python software. (Prerequisites: ISEE-330 or MECE-320 or BIME-200 or equivalent course or students in ISEE-MS, SUSTAIN-MS, ENGMGT-ME, MECE-MS, MECE-ME, or MIE-PHD programs.) **Lecture 3, Credits 3 (Fall)**

ISEE-731

Advanced Topics in Human Factors and Ergonomics

Advanced topics are selected based on current ergonomic and human factors issues and interests of students. Course is taught using a seminar format. Students are required to select, read, and discuss scientific literature relevant to the fields of human factors and ergonomics. (Prerequisites: ISEE-330 or equivalent course or students in ISEE-MS, SUSTAIN-MS, ENGMGT-ME, or MIE-PHD programs.) **Lecture 3, Credits 3 (Spring)**

ISEE-732

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, NIOSH Guidelines 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. (This course is restricted to students in the ISEE-BS/MS, ISEE-BS/ME, ISEE-MS, SUSTAIN-MS, ENGMGT-ME, or MIE-PHD programs or those with 4th year standing in ISEE-BS.) **Lecture 3, Credits 3 (Spring)**

ISEE-734

Graduate Engineering Psychology

In this course the students will learn to recognize the integrated (systems) nature of Engineering Psychology, the centrality of human beings in systems design, and to use the topics covered and the available knowledge base to adapt the environment to people. This course will cover several fundamental models of human information processing in the context of human-system interactions. The models may include but are not limited to Signal Detection Theory, Information Theory, theories of attention, both normative and naturalistic decision making-models, Control Theory, and the Lens Model of Brunswick, as well as models of the human as a physical engine, that is, anthropometry, biomechanics, and work physiology. Most topics include readings in addition to the course text as well as a lab exercise with a detailed lab report. (This course is restricted to students in the ISEE-MS, SUSTAIN-MS or ENGMGT-ME programs or those with 5th year standing in ISEE-BS or ISEEDU-BS.) **Lecture 3, Credits 3**

ISEE-740

Design for Manufacture and Assembly

Course reviews operating principles of prevalent processes such as casting, molding, and machining. Students will use this knowledge to select appropriate production processes for a given component. For each process covered, guidelines governing proper design for manufacturability practices will be discussed and applied. (Prerequisites: ISEE-140 or MECE-104 or equivalent course or students in ISEE-MS, SUSTAIN-MS, ENGMGT-ME, MECE-MS, MECE-ME, or MIE-PHD programs.) **Lecture 3, Credits 3 (Spring)**

ISEE-741

3D Printing

This course begins with an introduction to commercial rapid prototyping processes, the materials involved, and the physics behind how they work. The course then transitions to research topics involving novel processes, applications, and materials. Class activities include a mix of lecture, lab, and project work. (Prerequisites: ISEE-140 or ISEE-304 or MECE-104 or MECE-304 or MECE-305 or equivalent course or students in ISEE-MS, SUSTAIN-MS, ENGMGT-ME, MECE-MS, MECE-ME or MIE-PHD programs.) **Lab 2, Credits 3 (Fall, Spring)**

ISEE-741

3D Printing

This course begins with an introduction to commercial rapid prototyping processes, the materials involved, and the physics behind how they work. The course then transitions to research topics involving novel processes, applications, and materials. Class activities include a mix of lecture, lab, and project work. (Prerequisites: ISEE-140 or ISEE-304 or MECE-104 or MECE-304 or MECE-305 or equivalent course or students in ISEE-MS, SUSTAIN-MS, ENGMGT-ME, MECE-MS, MECE-ME or MIE-PHD programs.) **Lecture 2, Credits 3 (Fall, Spring)**

ISEE-745

Manufacturing Systems

This course will provide an introduction to concepts and techniques in the design and analysis of production systems. A blend of traditional and modern approaches is brought into the classroom. At the end of the term, the student will be able to assess and analyze the performance of a given manufacturing system as well as to provide a framework for system redesign and improvement. Modern aspects such as lean manufacturing and setup time reduction are included in the context of the course. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Spring)**

ISEE-750**Systems and Project Management**

This course 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, chartering, adaptive project management methodologies, structuring of performance measures and metrics, technical teams and project management, 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. (Prerequisites: ISEE-350 or equivalent course or students in ISEE BS/MS, ISEE BS/ME, ISEE-MS, SUSTAIN-MS, ENGMGT-ME, PRODDEV-MS, MFLEAD-MS, or MIE-PHD programs.) **Lecture 3, Credits 3 (Fall)**

ISEE-751**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. (This course is restricted to students in MFLEAD-MS and PRODDEV-MS.) **Lecture 3, Credits 3 (Spring)**

ISEE-752**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 addressed. We cover EMV and Non-EMV decision-making concepts. Finally, the organizational use of decision analysis and its application in real-world case studies is presented. (Prerequisites: ISEE-325 or MATH-251 or STAT-205 or STAT-257 or MATH-252 or MCEE-205 or equivalent course or students in ISEE-MS, SUSTAIN-MS, ENGMGT-ME, or MIE-PHD programs) **Lecture 3, Credits 3 (Spring)**

ISEE-760**Design of Experiments**

This course presents an in-depth study of 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. Topics include: consideration of type 1 and type 2 errors in experimentation, sample size determination, completely randomized designs, randomized complete block designs, blocking and confounding in experiments, Latin square and Graeco Latin square designs, general factorial designs, the 2k factorial design system, the 3k factorial design system, fractional factorial designs, Taguchi experimentation. (Prerequisites: ISEE-325 or STAT-257 or MATH-252 or equivalent course or students in ISEE-MS, SUSTAIN-MS, ENGMGT-ME, or MIE-PHD programs.) **Lecture 3, Credits 3 (Spring)**

ISEE-761**Forecasting Methods**

Forecasting Methods will provide the engineering student with the skills necessary to perform data driven time series analysis from an engineering applications perspective. A process driven approach will be used covering the entire forecasting process from data preparation and pre-processing techniques to model selection, performance evaluation, and monitoring. A special emphasis will be placed on performance evaluation and improvement of models used to predict RIT energy demand and peak load days. The course will cover topics in data cleansing, data transformation, trend and seasonality analysis, smoothing techniques, regression analysis for forecasting, seasonal and non-seasonal ARIMA models, dynamic regression, neural networks and advanced modeling techniques for multivariate time series analysis. Lectures and assignments will focus on predicting RIT energy demand considering circuits with 2MW solar fields or similar data sets. (Prerequisites: ISEE-561 or ISEE-661 or equivalent course.) **Lecture 3, Credits 3 (Biannual)**

ISEE-770**Design Project Leadership**

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. (Prerequisites: ISEE-350 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

ISEE-771**Engineering of Systems I**

The engineering of a system is focused on the identification of value and the value chain, requirements management and engineering, understanding the limitations of current systems, the development of the overall concept, and continually improving the robustness of the defined solution. EOS I & II is a 2-semester course sequence focused on the creation of systems that generate value for both the customer and the enterprise. Through systematic analysis and synthesis methods, novel solutions to problems are proposed and selected. This first course in the sequence focuses on the definition of the system requirements by systematic analysis of the existing problems, issues and solutions, to create an improved vision for a new system. Based on this new vision, new high-level solutions will be identified and selected for (hypothetical) further development. The focus is to learn systems engineering through a focus on an actual artifact (This course is restricted to students in the ISEE BS/MS, ISEE BS/ME, ISEE-MS, SUSTAIN-MS, PRODDEV-MS, MFLEAD-MS, ENGMGT-ME, or MIE-PHD programs or those with 5th year standing in ISEE-BS or ISEEDU-BS.) **Lecture 3, Credits 3 (Fall, Spring)**

ISEE-772**Engineering of Systems II**

The engineering of a system is focused on the identification of value and the value chain, requirements management and engineering, understanding the limitations of current systems, the development of the overall concept, and continually improving the robustness of the defined solution. EOS I & II is a 2-semester course sequence focused on the creation of systems that create value for both the customer and the enterprise. Through systematic analysis and synthesis methods, novel solutions to problems are proposed and selected. This second course in the sequence revisits the first sequence and views the engineering of a system through a lean perspective, as such the emphasis is on the system development process itself. (Prerequisites: ISEE-771 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

ISEE-773**Engineering Value Creation**

This course focuses on the role of engineering in value creation. In particular, the effective integration of engineering activities for the transformation of novel ideas and technologies into marketable products and services. Topics include value engineering and value analysis, the engineering value chain, the innovation process, engineering sustainable value, and the technology development and management process. (Co-requisites: ISEE-771 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

ISEE-781**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. (This course is restricted to students in MFLEAD-MS and PRODDEV-MS.) **Lecture 3, Credits 3 (Fall)**

ISEE-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. (This course is restricted to students in MFLEAD-MS and PRODDEV-MS.) **Lecture 3, Credits 3**

ISEE-783**Advanced Topics in New Product Development**

This modular course is designed to complement previous coursework in the MPD program, with an emphasis on leadership/engineering concepts and tools needed by technical leaders of product development projects and organizations. The course is intended to fill gaps in the MPD program by covering important topics for product development leaders that were not covered or topics for which students have expressed interest in additional coverage. (This course is restricted to students in MFLEAD-MS and PRODDEV-MS.) **Lecture 3, Credits 3**

ISEE-785**Fundamentals of Sustainable Engineering**

This is a high level survey course that reviews the product lifecycle from various perspectives and highlights the leverage over material, process, and environmental impacts available at the design phase. Tools and strategies for reducing the environmental impacts associated with the sourcing, manufacture, use, and retirement of products will be reviewed and evaluated. (This course is restricted to students in ISEE-MS, SUSTAIN-MS, ENGMGT-ME, MECE-MS, MECE-ME, SUSPRD-MN, MIE-PHD or those with at least 4th year standing in ISEE-BS or ISEEDU-BS.) **Lecture 3, Credits 3 (Fall)**

ISEE-786

Lifecycle Assessment

This course introduces students to the challenges posed when trying to determine the total lifecycle impacts associated with a product or a process design. Various costing models and their inherent assumptions will be reviewed and critiqued. The inability of traditional costing models to account for important environmental and social externalities will be highlighted. The Lifecycle Assessment approach for quantifying environmental and social externalities will be reviewed and specific LCA techniques (Streamlined Lifecycle Assessment, SimaPro) will be covered. (This course is restricted to students in ISEE-MS, SUSTAIN-MS, ENGMGT-ME, MECE-MS, MECE-ME, SUSPRD-MN, MIE-PHD or those with at least 4th year standing in ISEE-BS or ISEEDU-BS.) **Lecture 3, Credits 3 (Spring)**

ISEE-787

Design for the Environment

This course will provide the student with systematic approaches for designing and developing environmentally responsible products. In particular, design trade-offs will be explored. (Prerequisites: ISEE-140 or ISEE-304 or MECE-304 or MECE-305 or students in SUSPRD-MN, ISEE-MS, SUSTAIN-MS, ENGMGT-ME, MECE-MS, MECE-ME, MIE-PHD programs.) **Lecture 3, Credits 3 (Fall)**

ISEE-788

Project with Paper

This course is used by students as a capstone experience. The student must demonstrate an acquired competence in a topic that is chosen in conference with a faculty advisor. The work may involve a research and/or design project with demonstration of acquired knowledge. A written paper and an oral presentation of the work are required. **Project 3, Credits 3 (Fall, Spring, Summer)**

ISEE-789

Special Topics

Topics and subject areas that are not regularly offered are provided under this course. Such courses are offered in a normal format; that is, regularly scheduled class sessions with an instructor. **Lecture 3, Credits 3 (Fall, Spring)**

ISEE-790

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. (Enrollment in this course requires permission from the department offering the course.) **Thesis, Credits 1 - 6 (Fall, Spring, Summer)**

ISEE-792

Engineering Capstone

Students must investigate a discipline-related topic in a field related to industrial and systems engineering, engineering management, sustainable engineering, product development, or manufacturing leadership. 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. (This course is restricted to students in ISEE-MS, ENGMGT-ME, SUSTAIN-MS, PRODDEV-MS, MFLEAD-MS or the ISEE BS/MS programs.) **Lecture 3, Credits 3 (Fall, Spring)**

ISEE-793

Manufacturing Leadership Capstone

For the MS in Manufacturing Leadership program. The purpose of the project is for students to demonstrate integrative application of knowledge and skills acquired during the program. A capstone project will be oriented to the solution of a manufacturing, operations, or supply chain management problem or to a technically related process. 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 encouraged. Projects must be approved in advance of registration. (This course is restricted to MFLEAD-MS Major students.) **Lecture 3, Credits 3 (Fall, Spring)**

ISEE-794

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. (Enrollment in this course requires permission from the department offering the course.) **Seminar, Credits 0 (Fall, Spring)**

ISEE-795

Graduate Seminar

This class introduces students to state of the art research and research methods in industrial, systems, and sustainable engineering. Presentations include off campus speakers and students/faculty presentations on current research under way in the department. (This course is restricted to students in ISEE-MS, SUSTAIN-MS or ISEE BS/MS.) **Seminar 1, Credits 0 (Fall, Spring)**

ISEE-796

Graduate Seminar II

The second in a two course sequence that introduces students to research methods in industrial engineering and presents the state of the art in industrial engineering research. The two-course sequence is designed to promote discussion and interaction on IE research topics and to present research methods such as conducting critical reviews of research literature, initiating background research on a thesis topic, and preparing a formal thesis proposal. (This course is restricted to students in ISEE-MS, SUSTAIN-MS or ISEE BS/MS.) **Seminar 1, Credits 0 (Spring)**

ISEE-797

Product Development Capstone I

For the MS in Product Development (MPD) program. Students in the program must demonstrate intellectual leadership in the field of new product development. The general intent of the Capstone 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 experiences in the program. Students are encouraged to start work on the project in advance of receiving formal credit. Team-based projects are strongly recommended. (This class is restricted to PRODDEV-MS Major students.) **Ind Study, Credits 3 (Fall)**

ISEE-798

Product Development Capstone

For the MS in Product Development (MPD) program. Students in the program must demonstrate intellectual leadership in the field of new product development. The general intent of the Capstone is to demonstrate knowledge of the integrative aspects of new product development in the context of a company-oriented problem solving 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 experiences in the program. Team-based projects are encouraged. Projects must be approved in advance of registration. (This class is restricted to PRODDEV-MS Major students.) **Lecture 3, Credits 3 (Fall, Spring)**

ISEE-799

Independent Study

This course is 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. Students registering for more than four credit hours must obtain the approval of both the department head and the adviser. (Enrollment in this course requires permission from the department offering the course.) **Ind Study, Credits 1 - 3 (Fall, Spring, Summer)**

Mechanical Engineering

MECE-605

Finite Elements

This course focuses upon theoretical and applied concepts pertaining to the finite element method. Direct and weighted residual formulation methods are derived and applied to problems in the area of structural analysis, fluid flow, and heat transfer. Foundational topics include shape functions, element formulation, element assembly, boundary conditions, matrix solution methods, mesh refinement, and convergence. The use of a standard commercial finite element software package is introduced. (Prerequisites: MECE-350 or equivalent course or graduate standing in MECE-MS or MECE-ME program. Co-requisite: MECE-707 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

MECE-606

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. Computer projects using Matlab/Simulink will be assigned and graded in this course including concepts of data analysis and how it performs to parameter estimation. Linearization of nonlinear system models and verification methods are also discussed. (Prerequisites: MECE-320 or equivalent course or graduate standing in the MECE-ME or MECE-MS program.) **Lecture 3, Credits 3 (Spring)**

MECE-610

Flight Dynamics

Flight Dynamics is a three (3) credit hour, three (3) contact hour lectures to introduce the student to dynamics of aircraft flight. This course deals with the three-dimensional dynamics of aircraft, including general aircraft performance, stability and control, and handling qualities. Topics include: static and dynamic stability; longitudinal and lateral/directional control; mathematical development of rigid-body 6DOF equations-of-motion describing full range of aircraft motion; attitude dynamics and quaternion alternative; aerodynamic forming term coefficient development; linearization of nonlinear aircraft models; simulation of aircraft trajectories; aircraft system modes; and aircraft handling qualities introduction. Graduate students are expected to learn additional topics, e.g., quaternion methods, DATCOM programming, and frequency domain analysis of aircraft modes. (Co-requisites: MECE-320 or equivalent course or graduate standing in the MECE-MS or MECE-ME program.) **Lecture 3, Credits 3 (Spring)**

MECE-611

Orbital Mechanics

Orbital Mechanics is a three (3) credit hour, three (3) contact hour lectures to introduce the student to mechanics of orbits. This course introduces orbital mechanics and space flight dynamics theory with application for Earth, lunar, and planetary orbiting spacecraft. Content includes: historical background and equations of motion, two-body orbital mechanics, orbit determination, orbit prediction, orbital maneuvers, lunar and interplanetary trajectories, orbital rendezvous and space navigation. The two-body orbital mechanics problem, first approximation to all exploration orbits or trajectories, is covered in full detail. Students develop computer based simulations using Matlab of orbital mechanics problems including a final mission project simulation from Earth to Mars requiring a number of orbit phases and transfers between these phases. Graduate students are expected to learn additional topics, e.g., Gibbs Method, Lambert's Problem, Sidereal Time, and Orbit Determination from Angle and Range Measurements. (Prerequisites: MECE-205 or equivalent course or graduate standing in the MECE-MS or MECE-ME program.) **Lecture 3, Credits 3 (Fall)**

MECE-620

Introduction To Optimal Design

This course is an introduction to basic optimization techniques for engineering design synthesis. Topics covered include: techniques, the general problem statement, necessary conditions of optimization, numerical techniques for unconstrained optimization, constrained optimization through unconstrained optimization, and direct methods. Numerical solutions are obtained using MATLAB software. A design project is required. (Co-requisite: MECE-320 or equivalent course or graduate standing in the MECE-MS or MECE-ME program.) **Lecture 3, Credits 3 (Spring)**

MECE-623

Powertrain Systems and Design

This course will introduce the analysis and design of power transmission systems. Topics covered include spur, helical, bevel, and worm gears, gear trains, planetary gear systems, power transmission shafts, belt and chain drives. The transmission of power at the required speed and torque is the primary function of most power transmission systems, and is the focus of this course. Students will use this foundation to complete a case study project whereby they review and analyze how power is transmitted from the primary source to the remainder of the driveline by means such as manual transmissions, automatic transmissions, continuously variable transmissions, and direct drive systems. (Prerequisites: MECE-350 or graduate standing in MECE-ME or MECE-MS program.) **Lecture 3, Credits 3 (Fall)**

MECE-624

Vehicle Dynamics

The course focuses on the fundamentals of ground vehicle motion, control, and stability. The structure, stiffness, and mechanisms by which tires generate longitudinal and lateral forces and self-aligning moments are discussed. Steering geometry and steady-state and transient steering response for bicycle and four-wheel vehicle models are analyzed. The effect of suspension geometry and stiffness on stability and ride are discussed. Transmission system design to match engine characteristics and achieve required vehicle performance is discussed. (Co-requisites: MECE-320 or equivalent course or graduate standing in the MECE-MS or MECE-ME program.) **Lecture 3, Credits 3 (Spring)**

MECE-629

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, hydropower, biomass, and geothermal. Students will be responsible for a final design project. (Prerequisites: MECE-310 or equivalent course or graduate standing in MECE-MS or MECE-ME or SUSTAIN-MS or SUSTAIN-ME.) **Lecture 3, Credits 3 (Fall)**

MECE-638

Design of Machine Systems

This is an applied course in the selection of components and integration of those components into electro-pneumatic-mechanical devices and systems. Topics involve all aspects of machine design, including drive components and systems, motion generation and control, and electrical control hardware and strategy. (Prerequisites: MECE-205 and MECE-350 or equivalent courses or graduate standing in the MECE-MS or MECE-ME program.) **Lecture 4, Credits 3**

MECE-643

Classical Controls

This course introduces students to the study of linear control systems, their behavior and their design and use in augmenting engineering system performance. Topics include control system behavior characterization in time and frequency domains, stability, error and design. This is accomplished through classical feedback control methods that employ the use of Laplace transforms, block diagrams, root locus, and Bode diagrams. An integrated laboratory will provide students with significant hands-on analysis and design-build-test experience. (Prerequisites: MECE-320 or equivalent course or graduate standing in the MECE-ME or MECE-MS program.) **Lec/Lab 3, Credits 3 (Fall, Spring)**

MECE-644

Introduction To Composite Materials

This course is an introductory course to the fundamentals and applications of composite materials. Topics covered include constituents of composite materials, fabrication techniques, micromechanical analysis, macromechanical analysis, and the use of composites in design. Some laboratory work is to be performed, and a design project is required. (Prerequisites: MECE-203 and MECE-305 or equivalent courses or graduate student standing in MECE-MS or MECE-ME.) **Lecture 3, Credits 3 (Fall)**

MECE-650

Sustainable Energy Use in Transportation

The transportation sector represents nominally a third of the total energy consumption in the US, and presently, over 90% of this comes from petroleum sources. Transportation is responsible for about a quarter of greenhouse gas emissions and is a major source for several criteria pollutants. This course will introduce students to engineering practices used to evaluate transportation technologies from the standpoint of sustainability with an emphasis on light duty vehicles. Several emerging technologies including battery and hybrid electric vehicles, fuel cell vehicles, and bio-fuels will be considered. Particular attention will be devoted to the energy efficiency and emissions of the technology at the both vehicle and the fuel source levels. Additionally, the economic and social impacts will be examined. No text book will be assigned, and instead we will rely on open-access publications, journal articles, and electronic text available through the library. (Co-requisites: MECE-305 or equivalent course or graduate standing in MECE-MS or MECE-ME.) **Lecture 3, Credits 3 (Spring)**

MECE-655

Biomechanics

Biomechanics is an upper level undergraduate and graduate elective course designed to give students an introduction to fundamental concepts in Biomechanics as well as how to relate the biomechanics of motion to robotic systems. Course topics will include Biomechanics of Human Motion, Muscle Mechanics, Biomechanics of Prostheses, Artificial Limbs, Rehabilitation Biomechanics and Robotics, Actuators and Control, Biomimetic Robotics, Robotic Surgery, and Sensors. Students will be provided with fundamental pre-requisite knowledge related to each topic through readings, online resources, and in-class demonstrations. A final project is required. (Prerequisites: MECE-205 or BIME-200 or equivalent course or graduate standing in MECE-ME or MECE-MS program.) **Lecture 3, Credits 3 (Biannual)**

MECE-657

Applied Biomaterials

This course provides an overview of materials used in biomedical applications. Topics covered include structure and properties of hard and soft biomaterials, material selection for medical applications, material performance and degradation in hostile environments, and typical and abnormal physiological responses to biomaterials/environments. Some experiments will be performed in class and a major project is required. (Prerequisite: (MECE-305 or BIME-370) and (MECE-210 or BIME-320) or equivalent courses and restricted to MECE-ME or MECE-MS students.) **Lecture 3, Credits 3 (Spring)**

MECE-658

Introduction to Engineering Vibrations

Is concerned with analytically finding the dynamic characteristics (natural frequencies and mode shapes) of vibratory mechanical systems (single-degree and multi-degrees of freedom systems), and the response of the systems to external excitations (transient, harmonic, and periodic). Application to vibration damping techniques (Dynamic Vibration Absorbers) is also covered. In addition, laboratory exercises are performed, and an independent design project is assigned. (Prerequisites: MECE-320 or equivalent course or graduate standing in the MECE-ME or MECE-MS program.) **Lecture 3, Credits 3 (Fall)**

MECE-670

Manufacturing Processes and Engineering

The overall objective of this course is to provide students the exposure of traditional and non-traditional manufacturing processes which include casting, thermoforming, sheet metal forming, machining, polymer processing, joining, additive manufacturing, and more. Students will learn how to apply the basic properties of materials to manufacturing analysis and product design within an economic framework from lectures and projects. (Prerequisites: MECE-104 and MECE-203 and MECE-305 or equivalent courses or graduate standing in MECE-MS or MECE-ME programs. Co-requisites: MECE-350 or equivalent course or graduate standing in MECE-MS or MECE-ME programs.) **Lecture 3, Credits 3 (Fall)**

MECE-685

Mentored Research

The goal of this course is to introduce students to research methods in an immersive research environment. Students complete independent research under the supervision of faculty and PhD mentors in the mechanical engineering department. Research projects span the range of all engineering disciplines, as well as non-engineering majors such as medical illustration, public policy, business, math and science. Projects are directly related to and supportive of activities important to the faculty member's overall research goals. Students may wish to create a multi-year experience by taking one credit at a time each semester for several years. Student projects then grow and expand as the research and the student's skill set evolves. This course is ideally suited for any student interested in learning about the exciting research taking place at RIT, students considering a master's or PhD, and students in the honors program wanting to earn research credits towards their honors degree. Mechanical engineering dual degree and graduate students may wish to take this course to explore research topics prior to making the decision between project with paper and thesis. Project descriptions are updated regularly and made available on-line and through the mechanical engineering office. Interested students should contact the faculty listed for each project of interest. After meeting with the faculty, projects may be re-scoped to match the student's background, preparation and key interest areas. There may be a limited number of seats available. **Research, Credits 1 - 3 (Fall, Spring)**

MECE-689

Grad.Lower Level Special Topic

Topics and subject areas that are not regularly offered are provided under this course. Such courses are offered in a normal format; that is, regularly scheduled class sessions with an instructor. **Lecture, Credits 1 - 3 (Fall, Summer)**

MECE-699

Graduate Co-op

Up to six months of full-time, paid employment in the mechanical engineering field. See the ME graduate program coordinator or RIT's Office of Cooperative Education for further details. (This course is restricted to students in the MECE-MS or MECE-ME program.) **CO OP, Credits 0 (Fall, Spring, Summer)**

MECE-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. (This course is restricted to students in the MECE-MS or MECE-ME program.) **Lecture 3, Credits 3 (Fall)**

MECE-707

Engineering Analysis

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. (Prerequisites: (MATH-241 and MATH-326) or graduate student standing in the MECE-MS or MECE-ME programs.) **Lecture 3, Credits 3 (Fall, Spring)**

MECE-709

Advanced Engineering Mathematics

Advanced Engineering Mathematics provides the foundations for complex functions, vector calculus and advanced linear algebra and its applications in analyzing and solving a variety of mechanical engineering problems especially in the areas of mechanics, continuum mechanics, fluid dynamics, heat transfer, and vibrations. Topics include: vector algebra, vector calculus, functions of complex variables, ordinary differential equations and local stability, advanced matrix algebra, and partial differential equations. Mechanical engineering applications will be discussed throughout the course. (Prerequisites: MECE-707 or equivalent course or graduate student standing in MECE-MS or MECE-ME.) **Lecture 3, Credits 3 (Fall, Spring)**

MECE-725

Fundamentals of Computational Fluid Dynamics

The course presents the conceptual understanding necessary to design, modify and solve real world fluid flow codes using MATLAB. It will address solution methods for inviscid external flows at subsonic and supersonic levels, viscous flow solutions at subcritical Reynolds numbers, and steady and unsteady heat conduction. (Prerequisites: (MECE-117 and (MECE-355 or MECE-738 or MECE-751)) or (graduate standing in MECE-ME or MECE-MS and (MECE-738 or MECE-751)).) **Lecture 3, Credits 3 (Spring)**

MECE-730

Design Project Leadership

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 packages. (This course is restricted to students in an MECE-BS/MS program or MECE-MS or MECE-ME.) **Lecture 3, Credits 3 (Spring)**

MECE-731

Computational Fluid Dynamics

This course covers the basics of introduction to Computational Fluid Dynamics (CFD) in fluid mechanics and heat transfer. CFD methods of flow modeling are introduced with emphasis of in-class use of CFD software for modeling and problem solution. Course work involves tutorials and design examples. This course also introduces the students to some of the commercial CFD codes being used for solving thermal-fluid problems. Students complete an individual CFD study project including a written report and a presentation of the results. (Prerequisites: MECE-210 and MECE-317 or equivalent courses or graduate standing in MECE-MS or MECE-ME.) **Lecture 3, Credits 3 (Fall or Spring)**

MECE-733

Sustainable Energy Management

This course, Sustainable Energy Management, provides an overview of mechanical systems within energy intensive applications such as power plants, automobiles, and buildings with an emphasis on advanced thermodynamic analyses of sub-systems which possess the most visible energy signature in terms of energy usage, energy inefficiency, thermoeconomic costing, and exergy destruction. Fundamentals of system operation are explored as well as various sustainability measures. In addition, the interrelationship between energy intensive applications and public policy instruments and strategies are examined. Students will explore methods by which engineers evaluate energy-intensive systems to assess alignment with sustainability and communicate findings to inform the public policy process cycle. (Prerequisites: MECE-310 and MECE-352 or graduate standing in the MECE-MS or MECE-ME program.) **Lecture 3, Credits 3 (Spring)**

MECE-738

Ideal Flows

This 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. (Prerequisites: MECE-210 and MATH-231 and MATH-326 or equivalent courses or graduate standing in the MECE-MS or MECE-ME program.) **Lecture 3, Credits 3 (Fall)**

MECE-739

Alternative Fuels and Energy Efficiency

This course 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. (Prerequisites: MECE-352 or equivalent course or graduate standing in the MECE-MS or MECE-ME program.) **Lecture 3, Credits 3 (Fall)**

MECE-743

Digital Controls

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 and evaluated using Matlab/Simulink. A series of experimental exercises included using concepts throughout the course on an embedded controller. (Prerequisites: MECE-643 or equivalent course or graduate student standing in MECE-MS or MECE-ME.) **Lecture 3, Credits 3 (Spring)**

MECE-744

Nonlinear Controls

This course introduces the student to methods used to design advanced nonlinear control systems. Topics of this course include: Phase-State Plane Analysis, Existence of Limit Cycles, Lyapunov Stability (Direct and Indirect methods), nonlinear control design using Feedback Linearization, the Sliding Mode Control method, Numerical Optimization of PID laws, and Adaptive Control strategies. Students are expected to complete computer projects using Matlab/Simulink. (Prerequisites: MECE-643 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

MECE-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. (Prerequisites: MECE-305 or equivalent course or graduate standing in MECE-MS or MECE-ME program.) **Lecture 4, Credits 3 (Fall)**

MECE-751**Convective Phenomena**

This course introduces the student to the flow of real incompressible fluids beginning with a review of ideal flows. 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. Students should be familiar with concepts of ideal flows. MECE-738 is recommended. (Prerequisites: MECE-210 and MATH-231 and MATH-326 or equivalent courses or graduate standing in the MECE-MS or MECE-ME program.) **Lecture 3, Credits 3 (Spring)**

MECE-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. (Prerequisites: MECE-203 and MECE-210 and MECE-317 or equivalent courses or graduate standing in the MECE-MS or MECE-ME program.) **Lecture 3, Credits 3 (Spring)**

MECE-754**Fundamentals of Fatigue and Fracture**

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). (Prerequisites: MECE-317 and MECE-350 or equivalent courses or graduate standing in the MECE-MS or MECE-ME program.) **Lecture 4, Credits 3**

MECE-755**Microfluidics**

Applications areas of microfluidics, Fluid flow and heat transfer governing equations, continuum hypothesis, analytical solutions for laminar liquid flow at different Reynolds numbers, creeping flows, laminar flows, identification of forces - surface, body, inertia - and their importance in specific applications, surface tension effects, pressure drop and heat transfer calculations, slip flow in gas flows, single-phase liquid flow and flow boiling in microchannels, roughness effects, mixing, T-junction, bubble generators, diffusion effects, introduction to microfluidic devices and controls - Bubble generators, micro-reactors, lab-on-chip devices, microscale sensing, control and measurement. (Prerequisites: MECE-210 or equivalent course or graduate standing in MECE-ME or MECE-MS or ENGR-PHD or MCSE-PHD programs.) **Lecture 3, Credits 3 (Spring)**

MECE-756**Boiling and Condensation**

The course covers selected topics in boiling and condensation. The fundamental aspects will be introduced in the class. Fundamentals of phase change process will be emphasized. Several design examples will be covered to make students proficient in applying the theory to practical situations. The course has a design-oriented project that counts for majority of the grade. The projects are based on exciting new topics of current interest such as - visualization of boiling characteristics on enhanced surfaces, investigating different enhancement techniques, characterizing of nucleation behavior, effect of substrate on boiling, etc. Some of the topics covered include: Boiling curve, nucleation, bubble growth, critical heat flux, mechanisms of heat transfer, and enhancement techniques. (Prerequisites: MECE-210 and MECE-310 or equivalent course or graduate standing in MECE-ME or MECE-MS or ENGR-PHD or MCSE-PHD programs.) **Lecture 3, Credits 3 (Fall)**

MECE-758**Intermediate Engineering Vibrations**

Is concerned with analytically finding the dynamic characteristics (natural frequencies and mode shapes) of continuous mechanical vibratory systems (strings, rods, and beams), and the response of the systems to external excitations (transient and harmonic). Solutions using the finite element method is also introduced. (Prerequisites: MECE-658 or equivalent course or graduate student standing in MECE-MS or MECE-ME.) **Lecture 3, Credits 3 (Spring)**

MECE-777**Graduate 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. (Enrollment in this course requires permission from the department offering the course.) **Internship, Credits 3 (Fall, Spring, Summer)**

MECE-785**Mechanics of Solids**

This course provides a more advanced treatment of stress and strain concepts pertaining to the mechanics of deformable media and provides a theoretical foundation for a concurrent or follow-on course in finite elements. Topics include stress and strain transformations, two-dimensional theory of elasticity, stress functions, torsion, plate bending, and energy methods. (Prerequisites: MECE-350 or graduate standing in MECE-ME or MECE-MS program.) **Lecture 3, Credits 3 (Fall)**

MECE-789**Graduate Special Topics**

Topics and subject areas that are not regularly offered are provided under this course. Such courses are offered in a normal format; that is, regularly scheduled class sessions with an instructor. (This course is restricted to students in an MECE-BS/MS program or MECE-MS or MECE-ME.) **Lecture, Credits 1 - 3 (Fall, Spring)**

MECE-790**Thesis**

Thesis In conference with an adviser, a topic is chosen. Periodic progress reports and a final written document with an oral examination are required. (Enrollment in this course requires permission from the department offering the course.) **Thesis, Credits 0 - 6 (Fall, Spring, Summer)**

MECE-792**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 adviser. 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. (Enrollment in this course requires permission from the department offering the course.) **Ind Study, Credits 3 (Fall, Spring, Summer)**

MECE-795**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 required to attend a designated number of seminars. (This course is restricted to MECMS-U or MECE-MS or MECE-ME or MECEME-U Major students.) **Seminar 1, Credits 0 - 2 (Fall, Spring)**

MECE-799**Independent Study**

This course is 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. (Enrollment in this course requires permission from the department offering the course.) **Ind Study, Credits 1 - 3 (Fall, Spring, Summer)**

Microelectronic Engineering

MCEE-601**Microelectronic Fabrication**

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. 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. (Prerequisites: Graduate standing in the MCEE-MS or MCEMANU-ME program or permission of instructor.) **Lab 3, Credits 3 (Fall)**

MCEE-601 Microelectronic Fabrication
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, layout, 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. 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 chip. Laboratory work also provides an introduction to basic IC fabrication processes and safety. (Prerequisites: Graduate standing in the MCEE-MS or MCEMANU-ME program or permission of instructor.) **Lecture 3, Credits 3 (Fall)**

MCEE-602 Semiconductor Process Integration
This is an advanced level course in Integrated Circuit Devices and process technology. A detailed study of processing modules in modern semiconductor fabrication sequences will be done through simulation. Device engineering challenges such as shallow-junction formation, fin FETs, ultra-thin gate dielectrics, and replacement metal gates are covered. Particular emphasis will be placed on non-equilibrium effects. Silvaco Athena and Atlas will be used extensively for process simulation. Graduate paper required. (Prerequisites: MCEE-601 or equivalent course.) **Lab 2, Credits 3 (Spring)**

MCEE-602 Semiconductor Process Integration
This is an advanced level course in Integrated Circuit Devices and process technology. A detailed study of processing modules in modern semiconductor fabrication sequences will be done through simulation. Device engineering challenges such as shallow-junction formation, fin FETs, ultra-thin gate dielectrics, and replacement metal gates are covered. Particular emphasis will be placed on non-equilibrium effects. Silvaco Athena and Atlas will be used extensively for process simulation. Graduate paper required. (Prerequisites: MCEE-601 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

MCEE-603 Thin Films
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 the student with the challenges of creating and operating in a controlled environment. Physical and Chemical Vapor Deposition (PVD & CVD) 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 fundamental thin film processes to IC manufacturing are presented. Graduate paper required. (Prerequisites: Graduate standing in the MCEE-MS or MCEMANU-ME program or permission of instructor.) **Lab 3, Credits 3 (Fall)**

MCEE-603 Thin Films
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 the student with the challenges of creating and operating in a controlled environment. Physical and Chemical Vapor Deposition (PVD & CVD) 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 fundamental thin film processes to IC manufacturing are presented. Graduate paper required. (Prerequisites: Graduate standing in the MCEE-MS or MCEMANU-ME program or permission of instructor.) **Lecture 2, Credits 3 (Fall)**

MCEE-605 Lithography Materials and Processes
Microlithography Materials and Processes covers the chemical aspects of microlithography and resist processes. Fundamentals of polymer technology will be addressed and the chemistry of various resist platforms including novolac, styrene, and 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, including multi-layer techniques for BARC, double patterning, TARC, and next generation materials and processes are applied to optical lithography. Graduate paper required. (Prerequisites: Graduate standing in the MCEE-MS or MCEMANU-ME program or permission of instructor.) **Lab 3, Credits 3 (Fall, Spring)**

MCEE-605 Lithography Materials and Processes
Microlithography Materials and Processes covers the chemical aspects of microlithography and resist processes. Fundamentals of polymer technology will be addressed and the chemistry of various resist platforms including novolac, styrene, and 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, including multi-layer techniques for BARC, double patterning, TARC, and next generation materials and processes are applied to optical lithography. Graduate paper required. (Prerequisites: Graduate standing in the MCEE-MS or MCEMANU-ME program or permission of instructor.) **Lecture 3, Credits 3 (Fall, Spring)**

MCEE-615 Nanolithography Systems
An advanced course covering the physical aspects of micro- and nano-lithography. Image formation in projection and proximity systems are studied. Makes use of optical concepts as applied to lithographic systems. Fresnel diffraction, Fraunhofer diffraction, and Fourier optics are utilized to understand diffraction-limited imaging processes and optimization. Topics include illumination, lens parameters, image assessment, resolution, phase-shift masking, and resist interactions as well as non-optical systems such as EUV, maskless, e-beam, and nanoimprint. Lithographic systems are designed and optimized through use of modeling and simulation packages. Graduate paper required. (Prerequisites: MCEE-605 or equivalent course.) **Lab 3, Credits 3 (Fall, Spring)**

MCEE-615 Nanolithography Systems
An advanced course covering the physical aspects of micro- and nano-lithography. Image formation in projection and proximity systems are studied. Makes use of optical concepts as applied to lithographic systems. Fresnel diffraction, Fraunhofer diffraction, and Fourier optics are utilized to understand diffraction-limited imaging processes and optimization. Topics include illumination, lens parameters, image assessment, resolution, phase-shift masking, and resist interactions as well as non-optical systems such as EUV, maskless, e-beam, and nanoimprint. Lithographic systems are designed and optimized through use of modeling and simulation packages. Graduate paper required. (Prerequisites: MCEE-605 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

MCEE-620 Photovoltaic Science and Engineering
This course focuses on the principle and engineering fundamentals of photovoltaic (PV) energy conversion. The course covers modern silicon PV devices, including the basic physics, ideal and non-ideal models, device parameters and design, and device fabrication. The course discusses crystalline, multi-crystalline, amorphous thin films solar cells and their manufacturing. Students will become familiar with basic semiconductor processes and how they are employed in solar cells manufacturing. The course further introduces third generation advanced photovoltaic concepts including compound semiconductors, spectral conversion, and organic and polymeric devices. PV applications, environmental, sustainability and economic issues will also be discussed. Evaluations include assignments and exams, a research/term paper on a current PV topic. (This course requires permission of the Instructor to enroll.) **Lecture 3, Credits 3 (Spring)**

MCEE-699 Graduate Co-op
Up to six months of full-time, paid employment in the microelectronic engineering field. See the graduate program coordinator or RIT's Office of Cooperative Education for further details. **CO OP, Credits 0 (Fall, Spring, Summer)**

MCEE-704 Physical Modeling of Semiconductor Devices
A senior or graduate level course on the application of simulation tools for physical design and verification of the operation of semiconductor devices. The goal of the course is to provide a more in-depth understanding of device physics through the use of simulation tools. Technology CAD tools include Silvaco (Athena/Atlas) for device simulation. The lecture will explore the various models that are used for device simulation, emphasizing the importance of complex interactions and 2-D effects as devices are scaled deep-submicron. Laboratory work involves the simulation of various device structures. Investigations will explore how changes in the device structure can influence device operation. (This course requires permission of the Instructor to enroll.) **Lab 3, Credits 3 (Fall)**

MCEE-704 Physical Modeling of Semiconductor Devices
A senior or graduate level course on the application of simulation tools for physical design and verification of the operation of semiconductor devices. The goal of the course is to provide a more in-depth understanding of device physics through the use of simulation tools. Technology CAD tools include Silvaco (Athena/Atlas) for device simulation. The lecture will explore the various models that are used for device simulation, emphasizing the importance of complex interactions and 2-D effects as devices are scaled deep-submicron. Laboratory work involves the simulation of various device structures. Investigations will explore how changes in the device structure can influence device operation. (This course requires permission of the Instructor to enroll.) **Lecture 3, Credits 3 (Fall)**

MCEE-706 SiGe and SOI Devices and Technologies
This course introduces students to the fundamentals of III-V, 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, high-electron mobility transistors (HEMTs) and tunnel FETs. Fabrication technologies for realizing SOI substrates that include SIMOX and SMART CUT technologies are described. The physics of transistors built on SOI substrates will be discussed. At the completion of the course, students will write a review paper on a topic related to the course. (This course requires permission of the Instructor to enroll.) **Lecture 3, Credits 3 (Spring)**

MCEE-713

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. (Prerequisites: Graduate standing in the MCEE-MS or MCEMANU-ME program or permission of instructor.) **Lecture 3, Credits 3 (Fall)**

MCEE-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). (Prerequisites: Graduate standing in the MCEE-MS or MCEMANU-ME program or permission of instructor.) **Lecture 3, Credits 3 (Fall)**

MCEE-730

Metrology for Failure Analysis and Yield of ICs

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. (Prerequisites: MCEE-201 or MCEE-360 or graduate student standing in the MCEE-MS program.) **Lecture 3, Credits 3 (Fall)**

MCEE-732

Microelectronics Manufacturing

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. Associated is a lab for on-campus section (01) and a graduate paper/case study for distance learning section (90). The laboratory for this course is the student-run factory. Topics include Lot tracking, query processing, data collection, lot history, cycle time, turns, CPK and statistical process control, measuring factory performance, factory modeling and scheduling, cycle time management, cost of ownership, defect reduction and yield enhancement, reliability, process modeling and RIT's advanced CMOS process. 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. (Prerequisites: MCEE-601 or equivalent course.) **Lecture 8, Credits 3 (Spring)**

MCEE-770

Microelectromechanical Systems

This course will provide an opportunity for the student to become familiar with the design, fabrication technology and applications of Microelectromechanical systems. This is one of the fastest growing areas in the semiconductor business. Today's MEMS devices include accelerometers, pressure sensors, flow sensors, chemical sensors, energy harvesting and more. These devices have wide variety of applications including automotive, consumer, military, scientific, and biomedical. Students will select a MEMS device/project to be made and then design, fabricate, test, prepare a project presentation and final paper. (Prerequisites: MCEE-601 and EEEE-587 or EEEE-787 or equivalent courses.) **Lab 2, Credits 3 (Fall)**

MCEE-770

Microelectromechanical Systems

This course will provide an opportunity for the student to become familiar with the design, fabrication technology and applications of Microelectromechanical systems. This is one of the fastest growing areas in the semiconductor business. Today's MEMS devices include accelerometers, pressure sensors, flow sensors, chemical sensors, energy harvesting and more. These devices have wide variety of applications including automotive, consumer, military, scientific, and biomedical. Students will select a MEMS device/project to be made and then design, fabricate, test, prepare a project presentation and final paper. (Prerequisites: MCEE-601 and EEEE-587 or EEEE-787 or equivalent courses.) **Lecture 2, Credits 3 (Fall)**

MCEE-777

Master of Engineering 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. (Enrollment in this course requires permission from the department offering the course.) **Internship, Credits 1 - 4 (Fall, Spring, Summer)**

MCEE-789

Special Topics

This is a variable credit, variable special topics course that can be in the form of a course that is not offered on a regular basis. (This course requires permission of the Instructor to enroll.) **Lecture 3, Credits 1 - 3 (Fall, Spring, Summer)**

MCEE-790

MS 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; prepare a written paper in a short format suitable for submission for publication in a journal. (Enrollment in this course requires permission from the department offering the course.) **Thesis, Credits 1 - 6 (Fall, Spring)**

MCEE-792

Graduate Research Project

This course number is used to fulfill the graduate project requirement under the non-thesis option for the MS degree in Microelectronic Engineering. During this course, the student will be required to perform a literature survey, and conduct a limited scope investigation. Appropriate topics for this project may include: (i) development/characterization/documentation of semiconductor fabrication processes, (ii) characterization/measurement/documentation of semiconductor devices, or (iii) detailed simulation/design/documentation of semiconductor devices or processes. Alternative topics may be pursued with approval of the faculty advisor. The student must obtain the approval of an appropriate faculty member to supervise the paper before registering for this course. (This course is restricted to MCEE-MS Major students.) **Project 3, Credits 3 (Fall, Spring, Summer)**

MCEE-795

Graduate Seminar

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. (Prerequisites: Graduate standing in the MCEE-MS or MCEMANU-ME program or permission of instructor.) **Seminar 1, Credits 0 (Fall, Spring)**

MCEE-799

Graduate 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. (Enrollment in this course requires permission from the department offering the course.) **Ind Study, Credits 1 - 3 (Fall, Spring, Summer)**

Microsystems Engineering

MCSE-610

Applied Biofluid Mechanics and Microcirculation

This is a one-semester introductory graduate course that introduces and develops fundamental understanding of the flow dynamics of blood. The course includes a discussion of basic fluid mechanics, blood rheology, and biological regulation of blood flow. Emphasis will be placed on developing a physical understanding of each of the fundamental ideas and how it is applied to microcirculation and cutting-edge biomedical research. Applications of state-of-art micro/nanotechnologies such as microfluidics in the study of microcirculation, tissue engineering, and blood diagnostic will be also discussed in the class. The course is also open to undergraduate students who have taken courses in fluid dynamics, e.g., MECE (210)-Fluid Mechanics I, BIME (320)- Fluid Mechanics or equivalent, and are interested in blood flow and related biomedical engineering technologies. **Lecture 3, Credits 3 (Fall)**

MCSE-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. (This course is restricted to students in the MCSE-PHD program or those with permission of instructor.) **Lecture 3, Credits 3 (Fall)**

MCSE-703 **Material Science for Microsystems Engineering**
The intent of this course is to provide a comprehensive review of the fundamental concepts of materials science and engineering with applications to nano- and microsystems. Topics include crystallography, diffusion, phase diagrams, fluids, and thermal, elastic, electrical, optical and magnetic properties. This course provides students in the engineering or science fields of nano- and microsystems with the background for future coursework and research in materials engineering and applications. (This course is restricted to students in the MCSE-PHD program or those with permission of instructor.) **Lecture 3, Credits 3 (Spring)**

MCSE-705 **Epitaxial Crystal Growth and Thin Film Science**
This graduate course focuses on the epitaxial crystal growth and thin film science widely applicable in the electronics and semiconductor industry. This course provides a combination of fundamental and practical knowledge regarding deposition and characterization of metallic and semiconductor thin film materials. Topics include, but are not limited to, thermodynamics of thin film deposition, crystal structures and defects in thin films, the basic nucleation and growth mechanisms of thin films (growth models, lattice matching epitaxy and domain matching epitaxy), thin film processing techniques (physics vapor deposition, chemical vapor deposition, vapor phase epitaxy, molecular beam epitaxy, pulsed laser deposition), thin film growth instrumentation (energy source, chamber configurations, vacuum systems and growth controllers), and several advanced topics related to defect and dislocation control during the growth of thin films for electrical and optical devices. **Lecture 3, Credits 3 (Spring)**

MCSE-707 **Advanced Nanomaterials Characterization Methods**
This course provides a comprehensive overview of theoretical principles, instrumentation, applications, and practical concepts related to advanced techniques for characterization of nanoscale materials and systems. Topics include: diffraction theory, low-energy and reflection high-energy electron diffraction, X-ray diffraction, X-ray reflectivity; analytical scanning electron microscopy techniques including electron beam-induced current, energy-/wavelength-dispersive X-ray spectrometry, and electron backscatter diffraction; analytical transmission electron microscopy techniques including selected-area and convergent-beam electron diffraction, electron energy-loss spectroscopy, energy-filtered imaging, and electron holography; focused ion beam-based characterization and patterning; spectroscopic techniques including photo-, electro-, and cathodo-luminescence spectroscopy, Raman spectroscopy, and Auger electron spectroscopy; scan probe microscopy techniques including atomic force, magnetic force, photo-induced force, Kelvin probe force, scanning tunneling, scanning near-field optical, and scanning microwave impedance microscopy; and ion beam techniques including secondary ion mass spectrometry and local electrode atom probe tomography. The above techniques will be explored with the aid of case studies from the current literature. Lecture content will be reinforced by active demonstrations conducted in various labs at RIT and University of Rochester. (Prerequisite: MCSE-703 and MTSE-601 or equivalent courses.) **Lecture 3, Credits 3 (Fall)**

MCSE-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. (Prerequisites: EEEE-374 or equivalent course or graduate student standing in the MCSE-PHD program.) **Lecture 3, Credits 3 (Spring)**

MCSE-713 **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. (Prerequisites: EEEE-374 or equivalent course or graduate student standing in the MCSE-PHD program.) **Lecture 3, Credits 3 (Fall)**

MCSE-714 **Quantum Mechanics for Engineers**
This course will give students comprehensive understanding of the foundations of quantum mechanics. The course will also provide 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; Angular momentum and the Hydrogen Atom; If time allows: Spin; Identical Particles. (Prerequisites: EEEE-353 and MATH-231 or equivalent courses or graduate student standing in the MCSE-PHD program.) **Lecture 3, Credits 3 (Fall)**

MCSE-715 **Photonic Integrated Circuits**
This course focuses on photonic integrated circuits (PICs) - an emerging technology where photonic chips (consisting of waveguides, lasers, detectors, modulators and more) are manufactured using integrated circuit technology and closely integrated with microelectronics. The circuits are finding applications in high performance communication, computing and sensing systems. The technology is rapidly growing in complexity and demand, and as the advantages of using photons are realized and the manufacturing hurdles are overcome, photonic circuits will become ubiquitous in future microsystems. Course topics include, fundamental concepts (waveguides, interference, light-matter interaction), PIC component modeling, schematic and layout driven design, PIC fabrication techniques, and PIC testing to round out the students understanding of integrated photonics. (Prerequisite: EEEE-374 or MCEE-320 or equivalent course or graduate standing in MCSE-PHD or ENGR-PHD or EEEE-MS or CMPE-MS or MCEE-MS.) **Lecture 3, Credits 3 (Spring)**

MCSE-731 **Integrated Optical Devices and Systems**
This course discusses basic goals, principles and techniques of integrated optical devices and systems, and explains how the various optoelectronic devices of an integrated optical system operate and how they are integrated into a system. Emphasis in this course will be on planar passive optical devices. Topics include optical waveguides, optical couplers, micro-optical resonators, surface plasmons, photonic crystals, modulators, design tools and 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. **Lecture 3, Credits 3 (Fall)**

MCSE-771 **Optoelectronics**
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. (Prerequisite: This class is restricted to degree-seeking graduate students, 4th or 5th year status or those with permission from instructor.) **Lecture 3, Credits 3 (Spring)**

MCSE-795 **Microsystems Ph.D. Seminar**
In this seminar course students will present their latest research and learn about the research taking place in the program. All Microsystems Ph.D. students enrolled full time are required to attend each semester they are on campus. (This course is restricted to students in the MCSE-PHD program or those with permission of instructor.) **Lecture 1, Credits 1 (Fall, Spring)**

MCSE-799 **Independent Study**
This course allows graduate students an opportunity to independently investigate, under faculty supervision, topics related to microsystems engineering. Proposals for independent study activities and assessment are subject to approval by both the supervising faculty member and the department head. **Ind Study, Credits 1 - 3 (Fall, Spring, Summer)**

MCSE-877 **Internship**
Internship is designed to enhance the educational experience of PhD students through full-time employment. (Enrollment in this course requires permission from the department offering the course.) **Internship, Credits 0 (Spring)**

MCSE-889 **Special Topics**
Topics and subject areas that are not regularly offered are provided under this course. Such courses are offered in a normal format; that is, regularly scheduled class sessions with an instructor. (This course is restricted to students in the MCSE-PHD program or those with permission of instructor.) **Lecture 3, Credits 3 (Fall, Spring)**

MCSE-890 **MCSE-Dissertation**
Research in an appropriate topic as arranged by doctoral candidate and dissertation adviser in fulfillment of the dissertation requirement. (Enrollment in this course requires permission from the department offering the course.) **Thesis, Credits 1 - 27 (Fall, Spring, Summer)**

Ph.D. in Engineering

ENGR-701

Interdisciplinary Research Methods

This course emphasizes collaboration in modern research environment and consists of five modules. Students will introduced to the concepts of inter-disciplinary and trans-disciplinary research conducted from both a scientific and an engineering perspective. Students will learn how to write a dissertation proposal, statement of work, timeline for their program of study and the elements of an effective literature review. Students will develop skills related to reviewing and annotating technical papers, conducting a literature search and proper citation. Students will demonstrate an understanding of (a) ethics as it relates to the responsible conduct of research, (b) ethical responsibility in the context of the engineering professions, (c) ethics as it relates to authorship and plagiarism, (d) basic criteria for ethical decision making and (e) identify professional standards and code of ethics relevant to their discipline. Students demonstrate an ability to identify and explain the potential benefits of their research discoveries to a range of stakeholders, including policy makers and the general public. **Lecture 3, Credits 3 (Fall)**

ENGR-702

Translating Discovery into Practice

This course provides graduate students with the professional skills needed by PhD graduates within their major research focus area to move the results of their research from the lab into practice. Students will demonstrate a strong contextual understanding for their research efforts. Students will learn professional skills related to Teamwork; Innovation, Entrepreneurship and Commercialization; Research Management; Policy and Societal Context; and Technical Writing. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Spring)**

ENGR-707

Engineering Analysis

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. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall, Spring)**

ENGR-709

Advanced Engineering Mathematics

Advanced Engineering Mathematics provides the foundations for complex functions, vector calculus and advanced linear algebra and its applications in analyzing and solving a variety of electrical engineering problems especially in the areas of control, circuit analysis, communication, and signal/image processing. Topics include: complex functions, complex integration, special matrices, vector spaces and subspaces, the nullspace, projection and subspaces, matrix factorization, eigenvalues and eigenvectors, matrix diagonalization, singular value decomposition (SVD), functions of matrices, matrix polynomials and Cayley-Hamilton theorem, state-space modeling, optimization techniques, least squares technique, total least squares, and numerical techniques. Electrical engineering applications will be discussed throughout the course. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall, Spring)**

ENGR-795

Doctoral 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 doctoral engineering students enrolled full time are required to attend each semester they are on campus. (Graduate standing in a technical discipline) (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Seminar 1, Credits 1 (Fall, Spring)**

ENGR-877

Doctoral Internship

Internship is designed to enhance the educational experience of PhD students through full-time employment. 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. (This course is restricted to students in the MCSE-PHD or ENGR-PHD program.) **Internship 3, Credits 0 (Fall, Spring, Summer)**

ENGR-889

Special Topics

Topics and subject areas that are not regularly offered are provided under this course. Such courses are offered in a normal format; that is, regularly scheduled class sessions with an instructor. **Lecture 3, Credits 3 (Fall, Spring, Summer)**

ENGR-890

Dissertation and Research

Doctoral-level research by the candidate on an appropriate topic as arranged between the candidate and the research advisor. Students must successfully pass the PhD Candidacy examination prior to enrolling in this course **Research 3, Credits 1 - 8 (Fall, Spring, Summer)**

ENGR-892

Graduate Research

Doctoral-level research by the candidate on an appropriate topic as arranged between the candidate and the research advisor. Students may count a maximum of 9 credits of ENGR-892 towards degree requirements. If the student enrolls cumulatively in more than 9 credits of ENGR-892, the additional credits above 9 will not be counted towards the degree. **Research 3, Credits 1 - 6 (Fall, Spring, Summer)**

ENGR-899

Independent Study

This course is used by students who plan to study a topic on an independent study basis. The student and instructor must prepare a plan of study and method of evaluation for approval by the program director prior to course registration. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Ind Study 3, Credits 3 (Fall, Spring, Summer)**

College of Engineering Technology

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Course numbering: RIT courses are generally referred to by their alphanumeric registration label. The four alpha characters indicate the discipline within the college. The final three digits are unique to each course and identify whether the course is noncredit (less than 099), lower division (100-299), upper division (300-599), or graduate level (600 and above).

Unless otherwise noted, the following courses are offered annually. Specific times and dates can be found in each semester's schedule of courses. Prerequisites/corequisites are noted in parentheses near the end of the course description.

Construction Management

CONM-650 Principles of Construction Leadership and Management
Introduction to leadership and management principles applicable to the construction industry including those associated with strategic planning, construction processes, communications, ethical behavior, human resources development, financial management, and risk management. There will be an emphasis on safety and loss prevention management, insurance and risk management, marketing construction services, and bonding requirements for construction companies. (This course is restricted to CONSMGT-MS students.) **Lecture 3, Credits 3 (Fall)**

CONM-689 Special Topics:
Special Topics is an experimental graduate course intended as a means for offering innovative topics not currently reflected in either the civil engineering technology or construction management curriculums. This is offered periodically, watch for titles in the course listing each semester. Special Topics course offerings may be co-listed with an undergraduate Special Topics course. (Enrollment in this course is restricted to students with graduate standing in CONSMGT-MS or EHSM-MS.) **Lecture, Credits 1 - 3 (Fa/sp/su)**

CONM-690 Sustainable Building Construction and Design
This course will prepare students to critically assess and prepare written communications regarding the current and evolving understandings, practices, and potentials of sustainable building construction and design and prepare them with the skills to determine and communicate value-to-cost differences between "green" and conventional designs. Students will also be able to understand the role of construction managers in the design and construction of buildings while incorporating sustainable strategies. (This course is restricted to CONSMGT-MS students.) **Lecture 3, Credits 3 (Spring)**

CONM-718 Construction Operations and Productivity
A study of construction operations with emphasis on productivity enhancement focusing on an integrated approach to planning, modeling, analysis, and design of construction operations. This includes productivity concepts; data collection; analysis of productivity data and factors affecting productivity; means for improving production and study of productivity improvement programs. (This course is restricted to CONSMGT-MS students.) **Lecture 3, Credits 3 (Fall)**

CONM-720 Construction Cost Analysis and Management
A logistical study of pre-construction cost analysis and construction management procedures, including conceptual estimating, project cost analysis and control, value engineering, life-cycle costing, feasibility studies, project financial and economic modeling, and quantitative risk analysis techniques. (This course is restricted to CONSMGT-MS students.) **Lecture 3, Credits 3 (Spring)**

CONM-760 Construction Client Development
This course introduces and develops techniques for construction client development, including: the structured sales approach; the referral system; building upon successful projects; exploring how satisfied clients can contribute to winning future construction contracts; the cost and the value of keeping all stakeholders satisfied; the requisite skills for successful construction project sales and how they differ from other professions in the organization. Students will analyze case studies of successful and unsuccessful construction contracts. (Prerequisites: CONM-650 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

CONM-788 Thesis Planning
Students will rigorously develop their thesis research ideas, conduct literature reviews, identify and plan methodologies, prepare schedules, and gain a clear understanding of the expectations of the faculty and the discipline. Each student will be required to prepare a committee approved thesis research proposal and may begin work on their thesis. (Prerequisite: GRCS-701 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

CONM-790 Thesis
The graduate thesis is a formal research document that empirically relates theory with practice. A formal written thesis and oral defense are required. (Prerequisites: CONM-788 or equivalent course.) **Thesis 3, Credits 3 (Spring)**

CONM-795 Comprehensive Examination
A written comprehensive exam is one of the non-thesis methodologies for completion of the MS degree. This course will provide a forum for independent review of the main concepts of the program core subject areas. The student will take a written examination at the conclusion of the course and must receive a passing grade of at least 80% to be successful. Students will have one additional opportunity to pass this examination if their initial attempt is unsuccessful. (Enrollment in this course requires permission from the department offering the course.) **Comp Exam 3, Credits 0 (Fall)**

CONM-797 Graduate Project
This course provides an opportunity for students to demonstrate their capabilities developed through their course of study to design, develop and/or evaluate a construction management related project culminating in a written report or manuscript and presentation. (Prerequisite: GRCS-701 or equivalent course.) **Project 3, Credits 3 (Biannual)**

Environmental Health and Safety Management

ESHS-601 Fire Protection
Introduces fundamental 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. Fire detection and extinguishment are covered along with building construction for fire prevention, life safety, fire codes, and related topics. This course is co-listed with ESHS-501; students may receive credit for ESHS-501 or ESHS-601, not both. (Students cannot take and receive credit for this course if they have taken ESHS-501.) **Lecture 3, Credits 3 (Fall)**

ESHS-611 Occupational Health
This course will provide students with an overview of the fundamentals of industrial hygiene. Emphasis will be on the toxicological effects of various industrial substances, on the body, monitoring and personal sampling for these substances and personal protection against such substances. This course may be co-listed with ESHS-511; students may receive credit for ESHS-511 or ESHS-611, not both. (This class is restricted to degree-seeking graduate students or those with permission from instructor. If you have earned credit for ESHS-511 or you are currently enrolled in ESHS-511 you will not be permitted to enroll in ESHS-611.) **Lecture 3, Credits 3 (Fall, Spring)**

ESHS-613 Solid and Hazardous Waste Management
An examination of strategies and technologies to move an organization toward environmental sustainability, including resource use reduction, material substitution, process and product modification, and waste minimization; and for handling and managing wastes including treatment, storage, transport, and disposal storing solid and hazardous waste. Associated environmental impacts, regulatory concerns, technical feasibility, and costs are considered. (Students who have completed ESHS-310 Solid and Hazardous Waste Management may not receive credit for this course.) (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Spring)**

ESHS-614**Industrial Wastewater Management**

This course investigates characteristics and sources of industrial wastewaters, related environmental impacts, regulatory implications, and technical considerations of current treatment and disposal methodologies. Students learn to identify appropriate methods, technologies, and sequences for source reduction, treatment and pretreatment, direct discharge, and management of treatment residuals. (Students who have completed ESHS-330 Industrial Wastewater may not receive credit for this course.) (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall)**

ESHS-615**Air Emissions Management**

This course will present an overview of industrial air pollution management: its sources, methods of reduction, control, and management. Students will become familiar with the history of air pollution, the chemistry and effects of pollutants, regulations and standards, and control technologies as well as developing analytical and quantitative skills necessary in air emissions management decision-making. By the end of the course, students will be able develop a comprehensive facility air emissions management plan. This course maybe co-listed with ESHS-525; students may receive credit for ESHS-525 or ESHS-615, not both. (This class is restricted to degree-seeking graduate students or those with permission from instructor. Students cannot take and receive credit for this course if they have taken ESHS-525.) **Lecture 3, Credits 3 (Fall, Spring)**

ESHS-620**Occupational Safety**

This course is an overview of the occupational safety management tools and techniques utilized in today's industry. Topics examined include OSHA requirements, record keeping, guarding, electrical safety, material handling, welding, fire prevention, excavation, medical surveillance, worker's compensation, inspection techniques, auditing, committees, incentives, and voluntary programs. (This course is restricted to students in the EHSM-MS program.) **Lecture 3, Credits 3 (Fall)**

ESHS-626**Exposure Assessment and Analysis**

The 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). **Lec/Lab 4, Credits 3 (Fall, Spring)**

ESHS-630**Mechanical and Electrical Controls and Standards**

Discussion of machine safety with emphasis on hazard analysis, risk estimation, safeguarding techniques, and electrical safety. Particular attention will be paid to applicable OSHA, ANSI, NFPA, and EN standards as they relate to wood, metal, films, and automation. Elements of the course will change regularly to reflect emerging issues in industry. This course is co-listed with ESHS-530; students may receive credit for ESHS-530 or ESHS-630, not both. (This class is restricted to degree-seeking graduate students or those with permission from instructor. Students cannot take and receive credit for this course if they have taken ESHS-530.) **Lecture 3, Credits 3 (Fall, Spring)**

ESHS-665**Sustainable Product Stewardship**

This course examines the principles of sustainable product stewardship, including the ethical, legal, and economic issues that product manufacturers face as well as the relationship between products and sustainability. Students will learn and apply some environmental sustainability, health and safety analysis techniques used to identify and manage product environmental sustainability aspects as well as health and safety hazards. Students will use case studies to examine the concept of product stewardship management through product life cycle thinking and extended producer responsibility. (Students who have completed ESHS-565 Product Stewardship may not receive credit for this course.) **Lecture 3, Credits 3 (Summer)**

ESHS-699**ESHS 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 semesters will be required. Department permission is required. **CO OP, Credits 0**

ESHS-720**Environmental, Health and Safety Management**

This is the initial course in the curriculum core of RIT's MS degree program in Environmental, Health and Safety (EHS) Management. It defines and profiles EHS management within the organization; explores EHS management history, motivations, and strategies; introduces current and developing systems for managing an organization's EHS aspects; and investigates the elements and implications of developing an organizational EHS vision and policy statement. The course's unique delivery style combines elements of distance-learning and an onsite executive-leader format. (This course is restricted to students in the EHSM-MS program.) **Lecture 3, Credits 3 (Fall)**

ESHS-722**EHS Law**

An overview of environmental, health and safety related law with an emphasis on legislative law. Topics include a review of the historical and modern sources for EHS law, the emergence of administrative law, and the responsibilities of the separate branches of government. Major EHS related legislation and their impact on EHS management systems will be covered. (This course is restricted to students in the EHSM-MS program.) **Lecture 3, Credits 3 (Spring)**

ESHS-725**EHS Accounting and Finance**

This course focuses on the environmental, health, and safety (EHS) costs of business decisions. Methods will be taught to identify and quantify EHS related costs and benefits that can lead an organization towards a more sustainable future. (This course is restricted to FCMG-MS, EHSM-MS Major students.) **Lecture 3, Credits 3 (Fall)**

ESHS-740**EHS Management System Design**

This course examines the design and development of environmental, health and safety management systems in order to implement an organization's policies and offers strategies for measurement of results in order to assess performance and ensure continual improvement. Significant team project work as well as individual work is required. (Prerequisites: ESHS-720 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

ESHS-750**EHS and FM Project Management**

This course has been designed to give the student an overview of the fundamental concepts of modern project management. Areas of focus include the project life cycle (PLC), the project management body of knowledge (PMBOK), program evaluation review technique (PERT), critical path method (CPM), and various budgeting and resource allocation techniques. Discussion of project management organizations, negotiation and conflict resolution, and project termination will be included, along with an introduction to Project Management Institute (PMI) and Microsoft Project for Windows. (This course is restricted to FCMG-MS, EHSM-MS Major students.) **Lecture 3, Credits 3 (Spring)**

ESHS-755**Corporate Social Responsibility**

This course will introduce social responsibility concepts and approaches presented in key documents like the ISO 26000 Social Responsibility Standard, and will explore strategies for assisting an organization to identify and implement socially responsible initiatives appropriate to the nature and scope of its activities, products, and services. (This course is restricted to students in the EHSM-MS program.) **Lecture 3, Credits 3 (Fall)**

ESHS-760**Integrating EHS Management**

This course examines strategies for integrating EHS systems and processes. Using case studies, the course explores interrelationships between EHS and total quality management, business value, reporting, 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. (Prerequisites: ESHS-720 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

ESHS-770**Risk Assessment, Management and Communication**

This course focuses on risk management systems, including implementation of risk management and risk reduction strategies. The course includes case studies and application of risk analysis, technological risk, cost benefit analysis and decision-making under uncertainty in a corporate environment. Risk communication strategies are examined as an integral step in the risk management process. (Prerequisites: ESHS-611 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

ESHS-780**EHS Internal Auditing**

This course provides an overview of the fundamentals of EHS internal auditing, including EHS internal audit program design and management principles, management system performance evaluation and corrective action techniques, and system improvements. Exercises provide opportunities to apply knowledge. (Prerequisites: ESHS-720 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

ESHS-788**Thesis Planning**

Students will rigorously develop their thesis research ideas, conduct literature reviews, identify and plan methodologies, prepare schedules, and gain a clear understanding of the expectations of the faculty and the discipline. Each student will be required to prepare a committee approved thesis research proposal and may begin work on their thesis. (Enrollment in this course requires permission from the department offering the course.) **Lecture 3, Credits 3 (Fall, Spring)**

ESHS-790**Thesis**

The graduate thesis is a formal research document that empirically relates theory with practice. A formal written thesis and oral defense are required. (Prerequisites: GRCS-701 and ESHS-788 or equivalent courses.) **Thesis 5, Credits 3 (Fall, Spring)**

ESHS-792

Continuation of Thesis

Continuation of Thesis (Enrollment in this course requires permission from the department offering the course.) **Cont, Credits 0**

ESHS-795

Comprehensive Exam

A written comprehensive exam is one of the non-thesis methodologies for completion of the MS degree. This course will provide a forum for independent review of the main concepts of the program core subject areas. The student will take a written examination at the conclusion of the course and must receive a passing grade of at least 80 percent to be successful. Students will have one additional opportunity to pass this examination if their initial attempt is unsuccessful. (Enrollment in this course requires permission from the department offering the course.) **Comp Exam 3, Credits 0 (Fall, Spring)**

ESHS-797

Graduate Project

This course provides an opportunity for students to demonstrate their capabilities developed through their course of study to design, develop, and/or evaluate an EHS management related project culminating in a written report or manuscript and presentation. (Prerequisite: GRCS-701 or equivalent course.) **Project 3, Credits 3 (Fall, Spring)**

ESHS-798

Continuation of Graduate Project

Continuation of Graduate Project (Enrollment in this course requires permission from the department offering the course.) **Cont, Credits 0**

Education Learning Instruction

EDLI-723

Group Dynamics and Facilitation Skills

Group dynamics explores current theories and models of how individuals work within groups. The outcome of this analysis is to allow students to learn to effectively manage, lead, and generate results from group processes. The facilitation of groups into teams to achieve stated outcomes is within the group process strategies learned. The outcome of this course is to provide students with an understanding of group dynamics and their impact on organizational interventions with emphasis on team building, facilitation tools, and techniques. (This course is restricted to student in the HRDE-MS program.) **Lecture 3, Credits 3 (Fall, Spring)**

EDLI-730

Theories of Learning

This course examines the physiological, psychological, and socio/cultural factors related to learning and development of humans throughout the life cycle, as appropriate for the organization's needs. Selected theories of learning and development are critically analyzed and applied to teaching contexts. Students are expected to critically examine their own assumptions and beliefs about learning, and development and develop an appropriate approach to the task of designing learning based on the organization's workforce and needs. Attention is given to stages of cognitive growth, the development of learning goals, learning environments, and to a variety of theories of learning. Learning styles are discussed as a sub component of learning theories. **Lecture 3, Credits 3 (Spring)**

EDLI-733

Instructional Design

The process of instructional design is both an art and science. The framework of this course is to teach the students how to design instruction regardless of content area to allow learners to successfully achieve stated outcomes. The components of the course include problem identification, needs assessment, analysis of learner's abilities, the design of measurable performance objectives, the development of assessment strategies within the design of instructional materials, and the formative and summative evaluation process. **Lecture 3, Credits 3 (Spring)**

EDLI-750

Strategic Career Development

Strategic Career Development 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 system theory approach. Additional topics include organizational 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 group work to understand the theory and workplace application issues. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall)**

EDLI-751

Career Counseling Techniques

This course introduces students to selected theories and techniques for use in counseling clients and/or employees about career issues. Students analyze and practice various counseling scenarios and apply theory. They learn to give and accept feedback related to career counseling skills through the use of role plays. Issues related to careers and the HR professional's roles are explored. The future of career counseling in the workplace is examined as it relates to HR planning. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Spring)**

EDLI-752

Assessments and Measurements in Human Resource Development

This course provides an introduction to the fundamentals of assessment and measurement tools used in human resource and organizational development activities. An overview of a variety of instruments will be studied and some will be administered. Reading, lecture and class activities will include theory of test development, criteria for administration, validity, reliability, and assessing best instruments for use. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fa/sp/su)**

EDLI-753

The Student Experience in Higher Education

This course explores the student experience in higher education. Since students are, arguably, a university's most important customer, how should institutions approach the student experience on and off campus? This course will prompt students to consider the wide range and types of colleges and universities around the world and the models used that form the college experience. These approaches impact students' perceptions of the higher education university reputation, marketability, alumni giving, and retention. Topics for investigation include: (1) campus facilities and third places; (2) student services; (3) student activities and athletics; (4) teaching and learning; (5) campus traditions; (6) assessment strategies. **Lecture 3, Credits 3 (Fall)**

EDLI-754

Critical Systems in Higher Education

Higher education is a vital societal component in American and global societies and must be accessible to citizens. This course examines current and historical perspectives of the critical systems in higher education to fund, manage risk, and adhere to lawful practices and lead. All of these systems affect students in areas of accessibility, value, customer service, and the higher education experience. Included is an exploration of how price, cost, and value shape what is provided by and who attends college as well as reviewing current practices and events that continue to shape higher education. **Lecture 3, Credits 3 (Summer)**

EDLI-755

Learning Assessment and Evaluation

In a learning environment assessing the accomplishment of learning outcomes involves designing evaluation instruments, collecting data regarding performance, and calculating the overall impact of learning. Of equal importance is to calculate the costs for the learning program to demonstrate a return on investment to the organization. This outcome is computed through measuring the increased competencies of the learners and determining the value the learning contributes to the organization. To achieve this outcome learners will measure and grade performance for a variety of intellectual learner domains as well as assess the overall program effectiveness through interpretation of data. This is an online class only. **Lecture 3, Credits 3 (Fall)**

EDLI-756

Learning Design and Technology

Learning in the 21st century requires creating an engaging and exciting learning experience whether you are interested in online, classroom-based or blended, and delivery for a school, college or training environment. This course guides you through the process of developing and applying a learning product or solution that addresses a performance gap or educational need in any educational or training experience. The course learning outcome is to develop an instructional strategy proposal, create a learning plan that includes technology to support the learning experience and then evaluate the effectiveness of that learning plan. Course topics include: learning in the 21st century, understanding diversity in learning design, and applying assistive technologies, analyzing task and learner needs; applying instructional design principles with a focus on educational technologies, exploring innovative and emerging technologies; and evaluating strategy. Upon completion of this course, students will be able to: • Demonstrate knowledge of a job analysis/needs analysis and selection of an appropriate model to accomplish learning. • Demonstrate the ability to develop and implement a learning strategy using technology, given the needs of the learners and the organization. • Describe how to conduct a formative evaluation process evaluating the effectiveness and efficiency of the selected learning strategy in the work environment including learner achievement and the organization's needs. • Evaluate technology used for learning and training purposes. This course is open to any graduate status student or department permission. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Summer)**

EDLI-757

Organization and Leadership in Higher Education

This course examines features of core functional areas of modern higher education. The course focuses on the administration of higher education institutions and includes (1) historical contexts for higher education; (2) student experience; (3) academic and administrative issues; (4) infrastructural concerns, including planning, technology, and facilities management. This course uses a survey perspective of these areas to provide a foundation for understanding the dimensions found within higher education. This course is open to RIT students with a graduate status, or those with department permission. **Lecture 3, Credits 3 (Spring)**

EDLI-758

Design for On-Line Learning

Online learning has grown to be a significant learning/teaching strategy for higher education. This course will include strategies for interactive learning activities to engage adult learner and achieve learning outcomes using a variety of instructional techniques appropriate for the online learning environment. This course will provide an opportunity to complete an actual work-related learning activity as an alternative to a case-based learning activity. **Lecture 3, Credits 3 (Fall, Summer)**

Facility Management

FCMG-660 Principles and Practice in Facility Management

Presents the overall methodology of facility management including organizational, managerial, ethical, and legal principles for the delivery of facility services. Topics discussed include: FM budgets, finance, history, regulatory and legal issues, corporate culture, contracts, purchasing and procurement, planning, management of projects, and personnel. It covers the relationship between the facility management function and the overall corporate structure. (This course is restricted to students in the FCMG-MS program.) **Lecture 3, Credits 3 (Fall)**

FCMG-699 FCMG Co-op
FCMG Graduate Co-op. Department permission is required. **CO OP, Credits 0**

FCMG-720 EHS in 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. (Prerequisites: FCMG-660 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

FCMG-740 Real Estate in Facility Management

This course has been designed to give the student the knowledge and tools to manage property assets as an investment and/or profit center. The concepts covered in this course include asset management, master planning, property acquisition and disposal, interior programming, space planning, property and facility design parameters, regulatory and legal issues, market and financial analysis, ownership and leasing management, constituent service, inventory control, and future trends. All relevant issues from planning for facility needs to life-cycle property management through ultimate property disposition are covered in this course. (Prerequisites: FCMG-660 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

FCMG-760 Operation and Maintenance in Facility Management

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. (Prerequisites: FCMG-660 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

FCMG-788 Thesis Planning

Students will rigorously develop their thesis research ideas, conduct literature reviews, identify and plan methodologies, prepare schedules, and gain a clear understanding of the expectations of the faculty and the discipline. Each student will be required to prepare a committee approved thesis research proposal and may begin work on their thesis. (Enrollment in this course requires permission from the department offering the course.) **Lecture 3, Credits 3 (Fall, Spring)**

FCMG-789 Special Topics in Facilities Management

Subject offerings of new and developing areas of knowledge in facilities management intended to augment the existing curriculum. Special topics courses are offered periodically. Watch for titles in the course listing each semester. **Lecture, Credits 1 - 3**

FCMG-790 Thesis

The graduate thesis is a formal research document that empirically relates theory with practice. A formal written thesis and oral defense are required. (Prerequisites: Grade of B or better in FCMG-788 or equivalent course.) **Thesis 3, Credits 3 (Fall, Spring)**

FCMG-795 Comprehensive Facility Management Examination

A written comprehensive exam is one of the non-thesis methodologies for completion of the MS degree. This course will provide a forum for independent review of the main concepts of each of the program core subject areas. The student will take a written examination at the conclusion of the course and must receive a passing grade of at least 80 percent to be successful. Students will have one additional opportunity to pass this examination if their initial attempt is unsuccessful. This examination is part of the comprehensive examination exit strategy. (Enrollment in this course requires permission from the department offering the course.) **Comp Exam 3, Credits 0 (Fall, Spring)**

FCMG-797

This course provides an opportunity for students to demonstrate their capabilities developed through their course of study to design, develop, and/or evaluate a facility management related project culminating in a written report or manuscript and presentation. In addition, students will also submit any work products that they create as part of their project (Enrollment in this course requires permission from the department offering the course.) **Project 3, Credits 3 (Fall, Spring)**

FCMG-799

A supervised investigation within a facility management area of student interest. Consent of the faculty sponsor and departmental approval are required. Students are limited to a maximum of three semester credit hours of independent study projects and two sections in any semester, and a maximum of six credit hours of independent study used to fulfill degree requirements. **Ind Study, Credits 1 - 3 (Fall, Spring)**

Manufacturing and Mechanical Engineering Technology

MCET-620

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 the experimental design process, additivity, static and dynamic signal-to-noise ratios, analysis of means, and ANOVA. The role of robust design methods in reducing variability for both products and processes and in integrating systems is emphasized. Students may not take and receive credit for this course if they have already taken MCET-582. (This course is restricted to graduate or BS/MS students in the MMSI-MS, MFSI-MS, MCSI-MS and EMSI-MS programs. Students cannot take and receive credit for this course if they have taken MCET-582.) **Lecture 3, Credits 3 (Fall)**

MCET-621

This course will provide a thorough understanding of beam structures under combined shear, bending, and torsional loads. Topics include the study of semi-monocoque structure idealizations, effects of tapered and laminated structures, shear deformations and warping, location of elastic axis in open and closed sections, torsion of multi-cell sections. Matrix methods are introduced and utilized throughout the course. The course has a project component that combines analytical, theoretical, and experimental methods. Students may receive credit for only this course or MCET-521, not both. (Students cannot take and receive credit for this course if they have taken MCET-521) **Lecture 3, Credits 3 (Spring)**

MCET-621

This course will provide a thorough understanding of beam structures under combined shear, bending, and torsional loads. Topics include the study of semi-monocoque structure idealizations, effects of tapered and laminated structures, shear deformations and warping, location of elastic axis in open and closed sections, torsion of multi-cell sections. Matrix methods are introduced and utilized throughout the course. The course has a project component that combines analytical, theoretical, and experimental methods. Students may receive credit for only this course or MCET-521, not both. (Students cannot take and receive credit for this course if they have taken MCET-521) **Recitation 1, Credits 3 (Spring)**

MCET-661

Multiphysics Modelling: Materials, Components, and Systems
Multiphysics modeling is the study of multiple interacting and coupled physical phenomena including heat transfer, fluid flow, deformation, electromagnetics, acoustics, and mass transport. Students will use numerical methods, specialized software, and computer simulations to solve engineering problems and understand the underlying physics of interacting complex engineering systems. This course may be cross-listed with MCET-561; BSMS program students are advised to enroll in the graduate level course. (This class is restricted to MMSI-MS, MCETMMSI-U or MECAMMSI-U or EMETMMSI-U students.) **Lecture 2, Credits 3 (Biannual)**

MCET-661

Multiphysics Modelling: Materials, Components, and Systems
Multiphysics modeling is the study of multiple interacting and coupled physical phenomena including heat transfer, fluid flow, deformation, electromagnetics, acoustics, and mass transport. Students will use numerical methods, specialized software, and computer simulations to solve engineering problems and understand the underlying physics of interacting complex engineering systems. This course may be cross-listed with MCET-561; BSMS program students are advised to enroll in the graduate level course. (This class is restricted to MMSI-MS, MCETMMSI-U or MECAMMSI-U or EMETMMSI-U students.) **Recitation 2, Credits 3 (Biannual)**

MCET-662

Advanced Fluid Mechanics and Modeling

The main purpose of this course is to help students develop a mastery of the underlying principles and the ability to efficiently solve variety of real fluid dynamics problems. The course focuses on the physical phenomena, mathematical formulations, and advanced problem-solving techniques and modeling for flows ranging from laminar incompressible flows to turbulence, with examples from mechanical engineering practice and technology. This course may be cross-listed with MCET-562; BSMS program students are advised to enroll in the graduate level course. (This class is restricted to MMSI-MS, MCETMMSI-U or MECAMMSI-U or EMETMMSI-U students.) **Lecture 2, Credits 3 (Spring)**

MCET-662

Advanced Fluid Mechanics and Modeling

The main purpose of this course is to help students develop a mastery of the underlying principles and the ability to efficiently solve variety of real fluid dynamics problems. The course focuses on the physical phenomena, mathematical formulations, and advanced problem-solving techniques and modeling for flows ranging from laminar incompressible flows to turbulence, with examples from mechanical engineering practice and technology. This course may be cross-listed with MCET-562; BSMS program students are advised to enroll in the graduate level course. (This class is restricted to MMSI-MS, MCETMMSI-U or MECAMMSI-U or EMETMMSI-U students.) **Recitation 2, Credits 3 (Spring)**

MCET-670

Concept Design and Critical Parameter Management

This course focuses on critical parameter management (CPM) as defined within the Design for Six Sigma framework. CPM tools and techniques include translating the voice of the customer into technical requirements, defining functions to fulfill the requirements, generating designs to physically fulfill the functions, data acquisition and analysis, and the evaluation and selection of superior product and subsystem designs that are safe to take to commercialization. Students are introduced to CPM best practices through case studies and hands-on projects. (This course is restricted to graduate or BS/MS students in the MMSI-MS, MFSI-MS, MCSI-MS and EMSI-MS programs.) **Lecture 3, Credits 3 (Spring)**

MCET-674

Plastics and Composites Materials

Study of advanced polymeric materials including their preparation, processing and application design. Topics will include both long and short fiber reinforced composites. Industrial modification of polymers into plastics compounds including polymer blends and additives will also be discussed. Students will complete a literature review of a current topic in advanced polymers. Students may receive credit for only this course or MCET-574, not both. (Students cannot take and receive credit for this course if they have taken MCET-574.Co-requisites: MCET-675 or equivalent course.) **Lecture 2, Credits 2 (Fall)**

MCET-675

Plastics and Composites Materials Laboratory

Laboratory exercises involving polymeric materials (e.g. composites, polymers blends) including their preparation, processing and application design. Conduct a research-oriented project including writing up the results as a conference paper/journal article submission. Students may receive credit for only this course or MCET-575, not both. (Students cannot take and receive credit for this course if they have taken MCET-575.Co-requisites: MCET-674 or equivalent course.) **Lab 2, Credits 1 (Fall)**

MCET-680

Plastics Manufacturing Technology

The course studies plastic materials and processing technology to manufacture various plastic products in plastics industry. The course emphasizes new materials, such as bio-degradable, environmentally friendly polymers, and process selections for engineering applications and design. Students may not take and receive credit for this course if they have already taken and received credit for MCET-580. (Students cannot take and receive credit for this course if they have taken MCET-580.) **Lecture 3, Credits 3 (Fall)**

MCET-683

Plastics Product Design

The study of design guidelines for plastic products based on the interrelationships between design, the material selected, the manufacturing process selected, and the tooling to be used. Students will research the feasibility of using polymeric materials to design a part or assembly not traditionally manufactured using plastics. Students may receive credit for only one course: MCET-583 or MCET-683 (This class is restricted to degree-seeking graduate students or those with permission from instructor. Students cannot take and receive credit for this course if they have taken MCET-583.) **Lecture 3, Credits 3 (Spring)**

MCET-692

Spray Theory and Application

This course covers the theory necessary to understand spray formation and evolution, as well as a host of spray applications. Knowledge of differential equations is required. Topics include drop size distributions, breakup of liquid sheets and ligaments, drop formation and breakup, drop motion and the interaction between a spray and its surroundings, drop evaporation, nozzle internal fluid mechanics, external spray characteristics, nozzle performance, and experimental techniques relevant to these subjects. Applications will include: (1) gas turbine engines, (2) internal combustion engine sprays, (3) sprays for geo-engineering, (4) agricultural sprays, (5) consumer products, (6) paints and coatings, and (7) use of non-traditional liquids in aeropropulsion and other systems. Time spent on each topic depends on student interest. Each student is expected to work on a final project, of their choosing, focused on a topic within the realm of spray theory and application. A research related topic is preferred, but not required. Students must design an experiment and correlate their results with their developed theoretical model. The project is the prime method for assessing student learning. Students will be asked to demonstrate a deep theoretical understanding of spray formation and applications. Students may take and receive credit for MCET-592 or MCET-692, not for both. (Students cannot take and receive credit for this course if they have taken MCET-592.) **Lecture 3, Credits 3 (Fall)**

MCET-695

Applied Finite Element Analysis

This course focuses on using commercial finite element analysis (FEA) software to analyze complex linear and non-linear systems in the areas of structural mechanics and heat transfer. Students will utilize a wide variety of analysis techniques including deflection, stress, mode shapes, optimization, heat transfer, and thermal-stress. A semester long project using FEA to solve an advanced problem relevant to each student's interest area is required. In addition, students will be given problems that extend beyond the material covered in class that will require independent investigation. Students may not take and receive credit for this course if they have already taken MCET-595. (This course is restricted to graduate or BS/MS students in the MMSI-MS, MFSI-MS, MCSI-MS and EMSI-MS programs. Students cannot take and receive credit for this course if they have taken MCET-595.) **Lecture 3, Credits 3 (Fall)**

MCET-720

Product and Production System Development and Integration

This course covers topics, processes and best practices in product development. Using Design for Six Sigma (DFSS) as a motivating philosophy, students are introduced 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. (This course is restricted to graduate or BS/MS students in the MMSI-MS, MFSI-MS, MCSI-MS and EMSI-MS programs.) **Lecture 3, Credits 3 (Fall)**

MCET-730

Polymer Engineering Research

This course introduces new graduate students to the fundamental concepts and skills relevant to plastics and polymer engineering research. Students will learn concepts in the chemistry and physics of polymeric materials and the essential techniques used to characterize them. Laboratory skills in the preparation of polymers, polymer blends, their fabrication into useful test specimens and their characterization will be emphasized. Following the successful completion of this course students will be prepared to carry out graduate level polymer engineering research. (This course requires permission of the Instructor to enroll.) **Lec/Lab 4, Credits 3 (Spring)**

MCET-799

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. **Ind Study 4, Credits 1 - 3 (Fall, Spring)**

MFET-600

MMSI Graduate Seminar

This course provides students that are new to the MMSI program an opportunity to develop an understanding of the department's research activities. The students will become more knowledgeable about the Manufacturing & Mechanical Systems Integration program, career options, the capstone and thesis project process (finding an advisor, required documentation and policies regarding completing a project on co-op) and department policies and procedures related to successful completion of the MMSI program. (This course is restricted to graduate or BS/MS students in the MMSI-MS, MCET-BS/MS, MFET-BS/MS, and EMET-BS/MS programs.) **Seminar 2, Credits 0 (Fall)**

MFET-625

Statistical Process Control

A course designed to provide in-depth understanding of statistical process control and acceptance sampling techniques. SPC helps you monitor process behavior to be used in quality process analysis and process improvement. Topics include statistical process charting, and process analysis along with how these techniques are applied to engineering and manufacturing organizations. Students can receive credit for only one of the following: MFET-625, CQAS-621, or STAT-621. (Prerequisites: Students may not take and receive credit for MFET-625 and STAT/CQAS-621.ot if STAT-621) **Lecture 3, Credits 3 (Fall)**

MFET-650**Manufacturing and Mechanical Systems Fundamentals**

This course is intended to help students learn to think like systems engineers. This course will provide a thorough understanding of the systems fundamentals, its design, modeling, and integration. Topics include a thorough coverage of systems architecture, conceptualization, modeling, development and management. Students in this course will be taught industry practices for systems engineering and management from concept stage to post implementation stage. System engineering and modeling tools will also be introduced to assist with the conceptualization, development, and implementation of systems. (This course is restricted to graduate or BS/MS students in the MMSI-MS, MFSI-MS, MCSI-MS and EMSI-MS programs.) **Lecture 3, Credits 3 (Fall)**

MFET-655**Surface Mount Electronics Manufacturing**

This course provides a thorough understanding of the technology, components, equipment, materials and manufacturing process for through hole technology and surface mount technology electronics manufacturing. Students will develop a strong foundation needed for advanced work in surface mount technology (SMT). The activities will provide the students an orientation and familiarization of the manufacturing equipment and process parameters for printed circuit board assembly. Graduate students will explore surface defects and remediation and will prepare a detailed annotated bibliography related to specific aspects of electronics manufacturing. Topics in Design for Manufacturing are also considered for high volume vs. low volume manufacturing. Students may only receive credit for this course or MFET-545, not both. (This course is restricted to graduate or BS/MS students in the MMSI-MS or at least 3rd year standing in EMET-BS/MS, MCET-BS/MS, MFET-BS/MS programs. Students cannot take and receive credit for this course if they have taken MFET-545.) **Lecture 3, Credits 3 (Fall)**

MFET-655**Surface Mount Electronics Manufacturing**

This course provides a thorough understanding of the technology, components, equipment, materials and manufacturing process for through hole technology and surface mount technology electronics manufacturing. Students will develop a strong foundation needed for advanced work in surface mount technology (SMT). The activities will provide the students an orientation and familiarization of the manufacturing equipment and process parameters for printed circuit board assembly. Graduate students will explore surface defects and remediation and will prepare a detailed annotated bibliography related to specific aspects of electronics manufacturing. Topics in Design for Manufacturing are also considered for high volume vs. low volume manufacturing. Students may only receive credit for this course or MFET-545, not both. (This course is restricted to graduate or BS/MS students in the MMSI-MS or at least 3rd year standing in EMET-BS/MS, MCET-BS/MS, MFET-BS/MS programs. Students cannot take and receive credit for this course if they have taken MFET-545.) **Recitation 1, Credits 3 (Fall)**

MFET-656**Advanced Concepts in Semiconductor Packaging**

The advanced course in semiconductor packaging will provide a thorough coverage of the materials, processes, failure, and reliability of chip level packaging. Specific topics include single-chip, multi-chip, wafer level and 3D stacked packaging, photonic integrated chip (PIC), smaller passives and embedded passive component technology, advanced substrates and microvia technology, solder technologies, metallurgy and joint formation, thermal management, thermal and mechanical behavior of packaging, failure analysis, and reliability testing. Course includes projects and literature review in topics of semiconductor packaging. This course is cross listed with MFET-556 students may receive credit for MFET-556 or MFET-656, not both. (Prerequisites: MFET-655 or equivalent course. Students cannot take and receive credit for this course if they have taken MFET-556.) **Lecture 3, Credits 3 (Spring)**

MFET-670**Manufacturing Automation Control**

This course will provide a thorough understanding of the manufacturing automation principles, practices and system integration. Topics include a thorough coverage of the automation hardware and software, essentials of digital and analog control using Programmable Logic Controllers (PLCs), industry best practices for programming PLCs and the essentials of Human Machine Interface (HMI) for data entry, manipulation and recording system status. (This course is restricted to graduate or BS/MS students in the MMSI-MS, MFSI-MS, MCSI-MS and EMSI-MS programs.) **Lecture 3, Credits 3 (Fall, Spring)**

MFET-689**Special Topics**

Special Topics is an experimental graduate course intended as a means for offering innovative topics not currently reflected in the Graduate Engineering Technology curriculum. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 1 - 3**

MFET-699**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. Department permission is required. **CO OP, Credits 0**

MFET-720**Applied Regression Analysis**

This course explores how to model data. Topics include simple linear regression, multiple linear regression, analysis of residuals, transformations, weighted least squares, influence diagnostics, dummy variables, selection of best linear models, nonlinear estimation, and model building. Students can receive credit for only one of the following: MFET-720, CQAS-741, or STAT-741. (Prerequisites: Students may not take and receive credit for MFET-720 and STAT/CQAS-741.) **Lecture 3, Credits 3 (Fall)**

MFET-730**Six Sigma for Design and Manufacturing**

This course presents the philosophy and tools that will enable participants to develop quality strategies and drive process improvements that are linked to and integrated with business plans. Continuous improvement principles are presented, within the six sigma format. The course will help prepare students for six sigma black belt certification. Students can receive credit for only one of the following: MFET-730, CQAS-701, or ISEE-682. (Prerequisites: Students may not take and receive credit for MFET-730 and STAT/CQAS-701 or ISEE-682.) **Lecture 3, Credits 3 (Spring)**

MFET-740**Experimental Design**

This class covers the design and analysis of experiments. We will focus on the design of the experiment to avoid problems that arise at the analysis stage with examples in engineering and manufacturing. Topics include the role of statistics in scientific experimentation; general principles of design, including randomization, replication, and blocking; completely randomized designs, randomized complete block designs, general factorial designs, split-plot designs, random vs. fixed effects, and mixed models. Students can receive credit for only one of the following: MFET-740, CQAS-670, or STAT-670. (Prerequisites: Students may not take and receive credit for MFET-740 and STAT/CQAS-670.) **Lecture 3, Credits 3 (Spring)**

MFET-788**MMSI Thesis Planning**

Students will rigorously develop their thesis research ideas, conduct literature reviews, identify and plan methodologies, prepare schedules, and gain a clear understanding of the expectations of the faculty and the discipline. Each student will be required to prepare a committee approved thesis research proposal and may begin work on their thesis. (Enrollment in this course requires permission from the department offering the course.) **Lecture 3, Credits 3 (Spring)**

MFET-789**MFET Special Topics**

Subject offerings of new and developing areas of knowledge in manufacturing intended to augment the existing curriculum. **Lecture 3, Credits 3 (Fall, Spring)**

MFET-790**MMSI Thesis**

The MMSI thesis is based on thorough literature review and experimental substantiation of a problem, by the candidate, in an appropriate topic. A written proposal has to be defended and authorized by the faculty adviser/committee. The proposal defense is followed by experimental work, a formal written thesis, and oral presentation of findings. The candidate should have completed the requisite courses for the program before enrolling for the thesis. (Prerequisites: MFET-788 or equivalent course.) **Thesis 3, Credits 3 (Fall, Spring, Summer)**

MFET-795**MMSI Comprehensive Exam**

A written comprehensive exam is one of the non-thesis or non-project methodology for completion of the MS-MMSI degree. Students will demonstrate a fundamental knowledge of the theories and foundation principles. This course will require the student to do an independent review of the concepts within the core courses and the chosen concentration area, and will culminate in a comprehensive written examination. The student must receive a passing grade of at least 80 percent to be successful. Students will have one additional opportunity to pass the exam, if their initial attempt results in a failing grade. (Enrollment in this course requires permission from the department offering the course.) **Comp Exam 3, Credits 0 (Fall, Spring, Summer)**

MFET-797**MMSI Capstone Project**

This course provides the MMSI graduate students an opportunity to complete their degree requirements by addressing a practical real-world challenge using the knowledge and skills acquired throughout their studies. This course is not only the culmination of a student's course work but also an indicator of the student's ability to use diverse knowledge to provide a tangible solution to a problem. The capstone project topic can be in the areas of product development, manufacturing automation, management system, quality management or electronics packaging. The course requires a comprehensive project report and a final presentation. (Enrollment in this course requires permission from the department offering the course.) **Project 3, Credits 3 (Fall, Spring, Summer)**

MFET-798**Continuation of Capstone**

Continuation of Capstone **Cont, Credits 0**

Packaging Science

PACK-660

Converting and Flexible Packaging

The course develops knowledge and techniques in converting and flexible packaging. Topics covered are converting materials, quality control practice in converting, evaluation of packaging film and converting and applications in flexible packaging. This course is co-listed with PACK-660; students may receive credit for PACK-560 or PACK-660, not both. (Students may not take and receive credit for PACK-560 and PACK-660. If you have earned credit for PACK-560 or you are currently enrolled in PACK-560 you will not be permitted to enroll in PACK-660.) **Lec/Lab 4, Credits 3 (Spring)**

PACK-699

Graduate 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. Department permission is required. **CO OP, Credits 0**

PACK-701

Research Methods

Discussion of the 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 transport environment, materials, quality preservation, sustainability, mechanical properties of packaging materials and systems. A research paper is required. **Lecture 3, Credits 3 (Fall)**

PACK-702

Graduate Writing Strategies

Taught in conjunction with Research Methods 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. A search of the literature for a defined 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 to the identified journal. **Lecture 3, Credits 3 (Fall, Spring)**

PACK-730

Packaging and the Environment

Consideration 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 interest are discussed. Primarily a discussion class for graduate students. Open to graduate non-majors. **Lecture 3, Credits 3 (Spring)**

PACK-742

Distribution Systems

The course develops knowledges and application skills of the distribution packaging. Topics covered are packaging used in distribution systems, integrated packaging supply chain, modeling and analysis of the distribution systems, and score card in packaging supply chain. Emphasises are given to estimate and predict the packaging protection and to optimize the packaging distribution using various tools. The lab focuses on development and evaluation of a distribution packaging. The projects are designed to assess the packaging performance in distribution systems. (This course is restricted to students in the PACK-MS program.) **Lecture 3, Credits 3 (Spring)**

PACK-750

Packaging Materials, Processes and Applications

This graduate level course is designed to present the theory, foundation principles and practices which form the basis of packaging science. **Lecture 4, Credits 3 (Fall)**

PACK-751

Advanced Packaging Design

The course develops knowledge of packaging design graphics and skills of package structure design. Topics covered are basics of engineering design graphics, technical sketch, project plan, design matrix, computer aided design (CAD), and rapid prototyping. Emphasis is given to use SolidWorks – CAD software to design typical packaging structures. The design project focuses on developing a packaging structure from an idea to an actual prototype. **Lec/Lab 4, Credits 3 (Spring)**

PACK-752

Advanced Computer Applications

The course develops knowledge and skills in applying two computer software packages for packaging design: Artios CAD and Adobe Illustrator. Topics covered are builder and rebuilder, solid modeling and drawing, animation, coloring, and painting. Emphasis is given to create a typical paperboard based carton with a proper structure and color usage. **Lec/Lab 4, Credits 3 (Spring)**

PACK-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/end user and meets the demands of the supply chain. (Prerequisites: PACK-451 or equivalent course or graduate student standing in the PACK-MS program.) **Lecture 3, Credits 3 (Spring)**

PACK-783

Advanced Packaging Dynamics

The study of instrumentation systems for analysis, evaluation and application of shock and vibration test methods to develop protective package designs and effective product/package interaction. A research paper is required. (This course is restricted to students in the PACK-MS program.) **Lecture 3, Credits 3 (Spring)**

PACK-783

Advanced Packaging Dynamics

The study of instrumentation systems for analysis, evaluation and application of shock and vibration test methods to develop protective package designs and effective product/package interaction. A research paper is required. (This course is restricted to students in the PACK-MS program.) **Recitation 1, Credits 3 (Spring)**

PACK-789

PS Special Topics

Packaging science special topics. **Lecture, Credits 1 - 3 (Fall, Spring, Summer)**

PACK-790

Research Thesis

A thesis is based on experimental evidence obtained by the candidate in an appropriate topic demonstrating the extension of theory into practice. A written proposal which is defended and authorized by the faculty advisor/committee followed by a formal written thesis and oral presentation of findings are required. Typically the candidate will have completed research methods, data analysis and graduate writing strategies prior to enrolling in this course and will start the thesis process as soon as they have completed these courses to allow them to finish the thesis when they have finished their coursework. The candidate must obtain the approval of their graduate adviser who will guide the thesis before registering for this course. (Enrollment in this course requires permission from the department offering the course.) **Thesis, Credits 1 - 6 (Fall, Spring, Summer)**

PACK-791

Continuation of Thesis

Continuation of Thesis (Enrollment in this course requires permission from the department offering the course.) **Cont, Credits 0**

PACK-795

Comprehensive Examination

A written comprehensive exam is one of the non-thesis methodologies for completion of the MS degree. Students will demonstrate a fundamental knowledge of the theories and foundation principles. This course will include a review of the main concepts of each of the core subjects and at the conclusion of the course the student will take a written examination and must receive a passing grade of at least 80 percent to be successful. Students will have one additional opportunity to pass this examination if their initial attempt results in a failing grade. (Faculty adviser approval required). (Enrollment in this course requires permission from the department offering the course.) **Comp Exam 3, Credits 0 (Fall, Summer)**

PACK-797

Graduate Project

The purpose of this course is to provide students the opportunity to conduct research, develop a plan and evaluation components and submit the project as a demonstration of final proficiency in the program. The topic selected by the student will be guided by the faculty teaching the class and it will require the student to coalesce and incorporate into the final project a culmination of all their course work in the program to date. (Enrollment in this course requires permission from the department offering the course.) **Project, Credits 1 - 3 (Spring)**

PACK-798

Continuation of Grad Project

Continuation of Graduate Project (Enrollment in this course requires permission from the department offering the course.) **Cont, Credits 0**

Print Media

PPRT-600

Graduate Seminar

This course provides students that are new to the PPRT program an opportunity to develop an understanding of the school's research activities. The students will become more knowledgeable about the Print Media program, career options, and exit strategies including thesis, capstone and culminating experience. Relevant topics including finding an advisor, required documentation, and policies regarding program completion and Co-op, as well as school policies and procedures relating to the successful completion of the PPRT program. **Seminar 1, Credits 0 (Fall)**

PPRT-601

Materials and 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 consumables in order to obtain an understanding necessary to make informed decisions about use and application. **Lab 3, Credits 3 (Fall)**

PPRT-601**Materials and 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 consumables in order to obtain an understanding necessary to make informed decisions about use and application. **Lecture 2, Credits 3 (Fall)**

PPRT-602**Tone and Color Analysis**

This course covers fundamentals of color measurement, color management system, and color reproduction technology for color matching and color image reproduction. Emphases are placed on CIE colorimetry, device calibration and characterization, and color management systems. (Students cannot take and receive credit for this course if they have taken MAAT-544.) **Lab 2, Credits 3 (Fall)**

PPRT-602**Tone and Color Analysis**

This course covers fundamentals of color measurement, color management system, and color reproduction technology for color matching and color image reproduction. Emphases are placed on CIE colorimetry, device calibration and characterization, and color management systems. (Students cannot take and receive credit for this course if they have taken MAAT-544.) **Lecture 2, Credits 3 (Fall)**

PPRT-603**Operations Management in the Graphic Arts**

An in-depth study of the factors affecting the efficiencies and effectiveness of print media organizations and ultimately their profitability. Includes consideration of both internal factors, such as quality level goals, training, scheduling, plant layout, and financial management, and external factors, such as environmental and legal issues and safety enforcement. **Lecture 3, Credits 3 (Spring)**

PPRT-618**TypoItalia: Typography Research in Northern Italy**

This course is designed to give students intensive educational experiences involving travel abroad to northern Italy. Cities visited in the class may include Venice, Parma, Treviso. The course will explore the history of typography while providing students with a cross-cultural outlook important to understanding the future of typography. Students will examine typography's rich history and modernization through travel abroad and investigate how research of the past can inspire innovation in the future. The course will include visits to typographic museums, lectures, guest speakers, hands-on experiences and activities as students conduct typographic research inspired as they travel. Travel expenses will be incurred for this course. (This course requires permission of the Instructor to enroll.) **Study Abroad, Credits 3 (Summer)**

PPRT-641**Digital Printing and Publishing**

This course provides students with the opportunity to learn the concepts and applications of digital printing. The course examines the technology of several major digital print engines and compares digital printing to conventional print processes. The economics and application of specific digital printing processes are examined from a workflow perspective. This course is cross-listed with MAAT-541; students may receive credit for MAAT-541 or PPRT-641, not both. (Not if MAAT-541) **Lab 3, Credits 3 (Fall)**

PPRT-641**Digital Printing and Publishing**

This course provides students with the opportunity to learn the concepts and applications of digital printing. The course examines the technology of several major digital print engines and compares digital printing to conventional print processes. The economics and application of specific digital printing processes are examined from a workflow perspective. This course is cross-listed with MAAT-541; students may receive credit for MAAT-541 or PPRT-641, not both. (Not if MAAT-541) **Lecture 2, Credits 3 (Fall)**

PPRT-642**Industry Issues and Trends**

Industry Issues and Trends presents a detailed analysis of the critical trends and issues related to the Graphic Communications industry. It provides an in-depth analysis of key technologies with a special emphasis on emerging, disruptive innovations as well as business, environmental and regulatory issues. This course emphasizes technological trends and is intended to provide students with a fuller understanding of changes in Graphic Communication constituencies and their role within the industry. By tracing historical roots, analyzing present issues and detailing future trends, students are prepared to develop insights into the nature and scope of the major challenges facing industry leaders and how to manage these challenges. This course is cross-listed with MAAT-561; students may receive credit for MAAT-561 or PPRT-642, not both. (Students may not take and receive credit for PPRT-642 and MAAT-561. If you have earned credit for PPRT-642 or you are currently enrolled in MAAT-561 you will not be permitted to enroll in PPRT-642.) **Lecture 3, Credits 3 (Fall)**

PPRT-644**Advanced Color Management**

This course embraces ICC-based color management practices by assessing color reproduction quality quantitatively and psychometrically. It also examines state-of-the-art tools, procedures, and techniques for device calibration and color control. Students are expected to work in a team environment, to plan, conduct experiments, and to publish a technical publication. (Prerequisites: PPRT-602 or equivalent course.) **Lab 2, Credits 3 (Spring)**

PPRT-644**Advanced Color Management**

This course embraces ICC-based color management practices by assessing color reproduction quality quantitatively and psychometrically. It also examines state-of-the-art tools, procedures, and techniques for device calibration and color control. Students are expected to work in a team environment, to plan, conduct experiments, and to publish a technical publication. (Prerequisites: PPRT-602 or equivalent course.) **Lecture 2, Credits 3 (Spring)**

PPRT-650**Top Media Sci: TOPIC**

Topics in Media Sciences provides a platform for students to explore the most contemporary issues in the rapidly evolving fields of media arts, media sciences, and media technologies. A subtopic course description will be published each term the course is offered and may have limited repeatability. This course can be repeated. **Lecture 3, Credits 3 (Fall, Spring)**

PPRT-651**Lab Topics in Media Sciences**

Lab Topics in Media Sciences provides a lab-based platform for students to explore the most contemporary issues in the rapidly evolving fields of media arts, media sciences, and media technologies. A subtopic course description will be published each term and may have limited repeatability. This course can be repeated. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lab 2, Credits 3 (Fall, Spring)**

PPRT-651**Lab Topics in Media Sciences**

Lab Topics in Media Sciences provides a lab-based platform for students to explore the most contemporary issues in the rapidly evolving fields of media arts, media sciences, and media technologies. A subtopic course description will be published each term and may have limited repeatability. This course can be repeated. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 2, Credits 3 (Fall, Spring)**

PPRT-653**Building Profit into Media Projects**

This course familiarizes students with costing and pricing practices in website development, print media, mobile media, and social media. It highlights areas of similarity in these media but more importantly focuses on those practices and customs that are unique to a specific medium. The course provides the necessary background for developing accurate media proposals that become contractual legal obligations and result in sustained profitability. This course is cross-listed with MAAT-563; students may receive credit for MAAT-563 or PPRT-653, not both. (Students may not take and receive credit for PPRT-653 and MAAT-563. If you have earned credit for PPRT-653 or you are currently enrolled in MAAT-563 you will not be permitted to enroll in PPRT-653.) **Lecture 3, Credits 3 (Spring)**

PPRT-654**Conventional Graphic Processes**

This survey course covers a comprehensive review of conventional print production technologies, with emphasis on offset lithography, flexography, screen, and gravure printing methods. Hands-on laboratory experiences underscore the technical strengths and limitations of commercial applications of the various processes, including the materials such as substrates, inks and appropriate metrologies. Quality assurance and process control procedures specific to each process are featured, and appropriate industry standards and specifications are reviewed. **Lab 2, Credits 3 (Spring)**

PPRT-654**Conventional Graphic Processes**

This survey course covers a comprehensive review of conventional print production technologies, with emphasis on offset lithography, flexography, screen, and gravure printing methods. Hands-on laboratory experiences underscore the technical strengths and limitations of commercial applications of the various processes, including the materials such as substrates, inks and appropriate metrologies. Quality assurance and process control procedures specific to each process are featured, and appropriate industry standards and specifications are reviewed. **Lecture 2, Credits 3 (Spring)**

PPRT-663**Technical Writing**

This course prepares a student to engage in a variety of written and oral communications necessary in academic, professional, and technical environments. Students are expected to produce appropriate audience-centered written materials based on techniques, organization, format, and style that are helpful for generating graduate-level writing. Students engage in peer-review of written documents. **Lecture 3, Credits 3 (Spring)**

PPRT-666

Typography Research

The course builds on fundamentals and skills taught in introductory and advanced typography courses by developing methods of investigation, research, and analysis, with the goal of enabling students to conduct independent research. Students will choose individual typographic topics to research (e.g. technology, psychology, history, aesthetics, imaging, writing systems, culture, and society). Course lectures will survey these topics. Students each give presentations on their topics and prepare a written report. The course emphasizes individual initiative and seminar participation. (This course is restricted to PRNTMED-MS Major students.) **Lecture 3, Credits 3 (Spring)**

PPRT-671

Advanced Digital Asset Management

In this course students will research the current and future trends associated with content management as well as digital asset management. This course includes archiving and retrieving practices for image and content repurposing. Students will understand the role of metadata in the automation of asset creation, storage, and retrieval. Best practices for digital asset management implementation strategies are emphasized. **Lecture 3, Credits 3 (Fall)**

PPRT-678

Printing Process Control

Students will gain a deeper understanding of the role of printing process control for repeatable color printing and predictable color image reproduction. Students will learn (1) how to use spectrophotometers to collect color measurement data from printed test targets, (2) how to use software to analyze color printing characteristics, including color gamut, tone value increase and gray balance, (3) press calibration methods, and (4) how to simulate the appearance of color image reproduction in various color-managed workflows. This course also covers relevant Committee for Graphic Arts Technology Standards (CGATS) and ISO printing standards, printing certification, and case studies for problem-solving in color-managed workflows. **Lab 2, Credits 3 (Spring)**

PPRT-678

Printing Process Control

Students will gain a deeper understanding of the role of printing process control for repeatable color printing and predictable color image reproduction. Students will learn (1) how to use spectrophotometers to collect color measurement data from printed test targets, (2) how to use software to analyze color printing characteristics, including color gamut, tone value increase and gray balance, (3) press calibration methods, and (4) how to simulate the appearance of color image reproduction in various color-managed workflows. This course also covers relevant Committee for Graphic Arts Technology Standards (CGATS) and ISO printing standards, printing certification, and case studies for problem-solving in color-managed workflows. **Lecture 2, Credits 3 (Spring)**

PPRT-688

Package Printing

This course introduces students to the package printing industry. Printing processes, materials, production workflows and quality control systems used in package printing are introduced. Students will oversee the workflows relevant to package production, from concept to design to finished product. This course is cross-listed with MAAT-558; students may receive credit for MAAT-558 or PPRT-688, not both. (Students may not take and receive credit for PPRT-688 and MAAT-558. If you have earned credit for PPRT-688 or you are currently enrolled in MAAT-558 you will not be permitted to enroll in PPRT-688.) **Lab 3, Credits 3 (Spring)**

PPRT-688

Package Printing

This course introduces students to the package printing industry. Printing processes, materials, production workflows and quality control systems used in package printing are introduced. Students will oversee the workflows relevant to package production, from concept to design to finished product. This course is cross-listed with MAAT-558; students may receive credit for MAAT-558 or PPRT-688, not both. (Students may not take and receive credit for PPRT-688 and MAAT-558. If you have earned credit for PPRT-688 or you are currently enrolled in MAAT-558 you will not be permitted to enroll in PPRT-688.) **Lecture 2, Credits 3 (Spring)**

PPRT-699

Print Media Grad Coop

The co-op will provide students with the opportunity to work in the graphic communication field. Co-ops are typically paid work experiences and can be either part-time (10-15 hrs/wk) or full-time (min 35 hrs/wk). All co-ops must fall within an RIT term (fall, spring, summer). Department permission required. **CO OP, Credits 0 (Fall, Spring, Summer)**

PPRT-703

Cross Media Workflow

This course is designed to expose students to all the elements needed to execute media projects across platforms. Students will learn concepts in project management as it applies to leading cross media projects and teams. Concepts and tools necessary for the implementation of a cross media workflow will be discussed and reinforced with hands-on exercises. Additionally, content management and industry standards and practices such as color management, asset management, and image optimization for output will be studied and applied through the context of cross media workflows. **Lab 2, Credits 3 (Spring)**

PPRT-703

Cross Media Workflow

This course is designed to expose students to all the elements needed to execute media projects across platforms. Students will learn concepts in project management as it applies to leading cross media projects and teams. Concepts and tools necessary for the implementation of a cross media workflow will be discussed and reinforced with hands-on exercises. Additionally, content management and industry standards and practices such as color management, asset management, and image optimization for output will be studied and applied through the context of cross media workflows. **Lecture 2, Credits 3 (Spring)**

PPRT-704

Research Methods and Trends in Graphic Media

This course provides a foundation for conducting scientific research in the graphic communications industry. Students will learn the scientific methods, how to generate hypotheses and research questions, conduct secondary research, select the best research design to answer a research question, and how to analyze basic survey data. This course will also introduce students to the current issues in the industry in preparation for them to identify a thesis or capstone project problem. **Lecture 3, Credits 3 (Fall)**

PPRT-705

Graphic Standards and Specifications

Students will evaluate the differences between standards and specifications, and comprehend their respective roles in various graphic production processes. Governing bodies and the processes involved in standards creation are addressed. Relevant information and metrics are reviewed, and students will analyze and prescribe the standard(s) most relevant to particular production or research settings, as well as discuss the interrelationships and dependences of standards and process-specific specifications. **Lecture 3, Credits 3 (Spring)**

PPRT-706

Commercial Graphic Trends and Processes

This course introduces students to the materials, technological processes and trends in conventional, digital, and functional print production. Theoretical models of innovation and change are covered and applied providing students with a robust comprehension of graphic communication constituencies and their role in various industry sectors. **Lecture 3, Credits 3 (Fall)**

PPRT-748

Continuation of Capstone

The course provides a student additional semester(s) to complete their capstone research, project, and documentation. (Prerequisites: PPRT-747 or equivalent course.) **Cont, Credits 0 (Fall, Spring, Summer)**

PPRT-751

Advanced Materials in Graphic Communication

This course offers an in depth study of the materials used in graphic communication. Students will learn the chemical and physical properties associated with consumables required by processes studied in the course in order to obtain an understanding necessary to make informed decisions about their use and application, with an emphasis on safety concerns. **Lab 2, Credits 3 (Fall)**

PPRT-751

Advanced Materials in Graphic Communication

This course offers an in depth study of the materials used in graphic communication. Students will learn the chemical and physical properties associated with consumables required by processes studied in the course in order to obtain an understanding necessary to make informed decisions about their use and application, with an emphasis on safety concerns. **Lecture 2, Credits 3 (Fall)**

PPRT-763

Applied Data Analytics

This course prepares a student to apply data analytics to understand the unmet and undefined content needs of a target audience. Students will learn secure and repeatable data analysis practices in a closed-loop cross media communications value chain. **Lecture 3, Credits 3 (Spring)**

PPRT-780

Thesis Seminar

This course will guide and monitor the progress of graduate students in the development of their written thesis proposal as defined in the SMS Thesis Manual. Students will review their work regularly throughout the semester, with the Graduate Director, SMS faculty, and their thesis committee. Students will be guided in the refinement of their thesis topic and structuring their methodology. Students will determine their thesis committee and create their thesis timeline, outline, and proposal culminating in a formal thesis proposal defense. (Prerequisites: PPRT-704 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

PPRT-790

Thesis

To conduct research on a topic relevant to the graphic arts industry. Topic must be approved by a committee comprising graduate faculty and an advisor. (Prerequisite: GRCS-701 or equivalent course.) **Thesis, Credits 6 (Fall, Spring, Summer)**

PPRT-796

Research Applications and Problem Solving

The culminating experience provides students the opportunity to combine and incorporate learnings gained in coursework and other experiences and apply this knowledge in a pragmatic undertaking relevant to the graphic communication and allied industries. Topic must be approved course instructor. (Prerequisite: GRCS-701 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

PPRT-797**Capstone**

The capstone course provides students the opportunity to combine and incorporate learnings gained in coursework and other experiences and apply this knowledge in a written capstone project relevant to the graphic communication and allied industries. Topic must be approved course instructor. (Prerequisite: GRCS-701 or equivalent course.) **Project 3, Credits 3 (Fall)**

PPRT-799**Independent Study**

The student will work with a faculty adviser to create a series of readings, writings, or original research that addresses a key concern in the field of graphic communications. **NOTE: Student must have a minimum 3.0 GPA ** (This course is restricted to PRNTMED-MS or MEDART-MS Major students.) **Ind Study, Credits 1 - 6 (Fall, Spring, Summer)**

PPRT-887**Media Sciences Grad Part-time Coop**

The co-op will provide students with the opportunity to work in the graphic communication field. Co-ops are typically paid work experiences and can be either part-time (10-15 hrs/wk) or full-time (min 35 hrs/wk). Department permission required. (This course is restricted to PRNTMED-MS or MEDART-MS Major students.) **CO OP, Credits 0 (Fall, Spring, Summer)**

PPRT-892**Continuation of Thesis Print Media**

This course allows the student to continue thesis research on a topic relevant to the graphic arts industry. Topic must be approved by a committee comprising graduate faculty and an adviser. (Prerequisites: PPRT-790 or equivalent course and student standing in PRNTMED-MS.) **Cont, Credits 0 (Fall, Spring)**

Robotics and Manufacturing Engineering Technology

RMET-671**Automation Systems Design and Control**

This course deals with the higher level of topics relating to automation control systems engineering. Learning different programming languages, troubleshooting techniques, advanced programming instructions, the use and application of Human Machine Interface (HMI) panels, analog devices uses and applications, advanced system design, networking and an introduction to Industry 4.0 are all covered in this course. Students will be expected to develop the main system and all subsystems required to solve an automation problem. (Students cannot take and receive credit for this course if they have taken RMET-571.) **Lecture 3, Credits 3 (Spring)**

RMET-671**Automation Systems Design and Control**

This course deals with the higher level of topics relating to automation control systems engineering. Learning different programming languages, troubleshooting techniques, advanced programming instructions, the use and application of Human Machine Interface (HMI) panels, analog devices uses and applications, advanced system design, networking and an introduction to Industry 4.0 are all covered in this course. Students will be expected to develop the main system and all subsystems required to solve an automation problem. (Students cannot take and receive credit for this course if they have taken RMET-571.) **Recitation 1, Credits 3 (Spring)**

RMET-685**Robots and Automation**

This courses focuses on the technology and application of robots in an integrated manufacturing environment. An introductory understanding of robotic hardware and software is provided. The hardware portion of this course involves robot configurations, drive mechanisms, power systems (hydraulic, pneumatic and servo actuators), end-effectors, sensors, and control systems. The software portion of this course involves the various methods of textual and lead through programming commonly found on commercial industrial robots, as well as simulation systems supplied by various manufacturers. Digital interfacing of robots with components such as programmable logic controllers, computer-controlled machines, conveyors, and numerical control is introduced. Robotic cell design and the socio-economic impact of robotics are also discussed. This course also has a strong experiential component that emphasizes hands-on training. This course may be cross listed with RMET-585. Students may not take and receive credit for this course if they have already taken RMET-585. (This course is restricted to students with graduate standing in MMSI-MS, MCET/MMSI-BSMS, EMET/MMSI-BSMS, MECA/MMSI-BSMS, RMET/MMSI-BSMS programs.) **Lecture 3, Credits 3 (Fall, Spring)**

RMET-685**Robots and Automation**

This courses focuses on the technology and application of robots in an integrated manufacturing environment. An introductory understanding of robotic hardware and software is provided. The hardware portion of this course involves robot configurations, drive mechanisms, power systems (hydraulic, pneumatic and servo actuators), end-effectors, sensors, and control systems. The software portion of this course involves the various methods of textual and lead through programming commonly found on commercial industrial robots, as well as simulation systems supplied by various manufacturers. Digital interfacing of robots with components such as programmable logic controllers, computer-controlled machines, conveyors, and numerical control is introduced. Robotic cell design and the socio-economic impact of robotics are also discussed. This course also has a strong experiential component that emphasizes hands-on training. This course may be cross listed with RMET-585. Students may not take and receive credit for this course if they have already taken RMET-585. (This course is restricted to students with graduate standing in MMSI-MS, MCET/MMSI-BSMS, EMET/MMSI-BSMS, MECA/MMSI-BSMS, RMET/MMSI-BSMS programs.) **Recitation 1, Credits 3 (Fall, Spring)**

RMET-687**Robotics: Sensors and Vision**

Robots in many applications require sensors and/or vision systems to allow the robot to fully understand its environment and tasks. Students learn how to design and integrate robot sensor and vision systems to enable the dynamic use of the robot's capabilities. Robot sensors, 2D and 3D visions systems along with lighting will be used to allow the student to conceptualize, design, and program robotic techniques related to path correction, dynamic positioning, 2D targeting, and 3D picking using robots. Projects will use both robots and simulation software. Students may receive credit for only this course or RMET-587, not both. (Prerequisites: MFET-685. Also, students cannot take and receive credit for this course if they have taken RMET-587.) **Lecture 3, Credits 3 (Spring)**

Telecommunications Engineering Technology

TCET-601**Programming and Problem Solving in Telecommunications**

This course provides students with the programming, scripting and problem-solving techniques required for other classes in the TCET MS curriculum and to provide the software skills that are required in today's telecommunication industry. The class will be taught using a programming language that is commonly used in industry today such as Python. The course will cover the following material: Basic programming constructs, Programming best practices, Algorithmic complexity, Data abstraction, Sorting and searching algorithms, Problem solving techniques. Homework assignments will be based upon real-world examples from the telecommunications industry. **Lecture 3, Credits 3 (Fall)**

TCET-620**Applied Machine Learning**

Machine learning has applications in a wide variety of fields ranging from medicine and finance to telecommunications and autonomous self-driving vehicles. This course introduces machine learning and gives you the knowledge to understand and apply machine learning to solve problems in a variety of application areas. The course covers neural net structures, deep learning, support vector machines, training and testing methods, clustering, classification, and prediction with applications across a variety of fields. The focus will be on developing a foundation from which a variety of machine learning methods can be applied. Students may not take and receive credit for this course if they have already taken EEET-520. (This class is restricted to degree-seeking graduate students or those with permission from instructor. If you have earned credit for EEET-520 or you are currently enrolled in EEET-520 you will not be permitted to enroll in TCET-620.) **Lecture 3, Credits 3 (Spring)**

TCET-661**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. (This course is restricted to students in the TCET-MS program.) **Lecture 3, Credits 3 (Fall)**

TCET-671**Patents and Trade Secrets**

This course explores the legal characteristics and limitations of intellectual property rights protected by patents and trade secrets in the United States through study of relevant statutes, court decisions, and inventor behavior. The course is appropriate for anyone who anticipates involvement in the creation or management of intellectual property rights. NOTE: A party's legal rights depend upon their unique and specific factual situation. This course does not provide legal advice or direction. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Biannual)**

TCET-689**Special Topics in MSTET**

Subject offerings of new and developing areas of knowledge in telecommunications engineering technology intended to augment the existing curriculum. Special Topics courses are offered periodically, watch for titles in the course listing each semester. **Lecture, Credits 1 - 3 (Spring)**

TCET-699

TCET Graduate Co-op. Department permission is required. **CO OP, Credits 0 (Fall, Spring, Summer)**

TCET-710**Principles of Telecommunications Networks**

The course provides the student with a solid understanding of local access and backbone network, 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. (This course is restricted to students in the TCET-MS program.) **Lecture 3, Credits 3 (Fall)**

TCET-715**Converged Network Concepts**

The course provides the student with a solid understanding of access, distribution and backbone network, architecture, equipment and technology related to a variety of service provided networks and services critical to the operation of converged and IP networks. Passive Optical Networking, Hybrid Fiber Coax technology, multiplexing, modulation schemes, coding, signaling and networking protocols used in convergence technologies for the delivery of information in a variety of packet and next generation networks are covered in detail. **Lecture 3, Credits 3 (Fall)**

TCET-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. (This course is restricted to students in the TCET-MS program.) **Lecture 3, Credits 3 (Spring)**

TCET-723**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. (Prerequisites: TCET-715 or TCET-710 and TCET-720 or equivalent courses.) **Lecture 3, Credits 3 (Fall)**

TCET-730**Telecommunications Policy and Issues**

The objective of this course is to enlighten students relative to telecommunications policy and standards sufficiently, in order for them to be able to deal with the real-world issues that confront telecommunications professionals on a daily basis. Students will not be prepared to act as regulatory experts or to replace specialized experts with legal training, but should be sufficiently cognizant of pertinent issues to know when it is prudent to call in such forces. The domestic as well as the international regulatory, policy and standard arenas will be explored. This course helps students to understand that the telecommunications environment is greatly effected by technology, policy, security, and market forces with a primary focus on telecommunications policy and all that it entails. (This course is restricted to students in the TCET-MS program.) **Lecture 3, Credits 3 (Fall)**

TCET-740**Fiber Optic Communications**

Fiber-optic, point-to-point telecommunication systems are used as a framework to understand the wide array of fiber-optic telecom technologies, including light sources, optical fiber, and photoreceivers. An emphasis on the nature & behavior of optical signals provides insight into these technologies and into the important fiber-channel impairments of attenuation and dispersion. Fundamental concepts and state-of-the-art advances of these technologies are covered, as well as component-level and system-level analysis. **Lecture 2, Credits 2 (Fall)**

TCET-741**Fiber Optic Communications Lab**

This course provides extensive hands-on experience with key technologies used within fiber-optic telecommunication systems, including optical fiber, laser diodes, light-emitting diodes, photodiodes, and pluggable transceivers, as well as key diagnostics such as power meters, oscilloscopes, optical time-domain reflectometers, and optical spectrum analyzers. Students will be trained in laser safety, ESD safety, and fiber-connector inspection, and will develop a broad understanding of fiber-optic test and measurement including transmitter & receiver characterization as well as measuring the fiber-channel impairments of attenuation and dispersion. (Co-requisite: TCET-740 or equivalent course.) **Lab 2, Credits 1 (Fall)**

TCET-745**Advanced Fiber-Optic Communications**

This course focuses on characterizing and designing the capacity and reach of fiber-optic transmission systems in terms of key performance metrics (BER, Q-factor, eye diagrams, and system margin, transmission penalty, optical-power budgets, and OSNR budgets), the impact of key physical impairments (loss, dispersion, nonlinearity), and techniques used to overcome these impairments (optical amplification, dispersion compensation, power mitigation). Widespread fiber-optic transmission modalities (such as wavelength-division multiplexing and amplitude modulation) as well as emerging modalities (such as polarization-division multiplexing and phase modulation) will be covered. (Prerequisites: TCET-740 and TCET-741 or equivalent courses.) **Lecture 3, Credits 3 (Spring)**

TCET-747**Next Generation Networks**

This hybrid 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 (NGN). The course consists of professor provided discussion on NGN followed by each student researching NGN types. Basically, a case study approach is utilized. Immediately 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. As a result, every student will not only benefit from their own research of topics/cases but also be informed of other NGN by other students. Students should already have some understanding of how to perform research and must possess at least adequate writing skills. (This course is restricted to students in the TCET-MS program.) **Lecture 3, Credits 3 (Fall)**

TCET-748**Fiber Optic Test and Measurement**

This course covers the test & measurement of fiber-optic components & diagnostics, including: time-based, frequency-based, polarization-based measurement of optical & electro-optic components; test-station design, specification, activation, calibration, and usage; reliability testing & industry test standards; optical-waveguide coupling; design & analysis of diagnostics; polarization generation, manipulation, and detection; data acquisition & analysis. (Prerequisites: TCET-740 and TCET-741 or equivalent courses.) **Lecture 3, Credits 3 (Spring)**

TCET-750**Wireless Systems Regulation**

The fundamental legal and regulatory principles of U.S. wireless mobile and fixed radio frequency communication systems are studied in this course. At the end of this course, students will be able to (1) analyze the legal and regulatory issues related to wireless base station site zoning approval, (2) calculate radio-frequency human exposure levels and (3) apply relevant regulations related to deployment of the wireless infrastructure. **Lecture 3, Credits 3 (Spring)**

TCET-751**Wireless Communications**

Wireless, digital point-to-point communication systems require a wide array of technologies, some analog (such as antennas, amplifiers, mixers) and some digital (filters, equalizers, decoders, etc.). The course focuses on presenting both system-level and component-level analyses of a complete transceiver operating on a fading channel. Fundamental concepts and classical techniques are presented, as well as some state-of-the-art advances. These concepts are illustrated with hands-on activities using software-defined radio. **Lecture 3, Credits 3 (Fall)**

TCET-752**Advanced Wireless Communication**

This course focuses on modern wideband wireless communications over the frequency-selective channel. It covers channel models, equalization and synchronization techniques, and contemporary modulations such as SC-FDE and OFDM. State-of-the-art and emerging technologies, such as MIMO, massive MIMO, and spatial modulation are included. These are studied in the context of current mobile and networking standards, such as 3G, LTE, and 5G, and IEEE 802.x. **Lecture 3, Credits 3 (Spring)**

TCET-753**Wireless Networks**

This course focuses on multiplexing, multiple access, medium access control, and frequency reuse, and how these influences a wireless network's choice of protocols, topology, security, efficiency, etc. Following this approach, cellular, sensor, WLANs, WPANs, IoT, and other important current wireless network technologies are explored. (Prerequisites: TCET-751 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

TCET-755**Wireless Communications Techniques**

This course focuses on techniques for data transmission over the wireless channel. Students who take this course will start by learning about digital communications over the noisy channel, including how to model, simulate, and evaluate the system's performance. Then, they will move on to the wireless channel, which presents a new set of challenges, such as multipath fading. Students will learn techniques to achieve reliable, efficient communication over this channel, such as coding, diversity, and MIMO. Students will be assigned exercises where they'll use a computer and a software-defined radio to simulate, design, and evaluate their own communications systems. (Prerequisites: TCET-750 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

TCET-760**Network Planning and Design**

This course teaches the art and science of metropolitan and wide area network 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. The following are typical types of projects: Write an RFP, design an extensive metropolitan and wide area network using the latest technologies, design an extensive fiber optic network using a design tool like OPNET Transport Planner. Note: Since some students may not yet have taken a fiber course, the OPNET project stresses the use of the tool rather than the specifics of fiber optics. (This course is restricted to students in the TCET-MS program.) **Lecture 3, Credits 3 (Spring)**

TCET-788**Thesis Planning**

This course begins the work on a previously approved thesis proposal and culminates upon successful investigation of the chosen research topic and scholarly development of initial data and results that show likelihood of successful completion of the thesis. The thesis advisor will specify the documentation and presentation needed to satisfy requirements for this course. The MSTET graduate thesis, delivered after subsequently completing TCET-790 Thesis, is a document that describes and presents the results of scholarly research in the field of telecommunications. The results of a MSTET graduate thesis provide new knowledge, processes, software or other assets that advance the state of the art of telecommunications, even in a modest way. (Department consent required) **Thesis, Credits 3 (Fall, Spring, Summer)**

TCET-789**Special Topics in MSTET**

Subject offerings of new and developing areas of knowledge in telecommunications engineering technology intended to augment the existing curriculum. Special topics courses are offered periodically. Watch for titles in the course listing each semester. **Lecture 3, Credits 1 - 3 (Fall, Spring)**

TCET-790**Thesis**

This course continues research work started in TCET-788 Thesis Planning after completion of that initial research and documentation. The MSTET graduate thesis is a document that describes and presents the results of scholarly research in the field of telecommunications. The results of a MSTET graduate thesis provide new knowledge, processes, software or other assets that advance the state of the art of telecommunications, even in a modest way. (Department consent required) (Prerequisites: TCET-788 or equivalent course.) **Thesis, Credits 3 (Fall, Spring, Summer)**

TCET-797**Graduate Project**

The MSTET graduate project describes and presents the results of scholarly research in the field of telecommunications. The results of a MSTET graduate project provide new knowledge, processes, software, or other assets that advance the state of the art of telecommunications or organize or implement existing knowledge in a unique and useful way. Department permission is required. (Enrollment in this course requires permission from the department offering the course.) **Project, Credits 3 (Fall, Spring, Summer)**

TCET-899**Graduate Independent Study**

Study or laboratory work on a topic in or related to telecommunications engineering technology. (This course requires permission of the Instructor to enroll.) **Ind Study, Credits 1 - 4 (Fall, Spring)**

GRCS-789**Selected Topics**

Selected topics is an innovative course not reflected in the accepted curriculum. Once the outline is submitted titles will appear in the course listing for the semester. The course may be taken more than once as topics change. **Lecture, Credits 1 - 3 (Fall, Spring, Summer)**

Graduate Writing and Research Courses

GRCS-701**Research Methods**

This is an introductory graduate-level survey course on research design/methods and analysis. The course provides a broad overview of the process and practices of research in applied contexts. Content includes principles and techniques of research design, sampling, data collection, and analysis including the nature of evidence, types of research, defining research questions, sampling techniques, data collection, data analysis, issues concerning human subjects and research ethics, and challenges associated with conducting research in real-world contexts. The analysis component of the course provides an understanding of statistical methodology used to collect and interpret data found in research as well as how to read and interpret data collection instruments. **Lecture 3, Credits 3 (Fall, Spring)**

GRCS-702**Principles of Research Communications**

Conducting research requires language skills to express the research concept, explain methodology and summarize the results. This course will focus on written communication skills including critical thinking, scholarly writing skills and the ability to synthesize research results to draw conclusions. Key to this course is the establishment of a defensible argument through which the student explains, convinces and establishes boundaries for the research subject. The focus of this course is to have students learn the mechanics of research writing and at the conclusion of the course to have generated elements of their final research thesis or capstone which can be used as a basis for further work with their home department or thesis/capstone faculty advisor. (Graduate College of Engineering Technology) **Lecture 3, Credits 3 (Fall, Spring)**

GRCS-703**Graduate Writing Strategies**

Students will demonstrate written communication skills applied to research and outcome methods. These methods include knowledge of the use of databases for research of a specified topic, use of appropriate references and citations, a written research proposal, a white paper, and a grant proposal. A search of the literature for a defined research topic, which includes an annotated bibliography to support the references used and a summary document for the results of the literature search. In addition, students will critique professional journals in their field and write a summary analysis of these articles. This course is typically offered to only RIT Dubai students. **Lecture 3, Credits 3 (Spring)**

College of Health Sciences and Technology

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Course numbering: RIT courses are generally referred to by their alphanumeric registration label. The four alpha characters indicate the discipline within the college. The final three digits are unique to each course and identify whether the course is noncredit (less than 099), lower division (100-299), upper division (300-599), or graduate level (600 and above).

Unless otherwise noted, the following courses are offered annually. Specific times and dates can be found in each semester's schedule of courses. Prerequisites/corequisites are noted in parentheses near the end of the course description.

Health Systems Management

HLTH-608 Integrated Health Systems and Population Health
This course discusses the delivery system of health care in the US. Specifically, the course will review the current status of American health care including research into population demographics and health and the concept of wellness and prevention. Following this a review of international health care models will occur to consider best practice as alternative care models for consideration for the US. In addition, the students will develop, for their area of interest and expertise, a strategy for incremental or radical innovation in how we provide health care to our constituents. **Lecture 3, Credits 3 (Fall)**

HLTH-610 Global Health Systems
This course will evaluate the modern challenges of global health from a multidisciplinary perspective. The key concepts of global health will be discussed, including various health determinants, human rights, health care systems, culture's impact on health, environmental concerns, nutrition, communicable and noncommunicable diseases, women's health issues, child and adolescent health, injuries, natural disasters and complex humanitarian emergencies, poverty's impact on health and more. Students will be expected to be active learners, lead class activities on certain days as part of group research project presentations, and actively participate in discussions. (A minimum of 3rd year standing is required to enroll.) **Lecture 3, Credits 3 (Fall)**

HLTH-611 Emergency Management in Health Care
The purpose of this course is to describe the fundamental attributes of emergency management to provide students with a foundation of understanding of the field, while also providing students with a basic understanding of how public health, medical, and health care services function as a part of disaster and emergency management. This course provides an introduction to emergency management and the role the health care organizations (public health, medicine, etc.) play in the four phases of emergency management (mitigation, preparedness, response, and recovery) and its core functions. Students will learn how to apply the core functions of emergency management in health-related disasters and other emergencies to identify solutions and methods to improve emergency management practice. (Prerequisites: HLTH-608 and HLTH-610 or equivalent courses.) **Lecture 3, Credits 3 (Spring)**

HLTH-612 Cultural Competency in Global Health
The Centers for Disease Control and Prevention and the World Health Organization are two of many health organizations that have emphasized the importance of cultural competence in health care. As our society becomes more global, sensitivity to and respect for various cultural norms is an integral component of health care delivery. This course defines cultural competency both in theory and in practice. Select topics to be addressed include: Introduction to cultural competency; diversity, equity and inclusion; how cultural competency impacts health practice; health disparity; language and communication; culture and health literacy; cultural competency; strategies for cultural competency assessment; practicing cultural competency, etc. (Prerequisites: HLTH-608 and HLTH-610 or equivalent courses.) **Lecture 3, Credits 3 (Spring)**

HLTH-700 Research Methods
This is an introductory graduate-level survey course on research design/ methods and analysis. The course provides a broad overview of the process and practices of social research in service-related contexts. Content includes principles and techniques of research design, sampling, data collection, and analysis including the nature of evidence, types of research, defining research questions, sampling techniques, data collection, data analysis, issues concerning human subjects and research ethics, and challenges associated with conducting research in real-world contexts. The analysis component of the course provides an understanding of statistical methodology used to collect and interpret data found in research as well as how to read and interpret data collection instruments. **Lecture 3, Credits 3 (Fall, Spring)**

HLTH-702 Graduate Writing Strategies
Taught in conjunction with Research Methods students will become articulate in a variety of business and research communication methodologies. These methods will include writing a research proposal, a white paper, critique professional journal articles and prepare a grant proposal. A search of the literature for a defined research proposal will include an annotated bibliography to support the references used in the research proposal. **Lecture 3, Credits 3 (Fall, Spring)**

HLTH-706 Leading Health Systems I
This is the first of three courses in the HSA, MS program that require students to be on campus. These "immersion" courses will be scheduled over a long weekend and will entail full days on campus as well as pre- and post-course work completed online. The concept is to immerse students in a series of experiences to support their development as high function managers and leaders within the health care industry. This course provides a detailed examination of the core principles of management as well as characteristics and disciplines that are required by persons holding management and leadership roles in health care delivery organizations. **Lecture 3, Credits 3 (Summer)**

HLTH-707 Health Care Finance and Reform
The health care industry is undergoing significant change as a result of reform. The Affordable Care Act directly affects the financing and delivery of health care. This course reviews the key elements of health care finance required of managers and leaders. Changes mandated by the Federal government will be explored in the areas of finance, care delivery and health insurance. **Lecture 3, Credits 3 (Spring)**

HLTH-710 Health Care Economics and Policy
This course provides an examination of the roles and responsibilities of policy makers on the health care system and the resulting economic impact of their policies. Students will compare and contrast the regulatory functions of varying levels of government, the political process and economic impacts as they relate to health care systems as well as examine control issues, economic functions and regulatory trends in the United States. In addition, an assessment will be made of national health systems and national health policies of other countries as they compare to the United States. **Lecture 3, Credits 3 (Spring)**

HLTH-712 Health Care Delivery
The health care industry is diverse and complex. This course is designed to provide a context for understanding the various elements of the US health care delivery system. The system is studied by reviewing the systems' history and roots, current and future state. Students will study the unique personal service orientation of health care and the sub-systems that support care delivery. The course will cover: services and modes of care delivery; roles, responsibilities and relationships of providers, payers, patients, support personnel and policymakers; reimbursement and insurance systems; health care outcomes; health care reform and government policies. Students will view the health care delivery system from a critical perspective and develop solutions to the access, quality, and cost issues. **Lecture 3, Credits 3 (Fall, Spring)**

HLTH-715 Reinventing Health Care
This course discusses reinventing health care in our country. Specifically the course will review the current status of American health care including research into population demographics and health and the concept of wellness and prevention. Following this a review of international health care models will occur to consider best practice as alternative care models for consideration for the US. Third the students will develop, for their area of interest and expertise a strategy for incremental or radical innovation in how we provide health care to our constituents. **Lecture 3, Credits 3 (Fall, Spring)**

HLTH-717 Bioethics
This course will provide students with an ethical framework consisting of knowledge of the principle theories and moral philosophers and their methods to approach decision making. Ethics will be further explored giving consideration of cultural norms and how this influences societal ethical decision making; a review of the ethics of the professions of health care; information about gaining access to the organizations ethical principles and an understanding of personal ethics. Using these as a foundation personal and professional ethics will be explored, developed and a decision making rationale developed through a sequence of exercises requiring ethical decision making related to finance, human resources, clinical issues and personal morality. **Lecture 3, Credits 3 (Spring, Summer)**

HLTH-718**Evidence-Based Management in Health Care**

The purpose of this course is to introduce students to evidence-based management practice in health care. The primary focus is to ensure that managers ask the right questions, use the best evidence available and make better decisions in carrying out their mission. Students will participate in the process of retrieval, appraisal, and synthesis of evidence in collaboration with other members of the health care team to improve processes and patient outcomes in diverse populations. Students complete an individual, final assignment demonstrating the ability to collect, document, and translate research (evidence) on the practice of health care management. **Lecture 3, Credits 3 (Spring)**

HLTH-723**Human Resources in Health Care**

This course focuses on the changing competitive health care environment that has made human capital an organization's key asset, with HR largely responsible for cultivating it. Specifically, students will learn the impact that human capital has on the HR division and function of health care organizations. The focus will be on how the "New HR" has become more strategic and fundamental to a health care organization's success and the need to meet the demands of highly skilled, educated and credentialed health care professionals. **Lecture 3, Credits 3 (Spring)**

HLTH-725**Health Care Strategic Marketing and Communications**

This course is designed to build innovative, customer-centered, thinking within the future leaders of the health care industry. This is accomplished with an introduction to the role of strategic decision making through the core principles of marketing (the 4Ps). Students will also experience basic data base management, conducting an internal and external environmental analysis, primary and secondary data gathering and interpretation and the creation of a marketing plan to meet an unsatisfied market need or build volume for a health care product or service. Finally, the role of corporate communication will be interwoven throughout the course as it supports marketing success. **Lecture 3, Credits 3 (Summer)**

HLTH-730**Health Care Financial Management I: Principles and Practice**

This course provides a basic understanding of health services financial management. We begin with elementary accounting concepts and then focus on financial statement preparation and analysis. Special topics areas include discounted cash flow, risk, capital investments evaluation, debt/equity financing, and financial decision making models such as break-even analysis, cash flow forecasting and the like. **Lecture 3, Credits 3 (Fall)**

HLTH-731**Health Care Financial Management II: Concepts/Applications**

This course builds on the foundational learning from Health Care Financial Management I: Principles & Practice. Course emphasis will be on for-profit entities within the health care sector. The course goes into greater depth on discounted cash flow analysis, risk, financial performance evaluation, capital investments, capital budgeting, debt, and equity financing. A key objective of this class is to develop the student's ability to engage in long-term financial modeling. Students will complete a comprehensive financial forecast as their final graded assessment for this field of study. (Prerequisites: HLTH-730 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

HLTH-732**Health Insurance and Reimbursement**

This course provides an in-depth review of the characteristics of successful health insurance plans with emphasis on cost containment and premium control techniques. Emphasis will be placed on learning various cost containment and quality improvement tools of an effective delivery system and how to apply those tools to different delivery structures. The relationship between shared risk and behavior change is explored as well as basic concepts of health insurance underwriting and the essentials of a successful provider payer partnership. **Lecture 3, Credits 3 (Fall)**

HLTH-733**Health Systems Quality and Organizational Learning**

This course will incorporate an examination of contemporary organizational systems thinking focusing on concepts relevant to health service organizations and their communities; emphasizing organizational quality, leadership, environment, strategy, structure, and processes. The course provides students with the evaluation of key factors affecting an organization's system as well as their community, through quality and analytical thinking; allowing the student to apply theories that suggest an effective organizational response to such influences and change. **Lecture 3, Credits 3**

HLTH-735**Management of Risk in Health Care**

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. This is a required course in the Health Systems Administration program and assignments/ applications are focused on healthcare issues. **Lecture 3, Credits 3 (Spring)**

HLTH-736**Health Care Operations: Building High Reliability Systems**

The challenges and complexities of the current health care environment require a skilled operations leader that will engage high performing teams, develop highly reliable processes, effectively manage expenses, and succeed in achieving desired outcomes in an increasingly competitive market. The increased focus on population health, payment reform pressure, the emergence of risk and value based payment models will challenge traditional healthcare organizations and require leadership focused on change management and performance improvement. The purpose of this course is to provide students the opportunity to analyze the health care organization using both qualitative and quantitative principles of operations management. It provides an integrated system and a set of contemporary operations improvement tools that can be used to make significant gains in any organization. This course is designed to provide the student with an overview of the field, and the ability to use some of the most commonly deployed operations tools and processes. **Lecture 3, Credits 3 (Spring)**

HLTH-737**Lean Sigma in Health Care**

This course teaches the principles Lean-Sigma and the application of its process improvement methodologies (and tools) in a health care environment. The curriculum examines the current challenges encountered in the healthcare industry and how the application of Lean-Sigma techniques can improve overall performance. A specific focus of the course is to learn the methodology used to obtain desired results of streamlining operations and enhancing administrative effectiveness in the clinical, administrative and service segments of health care. **Lecture 3, Credits 3 (Summer)**

HLTH-740**Health Care Leadership**

Highly trained clinical and administrative professionals drive the nature of work in health care. The purpose of this course is to provide students the opportunity to study leadership theory as it is applied in health care organizations. Leadership theories and applications geared toward professionals working in health service organizations will be emphasized. Students will learn to apply leadership theories via case studies and issue analysis of their active work environments. **Lecture 3, Credits 3 (Fall)**

HLTH-746**Leading Health Systems II**

This is the second of three courses in the MHSA program that require students to be on campus. These "immersion" courses will be scheduled over a long weekend and will entail full days on campuses well as pre- and post-course work completed online. The concept is to immerse students in a series of experiences to support their development as high function managers and leaders within the health care industry. This course builds on the first Leading Health Care Systems course and provides a in-depth examination of advanced management and leadership knowledge, skills and values required of contemporary leaders within health care systems. (Prerequisites: HLTH-706 or equivalent course.) **Lecture 3, Credits 3 (Summer)**

HLTH-750**Ethics in Human Subjects 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. **Lecture 3, Credits 3 (Spring)**

HLTH-760**Health IT and Decision Support**

This course is intended to explore current challenges in the health care system, and how the ability to understand and apply health data and associated health care information technology (IT) tools can improve the quality and cost of health care services. Students will learn about regulations, standards, and rules which impact health IT. The course will include a review of current and future health care technology tools and associated data collection, storage and exchange practices; and utilize applied case studies allowing students to demonstrate their ability to use health care information technology systems and data analytics to improve patient and provider outcomes. The role of technology will also be explored as it relates to strategy, adoption levels, care settings, and patient engagement. **Lecture 3, Credits 3 (Fall)**

HLTH-780**Internship**

This course provides the student with the opportunity to apply their graduate coursework to the world of work. Students will be placed or seek out internship opportunities in a work scenario similar to their ultimate career choice in the field. A mentor for the student must be identified in the place of the internship. The role of the mentor will be to work with students to develop a plan for the internship, facilitate the internship experience, and verify the student's accomplishment of specified outcomes as a result of the internship. Once the mentor approves of the plan of work and student accomplishments at the conclusion of the internship they will send this final report to the student's program advisor. (Enrollment in this course requires permission from the department offering the course.) **Internship 3, Credits 3 (Fall, Spring, Summer)**

HLTH-789**Selected Topics**

Selected topics is an innovative course not reflected in the accepted curriculum. Once the outline is submitted titles will appear in the course listing for the semester. The course may be taken more than once as topics change. **Lecture 3, Credits 3 (Fall, Spring, Summer)**

HLTH-794

Integrative Problem Solving

Students will demonstrate synthesis and integration of the theories and foundation principles of their discipline. This will be achieved through application of core knowledge in a series of progressive problem. **Lecture 3, Credits 3 (Fall, Summer)**

HLTH-796

Health Care Strategy: Analysis and Formulation

Having an effective organizational strategy is an essential component of all successful entities. Yet, practicing managers often engage in strategy formulation with very different conceptions of strategy and the strategic process. This course reviews the historical development of modern strategic theory and practice, with a focus on the works of Porter, Mintzberg, and Barney. More importantly, the course will address and utilize various analytical frameworks which infuse the strategic process with intellectual rigor while retaining the essence of strategy that is innovative and creative. **Lecture 3, Credits 3 (Spring)**

HLTH-797

Capstone

This course serves as a culminating experience in which students are expected to apply knowledge gained from their graduate experience to the real field of health care administration. The fundamental goal is to facilitate the research and development of a critical and creative recommendation to a problem or opportunity. Students will work under the guidance of a practicing health care administrator and the course faculty to develop a well researched, effectively written paper. This final course serves as a turning point for the student—from education to professional practice. (This course requires permission of the Instructor to enroll.) **Lecture 3, Credits 3 (Fall, Spring, Summer)**

HLTH-798

Health Systems Analysis and Innovation

This is the final of three courses in the MS HSA program that require students to participate in a first-hand analysis of a health system within the United States or outside our borders. The objective of the analysis is to critically examine and assess the structure, function and achievements of care delivery in a domestic or international health system. Students enrolled in this course must select either the domestic, international, independent study option as described by the program. **Lecture 3, Credits 3 (Summer)**

HLTH-799

Independent Study

Independent Study will provide students with the ability to study in a specialized area with an individual faculty member. Students, with the assistance of a faculty advisor, will propose a course of study. Independent Study students must obtain permission of an instructor and complete the CHST Graduate Independent Study Form to enroll. **Ind Study 1, Credits 1 - 4 (Fall, Spring, Summer)**

Medical Illustration

ILLM-601

Human Gross Anatomy

This course provides an in-depth study of the structure of the human body. Emphasis is on understanding the relationships between anatomical structures as well as their form, texture, and color. Dissection of a human cadaver is supplemented with lectures on the structure and function of the major organ systems. (This course is restricted to ILLM-MFA Major students.) **Lab 9, Credits 6 (Fall)**

ILLM-601

Human Gross Anatomy

This course provides an in-depth study of the structure of the human body. Emphasis is on understanding the relationships between anatomical structures as well as their form, texture, and color. Dissection of a human cadaver is supplemented with lectures on the structure and function of the major organ systems. (This course is restricted to ILLM-MFA Major students.) **Lecture 3, Credits 6 (Fall)**

ILLM-602

Anatomic Studies

Through independent research and acquired understanding of human gross anatomy, students create illustrations designed to support medical or graduate level instruction of Human Gross Anatomy. Course requires students to cognitively illustrate their subjects, rather than creating literal interpretations of their observations. Work is intended for full color print media. (This course is restricted to ILLM-MFA Major students.) **Studio 5, Credits 3 (Fall)**

ILLM-603

3D Modeling of Biomedical Forms

This course introduces strategies to create polygonal models of biomedical subjects. Students will use contemporary research to accurately define structure and suggest function. Instruction will also focus on lighting and "shader" systems that emphasize form and are consistent with tissue characteristics. (This course is restricted to ILLM-MFA Major students.) **Studio 6, Credits 3 (Fall)**

ILLM-606

3D Animation of Biomedical Forms

This course explores animating biomedical subjects and processes. Students will be asked to research contemporary theory defining their subjects' anatomy and create animations consistent with their findings. Frame by frame animation, blend shapes, non-linear deformers, and rigging systems will be introduced to permit students to choose the most effective method for creating motion and transformation. (Prerequisites: ILLM-603 or equivalent course.) **Studio 6, Credits 3 (Spring)**

ILLM-607

Computer Applications in Medical Illustration

Students will learn to use industry-standard raster and vector illustration software to create images based on independent research of medical topics. Students will also use page layout applications to combine digital images with text and other graphic elements. Coursework emphasizes creation of illustrations to support medical education and publishing. (This course is restricted to ILLM-MFA Major students.) **Lecture 2, Credits 3 (Spring)**

ILLM-607

Computer Applications in Medical Illustration

Students will learn to use industry-standard raster and vector illustration software to create images based on independent research of medical topics. Students will also use page layout applications to combine digital images with text and other graphic elements. Coursework emphasizes creation of illustrations to support medical education and publishing. (This course is restricted to ILLM-MFA Major students.) **Studio 3, Credits 3 (Spring)**

ILLM-608

Scientific Visualization

Emerging technologies enable scientists to visualize structures that are otherwise invisible to the naked eye. For example, molecular visualization software allows us to construct highly accurate molecular models from x-ray crystallography and other structural data. Cryo-EM and confocal microscopy are revealing the previously unknown structure of cellular organelles. Medical imaging systems allow us to reconstruct the human body in three dimensions from actual patient data (CT scans, MRI, etc.). This course explores the use of these technologies to provide references for traditional artwork and to export models for digital rendering and animation. (Prerequisites: ILLM-601 or equivalent course.) **Studio 6, Credits 3 (Spring)**

ILLM-612

Surgical Illustration

Students observe and sketch live surgical procedures at a local hospital. After further background research, students translate their sketches into finished illustrations that are used in medical training, patient education, and litigation. Demonstrations of sketching and rendering techniques are supplemented with lectures on general surgical principles and common procedures. (Prerequisites: ILLM-601 and ILLM-607 or equivalent courses.) **Studio 6, Credits 3 (Fall)**

ILLM-615

Interactive Media I

This course is an introduction to two dimensional computer illustration, animation, and interactive media as they apply to contemporary methods of instruction in medicine and allied health. Students will research a current topic in health care and develop interactive lessons that match the instructional objectives of their topic. Students will organize these lessons as a web site. (Prerequisites: ILLM-607 or equivalent course.) **Lec/Lab 6, Credits 3 (Fall)**

ILLM-616

Interactive Media II

This course continues the development of student web sites designed for allied health instruction. Advanced topics in two dimensional computer illustration, animation, and interactive media will be presented. Students will research current topics in health care and continue the development of the interactive lesson begun in the previous class. (Prerequisites: ILLM-615 or equivalent course.) **Studio 6, Credits 3 (Spring)**

ILLM-617

Portfolio and Business Practices

This course helps prepare students to enter the workforce in full-time positions or as freelance illustrators. Students create a traditional portfolio, personal identity package, and marketing materials. The course also introduces important business concepts such as copyright, licensing, pricing, contracts, taxation, and formation of a proper business. (Prerequisites: ILLM-612 or equivalent course.) **Lab 3, Credits 3 (Spring)**

ILLM-617

Portfolio and Business Practices

This course helps prepare students to enter the workforce in full-time positions or as freelance illustrators. Students create a traditional portfolio, personal identity package, and marketing materials. The course also introduces important business concepts such as copyright, licensing, pricing, contracts, taxation, and formation of a proper business. (Prerequisites: ILLM-612 or equivalent course.) **Lecture 2, Credits 3 (Spring)**

ILLM-618**Eye Ear and Nose Prosthetics**

This course provides an introduction to the field of anaplastology, a branch of medicine dealing with the prosthetic replacement or correction of an absent, disfigured, or malformed anatomic structure, usually on the face or limbs. Focusing on maxillofacial prosthetics and ocular prosthetics (artificial eyes), students learn the basic technical skills needed for an internship or apprenticeship in this field. **Fee: There is a \$45 fee for this course** (Prerequisites: This course is restricted to ILLM-MFA students who have successfully completed ILLM-601 or equivalent course.) **Lecture 2, Credits 3 (Spring)**

ILLM-618**Eye Ear and Nose Prosthetics**

This course provides an introduction to the field of anaplastology, a branch of medicine dealing with the prosthetic replacement or correction of an absent, disfigured, or malformed anatomic structure, usually on the face or limbs. Focusing on maxillofacial prosthetics and ocular prosthetics (artificial eyes), students learn the basic technical skills needed for an internship or apprenticeship in this field. **Fee: There is a \$45 fee for this course** (Prerequisites: This course is restricted to ILLM-MFA students who have successfully completed ILLM-601 or equivalent course.) **Studio 3, Credits 3 (Spring)**

ILLM-627**Advanced Digital Technology for Medical Instruction**

Students will work with 3D modeling and animation software along with gaming engines to create interactive learning modules for medical and scientific applications that can be experienced through virtual reality, augmented reality, or mixed reality. **Studio 6, Credits 3 (Spring)**

ILLM-628**Medical and Scientific Animation**

Students will work with 2 dimensional, 3 dimensional and editing software in order to develop a complete animation on the topic of their choice. **Studio 6, Credits 3 (Fall)**

ILLM-689**Special Topics**

This course is an upper division course on a topic of special interest that is not part of a formal curriculum. The course design may differ by topic or faculty member but will include prerequisites, contact hours, and examination/assessment procedures. The level of study is appropriate for students in their final two years of study. (This course is restricted to ILLM-MFA Major students.) **Lec/Lab, Credits 1 - 4 (Fall, Spring)**

ILLM-699**Medical Illustration Graduate Co-op**

The Medical Illustration Grad Co-op will provide students with the opportunity to work with established Medical Illustrators or related businesses to gain on-the-job experience in the profession. Co-ops are typically paid work experiences and can be either part-time (10-15 hrs/wk) or full-time (min. 35 hrs/wk). All co-ops must fall within an RIT term (Fall, Spring, Summer). **CO OP, Credits 0 (Fall, Spring, Summer)**

ILLM-799**Independent Study**

Medical Illustration Independent Study will provide students with the ability to study in a specialized area with an individual faculty member. Students, with the assistance of a faculty advisor will propose a course of study. Medical Illustration Independent Study students must obtain permission of an instructor and complete the Independent Study Permission Form to enroll. **Ind Study, Credits 1 - 6 (Fall, Spring, Summer)**

ILLM-890**Thesis**

Students conduct background research and create a body of artwork on a contemporary medical topic. The artwork is exhibited during one of several graduate thesis shows or during a screening of digital animation and interactive works. The thesis culminates with the production of a written thesis paper that documents the process of creating the work. (This course is restricted to ILLM-MFA Major students.) **Thesis, Credits 1 - 14 (Fall, Spring)**

ILLM-891**Continuation of Thesis**

The Continuation of Thesis course provides students additional semester(s) to complete their thesis research, project, and thesis document **Cont, Credits 0 (Fall, Spring, Summer)**

MEDS-601**Medical Terminology and Structured Medical Information**

An understanding and proper use of medical terminology is critical in the field of health care. Of equal importance is an understanding of how medical information is organized and retrieved. This course is designed for graduate level students interested in expanding their knowledge of medical terminology, related pathophysiology, and the origins of structured medical information. Emphasis is placed on etymology, definition, pronunciation, and correct utilization of terms. The course also includes putting the terminology into practice with the concepts of the organization and retrieval of information through structured medical information systems, e.g. MeSH, PubMed, and the Cochrane Library. **Lecture 3, Credits 3 (Fall)**

MEDS-615**Medical Pathophysiology**

This course is designed as a graduate-level course in pathophysiology, the study of disease and its consequences to human health. It covers mechanisms of cell injury, the homeostatic responses of cells and tissues, and the clinical manifestations of disease, concentrating on the disease states that are most frequently encountered in clinical practice, including infection, cancer, heart disease, and diabetes. The course follows a medical school model by using a clinical case-based approach that promotes active, team-based learning and professional written communication. Students will conduct independent research to create and illustrate a clinical case study. (This course is restricted to ILLM-MFA Major students.) **Lecture 3, Credits 3 (Spring)**

MEDS-620**Histology and Histopathology**

This graduate course in the Medical Illustration (MFA) program combines lecture and laboratory sessions to introduce students to the microscopic anatomy of both normal and pathologic human tissues and organs, with special emphasis given to the relationships between cellular architecture and normal versus altered physiologic function. Students will create illustrations and annotated digital images, and complete a final project designed to teach the etiology and pathogenesis of a chosen disease state to students at a graduate level. (One year of General Biology with lab) (This course is restricted to ILLM-MFA Major students.) **Lab 3, Credits 4 (Fall)**

MEDS-620**Histology and Histopathology**

This graduate course in the Medical Illustration (MFA) program combines lecture and laboratory sessions to introduce students to the microscopic anatomy of both normal and pathologic human tissues and organs, with special emphasis given to the relationships between cellular architecture and normal versus altered physiologic function. Students will create illustrations and annotated digital images, and complete a final project designed to teach the etiology and pathogenesis of a chosen disease state to students at a graduate level. (One year of General Biology with lab) (This course is restricted to ILLM-MFA Major students.) **Lecture 3, Credits 4 (Fall)**

MEDS-630**Human Immunology**

This graduate course in the Medical Illustration (MFA) program will provide an introduction to the fundamental facts and concepts on immunology to include: innate and adaptive immunity; cells, molecules, tissues and organs of the immune "system"; cell communication and interaction; antibody structure and function; and the application of these concepts to infectious diseases, vaccine design, autoimmune diseases, cancer, transplantation, regulation of the immune response, allergic reactions and immunosuppression. Students will gain an understanding of immunological principles and techniques, and their application to contemporary research, with results from instructor's research laboratory. (This course is restricted to ILLM-MFA Major students.) **Lecture 3, Credits 3 (Fall)**

MEDS-689**Special Topics**

This course is an upper division course on a topic of special interest that is not part of a formal curriculum. The course design may differ by topic or faculty member but will include prerequisites, contact hours, and examination/assessment procedures. The level of study is appropriate for students in their final two years of study. **Lecture, Credits 1 - 4 (Fall, Spring, Summer)**

MEDS-799**Independent Study**

Independent Study will provide students with the ability to study in a specialized area with an individual faculty member. Students, with the assistance of a faculty advisor will propose a course of study. Independent Study students must obtain permission of an instructor and complete the Independent Study Permission Form to enroll. **Ind Study, Credits 1 - 6 (Fall, Spring, Summer)**

MEDS-800**Psychology Internship Seminar**

The internship seminar is designed to provide the didactic component to help interns achieve the training competencies required by the American Psychological Association, the accrediting body for training in clinical psychology. Interns will be exposed to a variety of doctoral-level clinical psychology content experts in the local community who discuss the ethical conduct of clinical psychologists within the domains of practice, education, consultation, and research with a focus on empirically supported treatment, addiction, and working with diverse populations. The seminar will provide balanced programming for trainees pursuing work with child and adult populations. (Enrollment in this course requires permission from the department offering the course.) **Seminar 2, Credits 0 (Fall, Spring, Summer)**

Physician Assistant

PHYA-710

Graduate Project I

This is the first of a two-course sequence which will provide the physician assistant student with opportunities to prepare a formal graduate capstone project/paper. Projects may be in the form of: clinical practice essay, PA curriculum development, medically-related community service project, in-depth medical case review, meta-analysis of specific disease / syndrome, or original medical research. This capstone project/paper will build on clinical training and enable students to build skills for life-long learning as problem solvers and critical evaluators of medical and scientific literature. (This course is restricted to students in PHYA-BS with at least 4th year standing or those students with graduate standing in PHYA-MS.) **Ind Study 2, Credits 2 (Summer)**

PHYA-720

Graduate Project II

This course will provide the physician assistant student with continued preparation of a formal graduate project for the PA Program. Projects may be in the form of: clinical practice essay, PA curriculum development, medically-related community service project, in-depth medical case review, meta-analysis of specific disease/syndrome, or original medical research. This course will culminate with the completion of the capstone project/paper which is founded in clinical experience and enables students to build skills for life-long learning as problem solvers and critical evaluators of medical and scientific literature. (This course is restricted to students in PHYA-BS with at least 4th year standing or those students with graduate standing in PHYA-MS.) **Ind Study 2, Credits 2 (Fall)**

PHYA-729

Clinical Epidemiology

This course provides students with a foundation in epidemiological concepts from which infectious and non-infectious diseases manifest in acute and chronic settings. Course focuses on descriptive and analytical research designs, conditions associated with their use, and subsequent strengths and weaknesses. Principles of clinical epidemiology are applied to real-world clinical applications in addressing acute and chronic disease characteristics. (This course is restricted to students in PHYA-BS with at least 4th year standing or those students with graduate standing in PHYA-MS.) **Lecture 3, Credits 3 (Spring)**

PHYA-750

Pediatrics

This mandatory rotation in the field of pediatric medicine provides hands-on clinical exposure and experiences. This builds on solid basic medical knowledge and competencies acquired in the didactic, pre-clinical coursework. (This class is restricted to students in PHYA-BS with at least 4th year standing or PHYAST-BS or those students with graduate standing in PHYA-MS.) **Clinical 15, Credits 4 (Fall, Spring, Summer)**

PHYA-751

Internal Medicine

This mandatory rotation in the field of general medicine provides hands-on clinical exposure and experiences. This builds on solid basic medical knowledge and competencies acquired in the didactic, pre-clinical coursework. (This class is restricted to students in PHYA-BS with at least 4th year standing or those students with graduate standing in PHYA-MS.) **Clinical 15, Credits 4 (Fall, Spring, Summer)**

PHYA-752

Women's Health

This mandatory rotation in the field of obstetrics and gynecologic medicine provides hands-on clinical exposure and experiences. This builds on solid basic medical knowledge and competencies acquired in the didactic, pre-clinical coursework. (This class is restricted to students in PHYA-BS with at least 4th year standing or those students with graduate standing in PHYA-MS.) **Clinical 15, Credits 4 (Fall, Spring, Summer)**

PHYA-753

Emergency Medicine

This mandatory rotation in the field of emergency medicine provides hands-on clinical exposure and experiences. This builds on solid basic medical knowledge and competencies acquired in the didactic, pre-clinical coursework. (This class is restricted to students in PHYA-BS with at least 4th year standing or PHYAST-BS or those students with graduate standing in PHYA-MS.) **Clinical 15, Credits 4 (Fall, Spring, Summer)**

PHYA-754

Surgery

This mandatory rotation in the field of surgery provides hands-on clinical exposure and experiences. This builds on solid basic medical knowledge and competencies acquired in the didactic, pre-clinical coursework. (This class is restricted to students in PHYA-BS with at least 4th year standing or PHYAST-BS or those students with graduate standing in PHYA-MS.) **Clinical 15, Credits 4 (Fall, Spring, Summer)**

PHYA-755

Orthopedics

This mandatory rotation in the field of orthopedic medicine provides hands-on clinical exposure and experiences. This builds on solid basic medical knowledge and competencies acquired in the didactic, pre-clinical coursework. (This class is restricted to students in PHYA-BS with at least 4th year standing or PHYAST-BS or those students with graduate standing in PHYA-MS.) **Clinical 15, Credits 4 (Fall, Spring, Summer)**

PHYA-756

Geriatrics

This mandatory rotation in the field of geriatric medicine provides hands-on clinical exposure and experiences. This builds on solid basic medical knowledge and competencies acquired in the didactic, pre-clinical coursework. (This class is restricted to students in PHYA-BS with at least 4th year standing or PHYAST-BS or those students with graduate standing in PHYA-MS.) **Clinical 15, Credits 4 (Fall, Spring, Summer)**

PHYA-757

Behavioral Health

This mandatory rotation in the field of psychiatric medicine provides hands-on clinical exposure and experiences. This builds on solid basic medical knowledge and competencies acquired in the didactic, pre-clinical coursework. (Matriculation into the fifth year of the PA Program) (This class is restricted to students in PHYA-BS with at least 4th year standing or those students with graduate standing in PHYA-MS.) **Clinical 15, Credits 4 (Fall, Spring, Summer)**

PHYA-758

Family Medicine

This mandatory rotation in the field of family medicine provides hands-on clinical exposure and experiences. This builds on solid basic medical knowledge and competencies acquired in the didactic, pre-clinical coursework. (This class is restricted to students in PHYA-BS with at least 4th year standing or those students with graduate standing in PHYA-MS.) **Clinical 15, Credits 4 (Fall, Spring, Summer)**

PHYA-759

Elective Rotation

This mandatory rotation in an elective field of medicine provides additional hands-on clinical exposure and experiences. This builds on solid basic medical knowledge and competencies acquired in the didactic, pre-clinical coursework. (This class is restricted to students in PHYA-BS with at least 4th year standing or those students with graduate standing in PHYA-MS.) **Clinical 15, Credits 4 (Fall, Spring, Summer)**

PHYA-761

Professional Practice I

This is the first in a sequence of courses designed for the physician assistant student in the clinical setting. The course will cover discipline specific areas including a pulmonary workshop and lectures on topics such as working with a pharmaceutical company, professionalism, and rehabilitative medicine. The course will also include an ongoing Evidence-Based Medicine (EBM) series and physician assistant national certification exam board review. (This class is restricted to students in PHYA-BS with at least 4th year standing or PHYAST-BS or those students with graduate standing in PHYA-MS.) **Lecture 3, Credits 2 (Summer)**

PHYA-762

Professional Practice II

This is the second in a sequence of courses designed for the physician assistant student in the clinical setting. The course will cover discipline specific areas including complementary medicine lectures and professionalism. The course will also include an ongoing Evidence-Based Medicine (EBM) series and physician assistant national certification exam board review. (Prerequisites: PHYA-761 or equivalent course.) **Lecture 3, Credits 2 (Fall)**

PHYA-763

Professional Practice III

This is the last in a sequence of courses designed for the physician assistant student in the clinical setting. The course will cover discipline specific areas including lectures regarding PA workforce issues, coding and billing, social service work and a resume writing workshop. The course will also include an ongoing Evidence-Based Medicine (EBM) series and physician assistant national certification exam board review. (Prerequisites: PHYA-762 or equivalent course.) **Lecture 3, Credits 2 (Spring)**

Wegmans School of Health and Nutrition

Exercise Science

EXSC-650

Exercise Physiology

Exercise Physiology is the scientific basis for the field of Exercise Science. This course provides students with an opportunity to deepen their understanding of the body's responses and adaptations to exercise. Neuromuscular physiology is reviewed along with energy systems and mechanisms of fatigue. The cardiorespiratory system is examined with a focus on control and regulation during activity and there is a look at the physiological components of exercise training. Environmental factors that impact sport activities as well as training techniques which optimize performance will be reviewed. The differences in performance and adaptation that exist between children, adolescents, and adults as well as between males and females will be compared and contrasted. Exercise's influence on long term health and fitness will conclude the course. Laboratory experiences will allow students to integrate and apply the concepts of exercise physiology through investigative experiments. **Lab 3, Credits 4 (Fall)**

EXSC-650**Exercise Physiology**

Exercise Physiology is the scientific basis for the field of Exercise Science. This course provides students with an opportunity to deepen their understanding of the body's responses and adaptations to exercise. Neuromuscular physiology is reviewed along with energy systems and mechanisms of fatigue. The cardiorespiratory system is examined with a focus on control and regulation during activity and there is a look at the physiological components of exercise training. Environmental factors that impact sport activities as well as training techniques which optimize performance will be reviewed. The differences in performance and adaptation that exist between children, adolescents, and adults as well as between males and females will be compared and contrasted. Exercise's influence on long term health and fitness will conclude the course. Laboratory experiences will allow students to integrate and apply the concepts of exercise physiology through investigative experiments. **Lecture 3, Credits 4 (Fall)**

EXSC-689**Topics in Exercise Science**

Topics in Exercise Science engages graduate students to explore topics in exercise science that are either novel findings, of current concern, hold media interest, or require a unique presentation platform. Course content and delivery methods will vary for each course offering, but will include development of professional presentation skills, interpretation of evidence-based resources, and translation to future health and fitness practice. (Prerequisites: MEDS-250 or MEDS-251 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring, Summer)**

EXSC-690**Exercise Science Research**

This course is designed to give students an immersive and hands-on research experience. Students will use knowledge from prerequisite coursework to hypothesize, design, and conduct a research investigation that focuses on some facet of exercise physiology and science. Areas of skill development include hypothesis generation, logistical and ethical considerations of methodology construction, institutional review board submission, safe data collection, and data analysis and interpretation. This class will benefit those who desire an immersive hands-on exposure to conducting scientific research, and who wish to prepare for a career as a healthcare professional or graduate level scientist. (Prerequisites: EXSC-550 and NUTR-560 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

Health and Nutrition

WSHN-600**Principles and Practices of Health Education**

Students will discover fundamental theories, principles and practices of health education to assess, plan, implement and evaluate components of health that challenge our well-being. Students will develop and apply health education skills to promote community and public health. This course helps prepare students to apply for the Community Health Education Specialist (CHES) credentialing examination. **Lecture 3, Credits 3 (Fall, Summer)**

WSHN-624**Advanced Nutrition Science**

This course offers an in-depth exposure to macro and micronutrient metabolism and biochemistry in humans. Nutrient structure, function, and physiological regulations of digestion, absorption, and interactions are examined with translational concepts for conditions of health and disease. This integrated perspective of nutrient metabolism prepares students for advanced study of medical nutrition therapy. **Lecture 3, Credits 3 (Summer)**

WSHN-700**Research Methods in Health and Well-being**

Research Methods in Health and Well-being addresses requisite foundational skills to conduct rigorous, robust, and ethical research into problems related to health, nutrition and well-being. Evidence-based and translational research issues are presented in tandem with design of research studies, measurement approaches, funding opportunities, and research management considerations. **Lecture 3, Credits 3 (Fall)**

WSHN-701**Health and Nutrition Education and Evaluation**

In Health and Nutrition Education and Evaluation, content and research expertise are applied to design effective, theory-based health and nutrition education and establish it as evidence-based. Needs assessment, behavior change models, theories of motivation, and learning styles are presented in the context of planning health and nutrition education and sampling, recruitment, participant retention, instrument development, and data analysis to foster development of evaluation expertise. (Co-requisites: WSHN-700 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

WSHN-702**Dissemination and Implementation Science for Health and Well-being**

Dissemination and Implementation Science for Health and Well-being applies constructs practices, and values of dissemination and implementation sciences to health and well-being education activities. Strategies to foster translation of evidence-based practices to standard practice in public and private programs are applied in an experiential learning format. (Prerequisites: WSHN-700 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

WSHN-710**Health Risk Identification and Management**

This course will explore health risk assessment and management, including determinants of population health; using epidemiological, clinical, and toxicological methods for identifying health hazards. Population health surveillance combined with methods of population health risk assessment will be considered regarding regulatory, economic, and technological approaches to population health risk management. Application of principles will be practiced through the examination of case studies. (Prerequisites: WSHN-700 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

WSHN-715**Culinary and Food Systems Management**

Food supply concepts are integrated with principles and practices to manage food service and culinary operations of all sizes. Topics include food safety and allergen training, food production, inventory control, menu planning, food systems sustainability, fiscal management, technology application, human resource development, marketing. Addresses food systems requirements for dietetics and nutrition pathway of the nutritional sciences degree. Prepares student for supervised experiential learning in culinary and food systems management. **Lecture 3, Credits 3 (Summer)**

WSHN-720**Topics in Health and Nutrition**

Topics in Health and Nutrition engages learners to explore topics of current concern and interest in health and nutrition. Topic-specific literature selection, review, and dissection are the focus of group-based journal club discussions that also foster group facilitation and decision-making skills. Issues of individual interest drive investigative and summative activities that develop abilities in peer review and dissemination, including writing, graphic display, and technology-based modes. **Lecture 3, Credits 3 (Fall, Spring, Summer)**

WSHN-730**Nutritional Assessment and Counseling**

Fundamental principles and techniques of the art and science of nutritional assessment and counseling are developed in this active learning course. Newly acquired skills are utilized in experiences with case studies, simulation mannequins, and volunteers. Digital and technology-driven tools and experiences are incorporated into nutrition assessment and counseling instruction and experiences. In tandem with Medical Nutrition Therapy, this course prepares the student for clinical supervised experiential learning in healthcare settings. (Prerequisite: NUTR-626 or equivalent course.) **Lec/Lab 3, Credits 3 (Spring)**

WSHN-790**Health and Well-being Management Thesis**

Application of writing and research skills and principles in an independent investigation of a focused problem under direction of thesis adviser. Components include review of literature, definition of research aims, data collection and analysis, interpretation and discussion of findings, preparation of written paper following specified guidelines and standards, and oral defense of thesis. Enrollment for 6 credits in one semester or as necessary over multiple semesters for a total of 6 credits. (Prerequisites: WSHN-702 or thesis advisor approval or equivalent course.) **Thesis, Credits 1 - 6 (Fall, Spring, Summer)**

WSHN-791**Continuation of Thesis**

This course provides students additional semester to complete their thesis research, document and defense. **Cont, Credits 0 (Fall, Spring, Summer)**

WSHN-797**Health and Well-being Management Project**

Application of writing and research skills and principles in an independent investigation of a focused problem under direction of a project adviser. Preparation of a Project Report following specified guidelines and standards, and oral presentation of the key report components. (Prerequisites: WSHN-702 or project advisor approval or equivalent course.) **Project 3, Credits 3 (Fall, Spring, Summer)**

WSHN-799**Independent Study**

This course provides the opportunity for independent investigation, under faculty supervision, on a subject matter either not included in existing courses or further investigation of a topic of interest presented in another course. A student-driven, faculty mentored proposal is drafted that describes the plan of work, deliverables expected, evaluation criteria, and possible credit load. **Ind Study, Credits 1 - 4 (Fall, Spring, Summer)**

Nutrition Management

NUTR-610**Integrative Approaches to Health**

This one credit class offers an overview of controversial and accepted integrative health therapies, diet therapies, basic herbal medicine guidelines, and vitamin/mineral supplementation. **Lecture 1, Credits 1 (Fall)**

NUTR-625

Medical Nutrition Therapy I

This course is the first of a two-course series concerned with the review and application of biological metabolism and the interrelationships of nutrients, hormones, enzymes, and other biochemical substances in humans. Modification of nutritional intake to meet nutritional needs altered by diseases and stress as well as the use of alternate methods of feeding (enteral/parenteral) to meet nutritional needs is discussed in depth. This course emphasizes the practical applications of medical nutritional therapy for use with patients/clients. **Lecture 3, Credits 3 (Fall)**

NUTR-626

Medical Nutrition Therapy II

This course is the second of a two-course series concerned with the review and application of biological metabolism and the interrelationships of nutrients, hormones, enzymes, and other biochemical substances in humans. Modification of nutritional intake to meet nutritional needs altered by diseases and stress as well as the use of alternate methods of feeding (enteral/parenteral) to meet nutritional needs is discussed in depth. This course emphasizes the practical applications of medical nutritional therapy for use with patients/clients. (Prerequisite: NUTR-625 or equivalent course.NUTR-625 Prereq) **Lecture 3, Credits 3 (Spring)**

NUTR-650

Community Nutrition

Study of current nutrition issues and delivery of food and nutrition services in the community. The course is designed to allow senior level and graduate students to acquire skills necessary to deliver services in the public health and private sector markets. Individual practicum in community facility is required and arranged by the instructor. (Prerequisite: NUTR-625 or equivalent course.NUTR-625 Prereq) **Lab 4, Credits 3 (Spring)**

NUTR-650

Community Nutrition

Study of current nutrition issues and delivery of food and nutrition services in the community. The course is designed to allow senior level and graduate students to acquire skills necessary to deliver services in the public health and private sector markets. Individual practicum in community facility is required and arranged by the instructor. (Prerequisite: NUTR-625 or equivalent course.NUTR-625 Prereq) **Lecture 2, Credits 3 (Spring)**

NUTR-654

Life Cycle Nutrition

An applied course for the Nutrition Management major regarding the nutritional needs throughout the life cycle. Emphasis is given to nutrition during pregnancy, infancy, early childhood, adolescence, young and middle adulthood, and the elderly. Practicum in facilities delivering nutrition services to these age groups is required. Practicum hours by arrangement. **Lecture 3, Credits 4 (Spring)**

NUTR-654

Life Cycle Nutrition

An applied course for the Nutrition Management major regarding the nutritional needs throughout the life cycle. Emphasis is given to nutrition during pregnancy, infancy, early childhood, adolescence, young and middle adulthood, and the elderly. Practicum in facilities delivering nutrition services to these age groups is required. Practicum hours by arrangement. **Lab 1, Credits 4 (Spring)**

NUTR-655

Nutrition Throughout the Lifecycle

This course emphasizes the interrelationships of social, psychological, physiological, and biochemical factors and their impact on nutrient requirements and recommendations for food intake during specific stages of the life cycle. Emphasis is given to nutrition during pregnancy, infancy, early childhood, adolescence, young and middle adulthood, and the elderly. **Lecture 3, Credits 3 (Spring)**

NUTR-660

Health and Nutrition Research Foundations

This course offers graduate students with limited research experience the opportunity to learn basic research principles and integrate with skills and knowledge from other courses to conduct research in an area of professional interest. The research project includes gathering primary data, assessing and summarizing the data, and sense-making or drawing conclusions from the data. Students will complete activities to gain skills in project management, secondary research development, and Human Subject Research (HSRO) submission. **Lecture 3, Credits 3 (Fall, Summer)**

NUTR-680

Global Food and Nutrition Perspectives

This course provides an overview of global food and nutrition concepts and issues from both developed and developing country perspectives. Topics include breastfeeding, macronutrients and micronutrient problems, food security and access, food emergencies, maternal and child health and the impacts of socio-economic disparities on nutrition status. Also addressed are challenges in food and nutrition policy development, program design and implementation that are unique to global efforts and sustainable development goals (SDGs). Students apply course content and analytical thinking skills to a unique self-selected country and develop dissemination skills by informing others of the unique food, nutrition and health issues. (Co-requisite: NUTR-654 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring, Summer)**

College of Liberal Arts

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Course numbering: RIT courses are generally referred to by their alphanumeric registration label. The four alpha characters indicate the discipline within the college. The final three digits are unique to each course and identify whether the course is noncredit (less than 099), lower division (100-299), upper division (300-599), or graduate level (600 and above).

Unless otherwise noted, the following courses are offered annually. Specific times and dates can be found in each semester's schedule of courses. Prerequisites/corequisites are noted in parentheses near the end of the course description.

Communication and Media Technology

COMM-605 Social Media Analytics and Research

This course focuses on social media research and ethics of applying various methodological approaches to study public data, users and messages. Students will be introduced to a variety of techniques and concepts used to obtain, monitor and evaluate social media content with a focus on how the analytics could inform communication strategies. During the course, students will also learn how to design and evaluate social media-based research studies. **Lec/Lab 3, Credits 3 (Spring)**

COMM-606 Digital Storytelling

This course provides students with a comprehensive understanding of digital storytelling through an analysis of current trends as well as by utilizing hands-on workshop experiences. Students will develop skills such as content strategy, digital storytelling best practices, content production, and audience analysis. Students in the course will develop critical skills to conceptualize, develop and execute an effective digital storytelling project. **Lec/Lab 3, Credits 3 (Fall)**

COMM-702 Communication Theories

Over the course of this term we will cover mass communication theory from its inception as a field of study, to major trends, followed by current applications of previous paradigms, and finally into the development of new theoretical frameworks. While the main focus of this course is the integration of current mass communication theory with an individual and organizational online presence, we will also focus on how digital platforms can inform the future of theoretical research and vice versa. From a practical perspective, students will be able to apply these theories to their integrative approaches in creative digital communication and design. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Seminar 3, Credits 3 (Fall)**

COMM-703 Research Methods in Communication

This course is designed to introduce students to qualitative and quantitative research methods in communication and guide them in choosing the appropriate method for their thesis research project. Topics may include research perspectives, ethics and IRB, variables, sampling methods, reliability and validity, survey, experiments, content analysis, in-depth interview, focus group, observations/ethnography, and mixed methods. (Prerequisites: COMM-702 or equivalent course.) **Seminar 3, Credits 3 (Spring)**

COMM-708 Communication Education

An analysis of and practicum in teaching communication in higher education. Students explore teaching and learning styles, the role of technology in higher education, and teaching assessment methods. Students create teaching resources and gain teaching experience in a college classroom. **Seminar, Credits 3 (Spring)**

COMM-709 Digital Advertising

This course aims to help students understand the strategic use of digital media from both scholarly and professional perspectives, considering both brand and audience viewpoints. This course will cover the types and practices of digital advertising, including search engine optimization, paid search advertising, display advertising, email marketing, social media marketing, and reputation management. **Seminar 3, Credits 3 (Spring)**

COMM-710

Visual Communication

This course explores visual communication, the process through which individuals -- in relationships, organizations, and societies -- create and interpret visual messages. A variety of theories from the disciplines of art history, psychology, communication theory, and graphic design will be discussed to develop methods for analyzing mediated messages. Students analyze visual messages from the following media: print photography, video, film, and the internet. (This course is restricted to COMMTCH-MS Major students.) **Seminar, Credits 3 (Fall)**

COMM-714

Strategic Communication

This course will introduce students to the theory and practice of strategic communication in advertising, public relations, health communication, crisis/risk communication, and/or political communication. This course will cover problem identification, audience research, message creation, and execution of strategic communication activities. It will also cover ethics and strategic communication through digital media. By the end of the course, students should be able to analyze and execute various components to help solve problems or achieve an organization's goals and objectives. **Seminar 3, Credits 3 (Fall)**

COMM-715

Communication Design Principles

An introduction to design theory, history, and design for communication. In a practical, project-oriented setting, students will learn design theory and practice image analysis. Students will apply research, theory, and methodology to create visual communication artifacts using graphic design software. **Lec/Lab 3, Credits 3 (Spring)**

COMM-716

Communication and Identity

This course engages students in an analytical and applied exploration of the connection between self, identity, communication, media, and society. Drawing from classical and contemporary readings, as well as current events, the course will address topics such as identity and discourse, performance, intersectionality, and representation. Communication has been central to the development of ideas about collective and individual identities. Therefore, the course encourages students to critically examine the political implications of identity construction in our social world. Finally, the course examines how popular notions of identity function in media texts, corporate settings, and digital environments. **Lecture 3, Credits 3 (Spring)**

COMM-717

Artificial Intelligence and Communication

Communication has been impacted by automation and advances in information technology, and now artificial intelligence is changing how we interact with socio-technical systems. In this course, we will explore historical, ethical, computational, and cultural perspectives to understand the implications of algorithmic processes on communication and society. During the course, students will learn how to analyze various digital products and identify the potential consequences of algorithmic systems on various demographics. **Lecture 3, Credits 3 (Spring)**

COMM-720

Thesis Preparation Seminar

An introduction to graduate study and research in communication including the theoretical, conceptual, and methodological parameters of communication and its sub-disciplines. Participants will interact with the faculty teaching required and elective communication courses. Attention will be drawn to scholarly writing and research design. When possible, the course is organized in conjunction with the department's colloquium series. (This course is restricted to COMMTCH-MS Major students.) **Seminar 1, Credits 0 (Spring)**

COMM-789

Special Topics Communication

An in-depth examination of a selected aspect of the communication discipline (e.g. strategic communication, technical communication, visual communication, technology-mediated communication, advertising, public relations, journalism). Special Topics in Communication can be taken multiple times provided the topic being studied has changed. (Prerequisite: varies by topic) **Seminar 3, Credits 3 (Fall or Spring)**

COMM-799

Independent Study in Communication

A guided study culminating in a research project that allows students to pursue a subject independently with faculty guidance. Focuses on designing, conducting, and completing an independent study project. **Ind Study, Credits 1 - 3 (Fall, Spring, Summer)**

COMM-800

Communication Thesis/Project

A guided research project that focuses on designing, conducting, and completing a research project. The project culminates in a public presentation and defense. **Thesis, Credits 1 - 6 (Fall, Spring, Summer)**

COMM-890

Continuation of Thesis/Project

A guided research study culminating in an original, systematic, and scholarly study of a significant communication problem. Focuses on designing, conducting, and completing an independent research project. The progress of each project is publicly defended. **Cont, Credits 0 (Fall, Spring, Summer)**

COMM-999

Co-op

One semester of work experience in a professional setting related to the communication major. **CO OP, Credits 0 (Fall, Spring, Summer)**

Criminal Justice

CRIM-660

Project Based Learning in Criminal Justice

This course engages students in research that builds on problem identification and analysis in criminal justice. Topics may include exploration of community issues and views on justice, health and medical approaches to crime problems, practitioner orientations and practices relative to specific issues in criminal justice, and applications of new techniques, such as data science, to contemporary problems. Students will apply theoretical frameworks towards understanding the scope and nature of the problem in the form of working papers. The class culminates in a final project which will involve analysis and evaluation research components addressing the underlying problem/issue/program in consultation with the instructor. (Restricted to students in CRIM-BS/MS or CRIM-MS programs.) **Lecture 3, Credits 3 (Fall)**

CRIM-700

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 blameworthiness. 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. (CRIM-MS) **Seminar, Credits 3 (Fall)**

CRIM-701

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 adviser and the graduate coordinator, qualified students may substitute more specialized statistics courses or courses in such areas as geographical information systems (GIS). (CRIM-MS) **Seminar, Credits 3 (Fall)**

CRIM-702

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. (CRIM-MS) **Seminar, Credits 3 (Fall)**

CRIM-703

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. The prerequisite for this course will be a strong undergraduate foundation in theories of crime and criminality. (CRIM-MS) **Seminar, Credits 3 (Spring)**

CRIM-704

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 emphasize how these critical community dimensions are related to both crime and criminal justice. 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 (e.g., poverty, residential mobility, etc.) and social processes (e.g., social capital, collective efficacy, etc.) 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. Central to this will be a discussion of co-production (i.e., the intersection between formal and informal social control). (CRIM-MS) **Seminar, Credits 3 (Spring)**

CRIM-705

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 on its effectiveness. Detailed attention will be given to prevention/control strategies aimed at both juvenile and adult offenders. Programs will also be examined in the broader context of the ideology and philosophy of justice. Students will become familiar with the state of the art in crime and justice related interventions by studying the theory, practice and evaluation of contemporary crime and justice interventions. (CRIM-MS) **Seminar, Credits 3 (Spring)**

CRIM-706

Current Issues in CJ

This course provides an examination of current issues in criminal justice with an emphasis on the application of evaluation, management, theory and ethics to analysis of criminal justice policy. The goal is to engage students in discussion of current issues with their peers and with experts in the field. (CRIM-MS) **Seminar 3, Credits 3 (Fall)**

CRIM-710

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. (CRIM-MS) **Seminar, Credits 3 (Biannual)**

CRIM-711

Directed Readings in Criminal Justice

This course will be tailored to individual students' research interests as they explore areas of inquiry that may become topics for their thesis research. An emphasis will be placed on building a theoretically informed research question via existing literature and research in criminal justice and other disciplines (economics, psychology, sociology, and so on). Parallel to that effort, students will work to identify locally relevant research questions, potential research designs, and possible projects and/or agencies with whom which to conduct this research. (CRIM-MS) **Seminar 3, Credits 3 (Fall)**

CRIM-712

Crime and Media

This course is designed to analyze and critique the mainstream media's coverage of criminal justice issues, and to study how that coverage impacts society at large. The course will scrutinize, compare and contrast crime coverage of different eras, and will also discuss how that coverage is changing today with around-the-clock media outlets and ubiquitous social media. Among the issues studied will be the impact of crime coverage on public policy; the impact of televised trials; the editorial decisions made daily in newsrooms across America about the placement and priority of crime news; the trademarks that can catapult a crime story into local, regional or even national prominence; and the occasional alliances between law enforcement and media. (CRIM-MS) **Seminar 3, Credits 3 (Biannual)**

CRIM-775

Criminal Justice Capstone

The criminal justice capstone involves guided research on a topic approved by the instructor. The capstone requires students to develop, design and complete an original research project. Satisfactory completion involves the execution of a substantial research paper and includes a public oral presentation. **Project 3, Credits 3 (Fall, Spring)**

CRIM-799

Independent Study

A program of study executed by an individual student with assistance and guidance by an instructor, outside a regular classroom setting. Guidelines for designing and gaining approval for an independent study are provided in College of Liberal Arts Policy I.D. **Ind Study, Credits 1 - 6**

CRIM-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. (Prerequisites: CRIM-700 and CRIM-701 and CRIM-702 and CRIM-703 and CRIM-704 and CRIM-705 or equivalent courses.) **Thesis, Credits 1 - 6 (Fall, Spring, Summer)**

CRIM-890

Continuation of Thesis

The Continuation of Thesis offers the opportunity to fulfill the work plan agreed by the student and the thesis adviser in commencing the thesis project in criminal justice. The goal of the course is to complete the thesis research proposed in a thesis proposal. **Cont, Credits 0 (Fall, Spring, Summer)**

Economics

ECON-620

Environmental Economics

This graduate 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 governments to deal adequately with pollution and other environmental problems. While there is not a formal prerequisite for the course, some background in economics is very helpful. **Lecture 3, Credits 3 (Spring)**

ECON-701**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 class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Biannual)**

English**ENGL-610****Transnational Digital Creation Workshop**

The Transnational Digital Creation Workshop is a project-based study abroad experience for students interested in storytelling, digital literature, interactive narrative, digital installation, new media design and technology, human-computer interaction, film, animation, photography, narrative, arts and culture, or global digital cultures. The workshop explores digital writing and transnational collaboration through its methods, its themes, and its practical preparation of students to travel to another country, learning about its official language and culture, as well as prominent digital arts and literary traditions, past and present. The course explores a specific country's cultural and artistic contexts and uses these as the basis for collaborative digital creation projects that students develop with their transnational peers (via videoconferencing, online communication, and through travel to the location to collaborate on-site). The course's transnational research and creation projects provide students with an opportunity to creatively explore themes of global concern, cross-cultural communication, language, and computation-based writing (as the latter is inflected by local and global influences) in one or more ways. This interdisciplinary workshop enables students to put their digital arts, creative writing, literary, and cross-cultural communication skills into practice in new ways, to build their professional portfolio, and to experience working on a cross-cultural team with specific linguistic, cultural, institutional, and site-specific opportunities, challenges, and parameters. **Seminar 3, Credits 3 (Spring, Summer)**

ENGL-681**Natural Language Processing I**

This course provides theoretical foundation as well as hands-on (lab-style) practice in computational approaches for processing natural language text. The course will have relevance to various disciplines in the humanities, sciences, computational, and technical fields. We will discuss problems that involve different components of the language system (such as meaning in context and linguistic structures). Students will additionally work on modeling and implementing natural language processing and digital text solutions. Students will program in Python and use a variety of relevant tools. Expected: Programming skills, demonstrated via course work or instructor approval. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall)**

ENGL-682**Natural Language Processing II**

Study of a focus area of increased complexity in computational linguistics. The focus varies each semester. Students will develop skills in computational linguistics analysis in a laboratory setting, according to professional standards. A research project plays a central role in the course. Students will engage with relevant research literature, research design and methodology, project development, and reporting in various formats. (Prerequisite: ENGL-681 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

ENGL-684**Speech Processing II**

This course introduces students to speech and spoken language processing with a focus on real-world applications including automatic speech recognition, speech synthesis, and spoken dialog systems, as well as tasks such as emotion detection and speaker identification. Students will learn the fundamentals of signal processing for speech and explore the theoretical foundations of how human speech can be processed by computers. Students will then collect data and use existing toolkits to build their own speech recognition or speech synthesis system. This course provides theoretical foundation as well as hands-on laboratory practice. **Lecture 3, Credits 3 (Fall)**

ENGL-690**Creative Writing Workshop**

This course is for graduate students who want to explore creative writing. The focus will be on the generation and refinement of creative writing with an awareness of aesthetic principles and narrative techniques. Ongoing work will be discussed regularly with workshop groups, which will help students rethink their work and become better editors. Through reading, writing, discussion, critique, and revision, students will see their own writing in a larger aesthetic and historical context, culminating in a substantial body of work ready for publication. Students will lead a discussion about at least one of the readings; circulate their work to at least two venues; read their own work at least once in a public event; and produce an individual final project that, as applicable, connects with their thesis. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Spring)**

Experimental Psychology**PSYC-600****Field Experience I: Professional School Psychology Foundations**

The purpose of the course is to introduce students to the field of school psychology. The student will participate in field and in-class activities enabling them to obtain firsthand knowledge and familiarity with the roles and functions of school psychologists, along with an introduction to the expected competencies required of school psychologists by state and national accrediting bodies. Field experiences will also give students the opportunity to gain firsthand knowledge and familiarity with school systems, collaborative problem solving, micro-skills in counseling, classroom management, and relevant professional and legal issues. (This course is restricted to SCPSYC-ACT or SCPSYC-MS Major students.) **Lecture 3, Credits 3 (Fall)**

PSYC-601**Field Experience II: Professional School Psychology Foundations**

The purpose of the course is to continue to immerse students in the field of school psychology. The student will participate in field and in-class activities enabling them to obtain firsthand knowledge and familiarity with current topics and issues that impact school psychologists. Field experiences will also give students the opportunity to gain firsthand knowledge and familiarity with the necessary competencies required of school psychologists by state and national accrediting bodies. These competencies and topics may include, but are not limited to: collaborative problem solving, bullying, learning disabilities, evidence based interventions, counseling, consultation, classroom management, applied behavioral interventions, curriculum based measurement, and relevant professional and legal issues. (This course is restricted to SCPSYC-ACT or SCPSYC-MS Major students.) **Lecture 3, Credits 3 (Spring)**

PSYC-603**Ethical and Legal Issues**

This course reviews the laws and ethical principles that affect the practice of school psychologists within a school-community systems context. (This course is restricted to SCPSYC-ACT or SCPSYC-MS Major students.) **Seminar, Credits 3 (Spring)**

PSYC-620**Interpersonal Intervention Skills**

This course presents counseling theories, techniques and strategies for working with children and adolescents and their families. It is designed to develop basic counseling and crisis intervention skills. Three areas that are given the most attention are developing one's counseling knowledge base, developing one's basic psychotherapeutic communication skills and developing one's self awareness. (This course is restricted to SCPSYC-ACT or SCPSYC-MS Major students.) **Lecture 3, Credits 3 (Fall)**

PSYC-630**Academic Assessment**

Students of this course 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 measurement. Extensive practice will be given in the administration and scoring of standardized assessment procedures. Emphasis will be placed on the use of various academic assessment procedures in schools and other settings. (This course is restricted to SCPSYC-ACT or SCPSYC-MS Major students.) **Lecture 3, Credits 3 (Fall)**

PSYC-631**Cognitive Assessment**

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. (This course is restricted to SCPSYC-ACT or SCPSYC-MS Major students.) **Lecture 3, Credits 3 (Spring)**

PSYC-632**Social-Emotional Assessment**

This course uses interviews, behavioral observations, rating scales, and projective measures for the assessment of child and adolescent personality and adaptive behavior. Students gain experience in administering, interpreting, and reporting results of measures currently used in the practice of psychology in the schools. **Lecture 3, Credits 3 (Spring)**

PSYC-640**Graduate Statistics**

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 include one- and two-sample inferential procedures, interval estimation, correlation, nonparametric tests, linear regression, and analysis of variance. Students will learn to integrate concepts with computer applications. Course content will be taught through lectures, discussion, and applied data analysis exercises. Student mastery of the material will be evaluated through small group discussion of data set analyses, written results of the analyses following APA style, and two exams. **Lecture 3, Credits 3 (Fall, Spring, Summer)**

PSYC-611

Applied Psychology Methods

This course explores various types of applied research methods as well as important methodological issues and concepts in areas of applied psychology. Methodologies studied include experimentation, quasi-experimentation, content analysis, surveys, and interviews. Methodological issues cover research ethics, reliability, threats to internal and external validity, demand characteristics, volunteer participant problems, and issues in sampling. **Lecture 3, Credits 3 (Fall)**

PSYC-642

Graduate Research Methods

This course provides students with sufficient background in the skills and knowledge necessary to be able to conduct psychological research on a wide variety of problems. In addition to introducing students to numerous research methods used in the discipline, the course will also assist students in planning their thesis research proposal. In parallel with covering core topics in research methodology (such as varieties of data, the role of theory and models in science, psychophysiological methods, subjective methods, and experimental design) the course is designed to guide students through the process of creating a feasible research proposal. Students will also use data to test their designs and practice their analyses. (This course is restricted to EXPSYC-MS Major students.) **Lecture 3, Credits 3 (Fall, Spring, Summer)**

PSYC-650

Applied Behavior Analysis

This course reviews scientifically-based principles, concepts, and methods of behavior analysis. Topics covered include behavioral assessment, data analysis, and approaches to behavior change. A special focus is on the functional behavioral assessment process within schools. Students will learn to develop assessment-based behavior intervention plans, which are tailored to the unique needs of individual students, through a collaborative problem-solving process involving families and school staff. (This course is restricted to SCPSYC-ACT or SCPSYC-MS Major students.) **Lecture 3, Credits 3 (Spring)**

PSYC-699

Psychology Co-op

Co-op in psychology. CO OP, **Credits 0**

PSYC-701

Advanced Practicum I: Issues in Diversity

The purpose of the course is for students to continue to participate in supervised field experiences in school/clinical settings along with a didactic component emphasizing the development and application of a multicultural and contextual lens within their field experiences. Students will gain knowledge necessary to work effectively with students from a wide variety of contextual, cultural, and linguistic backgrounds. Topics include but not limited to: multicultural theory, culture, cultural identity, social class, race and ethnicity, gender issues, religion and spirituality, and sexual orientation. (Prerequisites: PSYC-600 and PSYC-601 or equivalent courses.) **Seminar, Credits 3 (Fall)**

PSYC-702

Advanced Practicum II: Issues in Diversity

The purpose of the course is for students to continue to participate in supervised field experiences in school/clinical settings along with a didactic component emphasizing the development and application of a multicultural and contextual lens within their field experiences. Students will begin to apply their knowledge and available resources to further develop the skills necessary to work effectively with students from a wide variety of contextual, cultural, and linguistic backgrounds. Topics include but not limited to: ecological models, developmental contextualism, oppression, resilience, privilege and power, immigration and acculturation, and multicultural assessment. (Prerequisites: PSYC-600 and PSYC-601 or equivalent courses.) **Lecture 3, Credits 3 (Spring)**

PSYC-710

Developmental Psychopathology

This course presents a developmental-systems perspective and disorder-specific models of child and adolescent psychopathology. The course emphasizes (a) a conceptual understanding of specific psychological disorders, (b) the current literature on evidence-based assessment and intervention, (c) service delivery systems, and (d) the school psychologist's role in service delivery and in disseminating information to the schools and families. (Prerequisites: PSYC-713 or equivalent course) **Seminar, Credits 3 (Fall)**

PSYC-711

Graduate Biopsychology

A graduate level introduction to the field of behavioral neuroscience, the study of neurobiological basis of cognition and behavior. Topics include neuroanatomy and physiology, localization of function, brain injury, research methods in behavioral neuroscience, and biological basis of learning, language, memory, emotion, conscious states, sexual behavior, etc. **Lecture 3, Credits 3 (Spring)**

PSYC-712

Graduate Cognition

This course will survey theoretical and empirical approaches to understanding the nature of the mental processes involved in attention, object recognition, learning and memory, reasoning, problem solving, decision-making, and language. The course presents 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. **Seminar, Credits 3 (Spring)**

PSYC-713

Graduate Developmental Psychology

This course is designed to enhance students' knowledge and skills with regard to infant, child, and adolescent development. We will examine a variety of topics that relate to the physical, cognitive, and social-emotional development of children and adolescents in the context of classic and current theory. We will also explore issues such as attachment, resiliency, and policy issues that pertain to positive child and adolescent development. Students will gain an enhanced knowledge of the sequence of child development and the processes that underlie it by studying child development from a chronological approach. Theories that discuss the various domains of development will be examined through each age period. This course will emphasize the interdependence of all domains of development and contribute to an appreciation of the interrelatedness of theory, research, and applications. **Seminar, Credits 3 (Fall)**

PSYC-714

Graduate Engineering Psychology

In this course the students will learn to recognize the integrated (systems) nature of Engineering Psychology, the centrality of human beings in systems design, and to use the topics covered and the available knowledge base to adapt the environment to people. This course will cover several fundamental models of human information processing in the context of human-system interactions. The models may include but are not limited to Signal Detection Theory, Information Theory, theories of attention, both normative and naturalistic decision-making models, Control Theory, and the Lens Model of Brunswick, as well as models of the human as a physical engine, that is, anthropometry, biomechanics, and work physiology. Most topics include readings in addition to the course text as well as a lab exercise with a detailed lab report. **Seminar, Credits 3 (Biannual)**

PSYC-715

Graduate Perception

The course is designed to provide students with a deeper understanding of topics in perception. This course will be organized such that students will work in groups on various projects as well as covering topics through readings and classroom discussion. The topics may include, but are not limited to: spatial frequency perception; aftereffects, 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 music and speech perception. The goal is to cover current research and theories in perception, looking at current developments and their antecedents. The course will be divided into various modules. Students will be assigned readings relevant to each section of the course, and will be expected to master the major concepts. Group discussion of the readings will complement lectures where the instructor will present relevant background material. There will also be laboratory time for the students, where they will examine empirical findings in perception, and develop their research skills in the field. **Lecture 3, Credits 3 (Biannual)**

PSYC-716

Graduate Social Psychology

This course explores topics related to understanding individuals in a social context. Topics may include, but are not limited to: Social Perception and Social Cognition; Attitudes; Social Identity; Prejudice and Discrimination; Interpersonal Attraction; Close Relationships; Social Influence; Prosocial Behavior; Aggression; Group Behavior; Artifacts and Methodological Issues in Social Psychology. Course format is seminar focused on reading assigned texts each week, writing reaction papers, and participating in discussion. Students will also conduct a study on the topic of their choice and present their findings both in an oral and written format. **Seminar, Credits 3 (Biannual)**

PSYC-717

Advanced Graduate Statistics

This course introduces students to more advanced inferential parametric and non-parametric data-analysis techniques commonly used in psychological research, but not covered (or not covered in depth) in the Graduate Statistics course. These techniques may include, but are not limited to: Reliability Analysis, Multiple Regression, Discriminant Analysis, Logistic Regression, Factor Analysis, Analysis of Covariance, Multivariate Analysis of Variance, Contrast Analysis, Mediator and Moderator Variable Analysis, Non-Parametric Tests, and Multi-level Modeling. 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. (Prerequisites: PSYC-640 or equivalent course.) **Lecture 3, Credits 3 (Biannual)**

PSYC-718**Clinical and Experimental Neuropsychology**

A graduate level introduction to the fields of clinical and experimental neuropsychology. Topics include the historical and theoretical underpinnings of modern neuropsychology and methods used to assess cognitive function including their selection, application, and interpretation. Disorders associated with damage to the brain and how they are assessed and managed will also be covered. **Seminar 3, Credits 3 (Biannual)**

PSYC-719**Human Factors in Artificial Intelligence**

This course will provide students with fundamental information for human-centered design of applications of artificial intelligence. There are three parts to the course: The first part is about methods of design and evaluation. The second part introduces students to the psychology of sensation and perception, memory, attention, judgment, decision-making, and problem solving, as well as human error and reliability. Finally, students will become familiar with design principles as they apply to displays and controls, human-computer interaction, human-automation interaction, and human-centered automation. Guest lectures and case studies will be examined to illustrate topics covered in it and to provide a survey of the current state of AI research, development, and controversies. Ethics and moral responsibility in technology development, with links to current policy debates, are also discussed in this context. **Lecture 1, Credits 1 (Fall)**

PSYC-720**Advanced Consultation**

This course focuses on the development of beginning competencies in consultation that will help students assist school professionals in building capacity to deliver effective services. Contextual influences on school consultation, models of consultation, and the stages of the consultation process within a problem-solving model will be emphasized. Issues relevant to individual case and classroom consultation will be covered. (Prerequisites: PSYC-620 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

PSYC-721**Academic Intervention**

Most referrals to school psychologists involve some sort of learning problem. What variables affect school learning? Are some influences more important than others? Which of these influences are alterable and therefore available as interventions to improve learning? What classroom strategies work best? We will examine theories of school learning 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. Students will learn to critically evaluate the instruction provided to a particular student in a given content area. In addition, students will learn to assess academic functioning within the learning environment, identify specific target areas for intervention, set appropriate goals and objectives, monitor student progress toward those goals and objectives, and evaluate the effectiveness of the intervention(s) in place as a result of the assessment. Students are expected to leave this course with a cursory understanding of the problem-solving process and the development and monitoring of effective interventions, and basic competence in applying this process. (Prerequisites: PSYC-630 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

PSYC-722**Advanced Counseling**

This course focuses on the refinement of counseling skills used with children and adolescents in individual and group counseling. Students will integrate theory, research and processes relative to individual and group work within cognitive-behavioral and solution-focused theoretical models. Students will consult with parents and teachers as they develop treatment plans, counseling interventions, progress monitor interventions, and write recommendations. Crisis intervention and group behavior management will also be addressed. This course is offered to second-year students matriculating in the school psychology program. (Prerequisites: PSYC-620 or equivalent course.) **Seminar, Credits 3 (Fall)**

PSYC-723**Systems and Organizational Interventions**

This course will assist students in building their consultation skills, with an explicit focus on systems-level issues and interventions. Students will learn principles of population-based prevention and intervention services and family-school collaboration. An array of evidence-based schoolwide interventions will be explored in depth with a focus on the role of the school psychologist within the larger system. (Prerequisites: PSYC-620, PSYC-630, PSYC-650 and PSYC-721 or equivalent courses.) **Lecture 3, Credits 3 (Spring)**

PSYC-730**Comprehensive Assessment Integration**

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 multidisciplinary evaluation teams. This course is offered to second-year students matriculating in the school psychology program. (Prerequisites: PSYC-631 and PSYC-632 or equivalent courses.) **Seminar, Credits 3 (Fall)**

PSYC-750**Internship**

The 1200-hour internship is the culminating experience in the school psychology program. 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. (All course work completed and faculty approval) (Enrollment in this course requires permission from the department offering the course.) **Internship, Credits 3 (Fall, Spring, Summer)**

PSYC-751**Graduate Research Seminar**

The guiding principle of Graduate Research Seminar is that it provides students the opportunity to begin examining potential thesis topics during the student's first semester in the program. The course will involve faculty presentations of their research offered weekly through the semester. (This course is restricted to EXPSYC-MS Major students.) **Seminar, Credits 0 (Fall)**

PSYC-752**Thesis Proposal**

The Thesis courses will vary widely but will fulfill the work plan agreed by the student and the adviser. The guiding principles of the Thesis Proposal course are to initiate thesis research including selecting a thesis advisor, choosing and defining a topic, surveying relevant research literature, and planning the research. To complete the course, the student will successfully submit and defend a thesis proposal, which is a detailed and complete plan of the thesis research. The thesis proposal should include exhaustive review of relevant literature, statement of the student's thesis, formulation of hypotheses, operational definitions of independent and dependent variables, and a detailed procedure for carrying out the research. The proposal may also include a section on anticipated results with a detailed plan for analysis of data. (This course is restricted to EXPSYC-MS Major students.) **Thesis, Credits 3 (Spring)**

PSYC-753**Thesis**

The Thesis courses will vary widely but will fulfill the work plan agreed by the student and the thesis adviser. The guiding principle of the Thesis course is to complete the thesis research proposed in Thesis Proposal. The Thesis course consists of carrying out the thesis research, including collection and analysis of data, and completion and public defense of the thesis document for partial fulfillment of the requirements of the degree. (This course is restricted to EXPSYC-MS Major students.) **Thesis, Credits 3 (Fall)**

PSYC-754**Graduate Psychology Capstone**

This is a project-based course for students enrolled in the MSc Experimental Psychology non-Thesis track focusing on discipline-specific scientific communication skills in the area of Psychology. The capstone course will provide students the opportunity to combine and incorporate knowledge and skills learned in prior coursework and experiences and demonstrate their ability to apply this knowledge in various assignments. A variety of written projects (white paper, focused literature review, and a resume) and an oral presentation will be required and should allow students to demonstrate proficiency in the Program. **Project 3, Credits 3 (Fall, Spring)**

PSYC-757**Special Topics in School Psychology**

This course is designed to allow the student to focus on a given special topic or area of research relative to school psychology. Such topics or activities may include selected readings, assessment techniques, direct intervention skills, or indirect intervention skills. This course may be offered from 1 to 3 credit hours depending on the specific topic covered. (This course is restricted to SCPSYC-ACT or SCPSYC-MS Major students.) **Lecture 3, Credits 1 - 3 (Fall, Spring)**

PSYC-790**Continuation of Thesis**

Restricted to gpsa graduate program only. Must have permission of department to register for this course. **Cont, Credits 0 (Fall, Spring, Summer)**

PSYC-798**Advanced Research in Psychology**

Practicum open to MSc Experimental Psychology students. This course gives the student first-hand experience in the field of Psychology. The experience may involve a specific research project or other relevant professional development projects independent of the student's thesis research. Students are closely supervised by a faculty member and will develop skills and gain experience in relevant advanced research and professional development in Experimental Psychology. (This course is restricted to EXPSYC-MS Major students.) **Research 3, Credits 3 (Fall, Spring, Summer)**

PSYC-799**Independent Study**

A program of study executed by an individual student with assistance and guidance by an instructor, outside a regular classroom setting. Guidelines for designing and gaining approval for an independent study are provided in College of Liberal Arts Policy I.D. **Ind Study, Credits 1 - 6 (Fall, Spring, Summer)**

Fine Arts

FNRT-776

Visual Culture

FNRT-776 is a graduate-level counterpart to FNRT-476. As such, students enrolled under the 776 number will be required to read the otherwise recommended reading; meet with the professor outside of class for an additional weekly discussion; and produce a final project that connects with their thesis work. Following current debate in the Journal of Visual Culture and calls for upcoming conferences on Visual Culture, graduate students will approach images as sites of gesture and as agents of intellectual productivity. Visual Culture studies recognize the predominance of visual forms of media, communication, and information in the contemporary world, investigating both "high" cultural forms such as fine art, design, and architecture and popular "low" cultural forms associated with mass media and communications. Visual Culture studies represents a turn in the discourse of the visual, which had focused on content-based, critical readings of images, and has since broadened its approach to additionally question the ways in which our consumption and production of images and image based technologies are structured. Analyzing images from a social-historical perspective, visual culture asks: what are the effects of images? Can the visual be properly investigated with traditional methodologies, which have been based on language, not imagery? How do images visualize social difference? How are images viewed by varied audiences? How are images embedded in a wider culture and how do they circulate? (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall)**

FNRT-777

Imag(in)ing Rochester

FNRT-777 is a graduate-level counterpart to FNRT-477. Students enrolled under the 777 number will be required to read the City and Culture Reader in addition to regular course readings; meet with the professor outside of class for an additional weekly discussion; and produce a final project that connects with their thesis work. Examining the ways in which culture, ethnicity, languages, traditions, governance, policies and histories interact in the production of the visual experience, graduate level students will approach the campus of RIT and the city of Rochester and their various urban spatial forms as image experiences, subject to interpretative strategies and the influence of other discourses. We will wander the well-traveled and the unbeaten paths, participating in and interrogating a wide range of our campus' and city's treasures and embarrassments, secrets and norms. In addition to these field trips, we will be reading from literature and cultural studies, as well as viewing films, advertisements and websites, and possibly attending theatrical and music performances or sporting events. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall)**

FNRT-783

Traumatic Images

FNRT-783 is a graduate-level counterpart to FNRT-483. Students enrolled under the 783 number will be required to read extensively in trauma theory, especially Cathy Caruth, Ruth Leys, Lisa Saltzman, and Eric Rosenberg. This theoretical discourse will contextualize course readings and material. Students will also meet with the professor outside of class for an additional weekly discussion; and produce a final project that connects with their thesis work. Traumatic Images investigates visual culture and its imagistic response to life's crises. Problems of identity and identification will be explored and confronted through works of photography, painting, mixed media, new media and film of the 19th, 20th, and 21st Centuries. Beginning with the late 19th Century vogue for images of hysterical women, crippled black-sheep family members and dead loved ones (as corpses and as ghosts), we then move on to consider the last century's fascination with pain and suffering, disease and violence, struggle and survival and then the 21st century's emphasis on terrorism. Specifically, we will focus on the gendering of images and imaging as disturbing pictures work to defy the formal and theoretical distinction between private and public, personal and collective experience and manage the often conflicting responsibilities to self, family, religion, race, nation and society. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Spring)**

FNRT-784

Art of Dying

FNRT-784 is a graduate-level counterpart to FNRT-484. Under the 784 number, graduate students will explore various disciplinary critiques of mourning practices and attitudes toward death. This interdisciplinary discourse will contextualize concepts of pathography and autopathography. Students will also meet with the professor outside of class for an additional weekly discussion; and produce a final project that connects with their thesis work. This course explores the experience of dying—a profoundly human and universal experience—as it is represented by artists who are themselves facing immanent 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 and writers living with and dying of disease—such as AIDS, cancer, and cystic fibrosis—as well as mortality and age. Topics such as aesthetics, artistic media, representation, grief, bereavement, illness, care-giving, aging, and the dying process will be considered within the context of issues of race, class, ethnicity, sexuality, gender, and community values. Some of the artists covered will be Jo Spence, Hannah Wilke, Elias Canetti, Bob Flanagan, Herve Guibert, Tom Joslin, Laurie Lynd, Audre Lorde, Charlotte Salomon, Keith Haring, Frida Kahlo, Bas Jan Ader, Ted Rosenthal, Felix Gonzalez Torres, Keith Haring, Eric Steel, Derek Jarman, Eric Michaels, and David Wojnarowicz. We will also explore some of the critical theory of Roland Barthes, Michel Foucault, Elaine Scarry, Susan Sontag, and Ross Chambers. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Spring)**

FNRT-799

Independent Study - Graduate

Independent Study - Graduate **Ind Study, Credits 1 - 12**

Philosophy

PHIL-703

Seminar in Art and Aesthetics

What is the relationship between art and knowledge, art and truth, art and politics, art and philosophical theory? What role is played in criticism by art theory, by considerations of the artists' intentions, by ethics and other forms of cultural criticism? What makes an interpretation of an artwork valid or invalid? How is aesthetic value related to other values? The questions discussed are philosophical questions about art and aesthetic experience. The meetings in this course are not lectures but discussions, and participation is required of all students. Since the theories and examples discussed are mostly from the Western canon, familiarity with the history of Western art is recommended. Graduate level elective. (This course is restricted to CIAS Graduate students.) **Lecture 3, Credits 3 (Fall)**

PHIL-799

Independent Study

A program of study executed by an individual graduate student with assistance and guidance by an instructor, outside a regular classroom setting. Guidelines for designing and gaining approval for an independent study are provided in College of Liberal Arts Policy I.D. (Enrollment in this course requires permission from the department offering the course.) **Ind Study, Credits 1 - 6 (Fall, Spring)**

Politics

POLS-641

Peacekeeping and Conflict Transformation

This course will provide an introduction to the dynamics of stabilization & reconstruction, and will address the complexities of the transformation from war to peace where the political, security, rule of law and economic elements are complex and interdependent. Students will discuss these patterns in the cases in Eurasia, the Middle East and Africa. M.Sc students will practice the type of analysis, planning, operations, and reporting used in national and multi-lateral agencies. **Lecture 3, Credits 3 (Summer)**

POLS-642

War, Diplomacy, and State-Building

This course will explore the process by which states disintegrate and fail, the armed conflicts that follow, and international peacekeeping and subsequent efforts to build institutions at the end of armed conflicts. It will consider cases in Eurasia, the Middle East and Africa. Students will consider the role of domestic and international actors, such as NATO, the US Government, the UN. They will explore these efforts in readings, class discussion, debates, presentation of research, and role-playing exercises. M.Sc. students will also practice the type of analysis, assessment and reporting used in national and multilateral agencies about these conflicts. **Lecture 3, Credits 3 (Summer)**

School Psychology

SPSY-610

Advanced Developmental Psychology

This course is designed to enhance students' knowledge and skills with regard to infant, child, and adolescent development. We will examine a variety of topics that relate to the physical, cognitive, and social-emotional development of children and adolescents in the context of classic and current theory. We will also explore issues such as attachment, resiliency, and policy issues that pertain to positive child and adolescent development. Students will gain an enhanced knowledge of the sequence of child development and the processes that underlie it by studying child development from a chronological approach. Theories that discuss the various domains of development will be examined through each age period. This course will emphasize the interdependence of all domains of development and contribute to an appreciation of the interrelatedness of theory, research, and applications. (This course is restricted to SCPSYC-ACT or SCPSYC-MS Major students.) **Seminar, Credits 3 (Fall)**

SPSY-640

Statistics

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 include one- and two-sample inferential procedures, interval estimation, correlation, nonparametric tests, linear regression, and analysis of variance. Students will learn to integrate concepts with computer applications. Course content will be taught through lectures, discussion, and applied data analysis exercises. Student mastery of the material will be evaluated through small group discussion of data set analyses, written results of the analyses following APA style, and two exams. This course is required for all students matriculating in the school psychology program. Non-matriculating students may take the course with instructor approval. (This course is restricted to SCPSYC-ACT or SCPSYC-MS Major students.) **Lecture 3, Credits 3 (Fall)**

SPSY-641

Research Methods

This course explores various types of applied research methods as well as important methodological issues and concepts in areas of applied psychology. Methodologies studied include experimentation, quasi-experimentation, analysis of qualitative data, surveys, and assessment research. A review and analysis of factors affecting both the knowledge to be gained from research and the quality of applied research include philosophy of science, research paradigms, ethics, reliability, and threats to validity. (This course is restricted to SCPSYC-ACT or SCPSYC-MS Major students.) **Lecture 3, Credits 3 (Spring)**

SPSY-711

Graduate Biopsychology

A graduate level introduction to the field of behavioral neuroscience, the study of neurobiological basis of cognition and behavior. Topics include neuro-anatomy and physiology, localization of function, brain injury, research methods in behavioral neuroscience, and biological basis of learning, language, memory, emotion, conscious states, sexual behavior, etc. (This course is restricted to SCPSYC-ACT or SCPSYC-MS Major students.) **Lecture 3, Credits 3 (Fall, Spring)**

SPSY-753

Thesis

This course provides students with the opportunity to conduct original research. The purpose of the course is for students to apply concepts they learn in research methods and inferential statistic course as well as experience the scientific method at a deeper level. The thesis is an optional requirement for those in the MS school psychology program, however, it is a requirement for the advanced graduate certificate. (Permission from instructor) (This course requires permission of the Instructor to enroll.) **Thesis, Credits 1 (Fall, Spring)**

Science, Technology and Society

STSO-621

Graduate Biodiversity and Society

This course explores the problems, issues, and values stemming from the current massive loss of biodiversity. Various justifications for preserving or conserving biodiversity will be examined. Although principals of conservation biology are presented, the social/cultural dimensions of the issue will be emphasized. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Spring)**

STSO-710

Graduate Science and Technology Policy Seminar

Examines how federal and international policies are developed to influence research and development, innovation, and the transfer of technology in the United States and other selected nations. Students in the course will apply basic policy skills, concepts, and methods to contemporary science and technology policy topics. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Seminar, Credits 3 (Fall)**

STSO-750

Graduate Sustainable Communities

The concept of sustainability has driven many national and international policies. More recently, we have become aware that unless we physically build and rebuild our communities in ways that contribute to sustainability, making progress toward that goal is unlikely. It is equally important to recognize the social/cultural context of sustainability. In addition, it is at the local level that the goals of equity (a key consideration in community sustainability), most often achieved through citizen participation and collaborative processes are most easily realized. This course will broaden students understanding of the concept of sustainability, particularly the concept of social sustainability. This course focuses on sustainability as a way to bring light to the connections between natural and human communities, between nature and culture, and among environmental, economic, and social systems. Working closely with local organizations, students will explore the applicability of theoretical concepts. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall)**

STSO-789

STSO Graduate Special Topics

Allows examination of a special problem or topical area in the field of STS or environmental studies at the graduate level. Topics and specific content and methods vary from year to year or semester to semester. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall, Spring)**

School of Individualized Study

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Course numbering: RIT courses are generally referred to by their alphanumeric registration label. The four alpha characters indicate the discipline within the college. The final three digits are unique to each course and identify whether the course is noncredit (less than 099), lower division (100-299), upper division (300-599), or graduate level (600 and above).

Unless otherwise noted, the following courses are offered annually. Specific times and dates can be found in each semester's schedule of courses. Prerequisites/corequisites are noted in parentheses near the end of the course description.

Professional Studies

PROF-621

Proposal Writing

This course focuses on reviewing examples of the elements of proposal responses and practicing creating those elements. Students learn the process of evaluating and responding to RFIs and RFPs with concentration on making bid decisions, organizing teams, identifying strategies, establishing credibility, ensuring technical clarity, taking advantage of technology, applying creativity, and writing persuasively. Topics include the proposal process that is practiced by government, industry, and grant-funding agencies. *Note: co-listed with TCOM-514. * **Lecture 3, Credits 3 (Spring)**

PROF-644

Science Writing

Course introduces students to the writing process for describing scientific and technological subject matter for presentation to general audiences. Students will learn to gather needed source material and organize, write and edit articles that cover developments in the scientific and technological communities. Various article formats used in professional, in-house, trade, and popular publications are presented. *Note: co-listed with TCOM 544. Students cannot receive credit for both. * **Lecture 3, Credits 3 (Fall)**

PROF-705

Context and Trends

The gateway course for students enrolled in the MS in professional studies degree program. Course provides students with opportunities to interact about controversial issues while discovering foundational knowledge about interdisciplinary history, theory, along with applied problem-solving, research methods and professional ethics. Students use this course as a means of designing and receiving approval for individualized plans of study. (Department permission required). Students should consult their adviser before registering. **Lecture 3, Credits 3 (Fall, Spring)**

PROF-709

Graduate Salon: Disciplines on the Boundary

To address complex problems, it is essential to explore how different disciplines talk to each other. By engaging in acts of "translation," disciplinary boundaries can be crossed to collaboratively and responsibly connect the ways disciplines frame and engage problems. The Salon will provide a venue for exploring how to think, talk, and work successfully across disciplinary boundaries. In our global society, graduates must think critically and ethically to assess complex interconnected systems and processes, perform in a variety of situations, and continually adapt within rapidly evolving technological and social environments. We will explore different disciplinary cultures and develop the translational skills required to understand how various disciplines converge on a given research problem. Salon themes include: Disciplinary World Making; Nature of Cognition & Consciousness; Conceptions of Science and Technology; Roles of Religion and Culture; Constructions & Interpretations of Time, Space & other Fundamentals; Chaos Theory; Disruption and the Creation of New Knowledge; Nature of Translation; and others. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Seminar 2, Credits 1 (Spring)**

PROF-710

Project Management

This course addresses project management from a multidisciplinary perspective, covering the fundamental nature of and techniques for managing a broad range of projects. Topics cover the Project Management Life Cycle from Planning to Termination. It also addresses the behavioral and quantitative facets of project management, as well as the use of methods, tools and techniques for the initiation, planning, and execution of projects. Introduces the standard framework, processes and knowledge areas of the Project Management Institute. *Note: Bachelors degree or minimum of 5 years of work experience in a project related business environment. Recommended education or work experience in organizational behavior, mathematics and basic accounting. *Note: BUSI-510 may not be substituted for BUSI-710 in a graduate concentration or the advanced certificate in project management. Additionally, a student may not register for and receive credit for both BUSI-510 and BUSI-710, whether taken as an undergraduate or graduate student. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall, Spring, Summer)**

PROF-711

Advanced Project Management

Advanced Project Management covers the topics necessary for implementation of and excellence in project management. It deals with turning the principles and theory of project management into practice. The course addresses the best practices for project management in the world; project portfolio management and ROI; the project office and Six Sigma; project risk management and integrated projects; corporate cultures, behavior, and cultural failures; informal, adaptive, and extreme project management; and critical chain project management. Integrates aspects of the framework, processes and knowledge areas of the Project Management Institute. *Note: Advanced Project Management is available in on-campus and online formats. (Prerequisite: (PROF-710 or DECS-744 or ISEE-750) or PROF-714 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring, Summer)**

PROF-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. It 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 and infrastructure differences in different regions; and time zone differences. Incorporates aspects of the framework, processes and knowledge areas of the Project Management Institute. (Prerequisite: PROF-710 or PROF-711 or PROF-714 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring, Summer)**

PROF-713

Program Management for Product and Service Development

Merely having an idea isn't enough for Organization success. It's the execution of the best possible idea that delivers value to an organization's shareholders. Organizations must have both the ability to choose their opportunities wisely and the ability to execute programs competently. Program Management is the discipline that integrates organizational strategy with activities, skills, tools, and techniques to ensure that organizations are choosing the best opportunities and executing with discipline. We explore the five domains of Program Management from the Project Management Institute (PMI) through a combination of readings, case studies and project work: Program Strategy Alignment, Program Benefits Management, Program Stakeholder Engagement, Program Governance and Program Lifecycle Management. We will explore the role of the Program Manager using product and service development and enhancement/development of organization capabilities as context. (Prerequisite: PROF-711 or PROF-715 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring, Summer)**

PROF-714

Agile Project Management

Business agility allows organizations to quickly adapt to new markets. In a fast paced ever changing world of highly competitive products and services, organizations need to be able to deliver solutions to market quickly in an uncertain environment. Agile Project Management provides an iterative and incremental framework to explore and deliver high risk solutions efficiently in a rapid response timeframe. We will explore Agile Project Management practices across multiple industries including Agile project roles following the Project Management Institute® Agile Practice Guide. (This course is available to RIT degree-seeking graduate students.) **Lecture 3, Credits 3 (Fall, Spring)**

PROF-715

Agile Leadership and Self Organizing Teams

Agile Leaders are able to work effectively in unpredictable and ambiguous situations. Being adaptable, promoting innovation and modeling a learning organization set apart Agile Leaders from their more traditional counterparts. We will explore the servant leadership characteristics of Agile leaders, how they create and lead self organizing teams, how they drive value into everything they do balancing agility with strategy without creating an environment of chaos. Additionally, we will explore the Agile Culture which allows for both dynamic approaches to the business while also ensuring clear strategy and stability for the employee community. We will explore the facets of an Agile Culture across various industries that promote a customer centric approach of value through empowered employees. (Prerequisite: PROF-714 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

PROF-716

Agile and Design Thinking

Finding and implementing solutions to customer problems that are both adaptable and incremental provide for the greatest flexibility and return on investment. Agile and Design Thinking supports project teams working in an environment that requires innovation as well as dealing with uncertainty. Agile encourages a collaborative relationship with customers that promotes flexibility to meet business needs. By focusing on the human element and customer experience, Agile and Design Thinking provide a framework for engaging customers in ensuring prioritization of organization, product and service solutions that deliver frequent value for the business. (Prerequisite: PROF-714 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

PROF-717

Agile Project Management in Practice

The purpose of this course is to provide students the opportunity to identify a business problem and utilizing Agile Project Management, develop a plan and implement two sprints as a demonstration of final proficiency in Agile Project Management. The topic selected by the student will be guided by the faculty teaching the class and it will require the student to coalesce and incorporate into the final project a culmination of all their course work in the Agile Project Management course series. (Prerequisite: BUSI-715 and BUSI-716 or equivalent courses.) **Lecture 3, Credits 3 (Fall)**

PROF-720

Individual Leadership Development

Long-term success and growth as a manager requires more than the requisite technical skills. How can you differentiate yourself from the many other managers in the global job market? Strong leadership skills enable you to stand out in the crowd and demonstrate your unique value to your team and the organization. A manager with a combination of effective technical skills and strong leadership skills will find him/herself in a position of strength within their team and organization. Are you one of these managers? If not, this course is designed for you and will help you create a personal plan for continued development. Topics include leadership styles, being a leader your team wants to follow, communication styles that resonate with others, the reality of office politics, and operating with mutual understanding and responsibility. **Lecture 3, Credits 3 (Spring)**

PROF-721

Building High Performance Teams

High-performing teams (HPT) are critical to maintaining an organization's competitive advantage. HPTs are critical to the success of an organization, and leaders do much more than manage these teams—they develop their teams with the goal of achieving success for their organization. Teams rely on their leader for guidance and encouragement; they'll respond positively to quality leadership, by building stronger relationships and rising to challenges. This course is designed to provide you with research-based, proven strategies to help develop and foster high-performing teams. Topics include building, fostering and coaching HPTs; leading globally dispersed/remote teams; diversity awareness in HPTs; facilitating group problem solving and decision-making; negotiation and conflict management; and crisis management. **Lecture 3, Credits 3 (Summer)**

PROF-730

Introduction to Future Foresight

This course exposes students to the concepts, tools and techniques necessary to develop an understanding of the challenging area of future foresight, where the focus is on anticipating and initiating future ideas, plans, trends, and issues. The course will cover topics that are relevant and important to today's leaders, decision makers, entrepreneurs, strategists and others. Topics include the future foresight approach with analysis of practice and theory, discussion and analysis of pertinent issues raised by future foresight design and application, future foresight developments and relevant issues, and the impact of future foresight on organizational planning and development. The use of future foresight approaches and tools in the UAE will be benchmarked with international, regional and local settings where lessons will be drawn. (Co-requisite: PROF-705 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

PROF-731

Systems Thinking

This course focuses on the introduction and use of leading-edge systems thinking and modelling tools that are necessary to diagnose and solve complex business and social problems. Students will learn how to implement a flexible and powerful approach to structuring managerial problems and visualizing the interconnectedness of business, social and environmental systems. The development of skills to conceptualize and build simulation models of an enterprise, enabling the exploration of the dynamic consequences of different strategy/policy decisions and the identification of key leverage points in the system, is a central goal of this course. Systems thinking in business and public policy as it pertains to firm growth and stagnation, competitive strategy, capability development and human resource policies, environmental sustainability, and the boom and bust dynamics of start-up businesses will be explored. Successful Industrial applications of applied systems thinking and business dynamics will be reviewed. (Co-requisite: PROF-705 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

PROF-732

Scenario Development and Analysis

The development and analysis of realistic future scenarios provides an organization with a useful and pragmatic framework for making better, more flexible decisions concerning its own strategy or longer-term development issues, as well as, in some instances, shorter-range operational or market-oriented questions. While most business organizations carry out some kind of strategic planning, those that include a futures component in the process gain a decided advantage, as they will have considered alternative future landscapes rather than basing their plan on the assumption that one particular future will materialize. This approach involves not only understanding a range of outcomes that might plausibly develop a given strategic environment, but also, using this vision to formulate resilient strategies and bring about organizational alignment and buy-in. In this course, students will learn the methodology for building future scenarios and will apply them to real-life examples in order to develop a portfolio of realistic scenarios for a specific organization or industry. (Co-requisite: PROF-705 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

PROF-733

Scenarios for Future Planning

This course focuses on integrating scenarios into strategy. Strategic planning requires – but sometimes fails to take fully into consideration – identifying and monitoring emerging issues, as well as understanding how current trends, already identified, could intensify, change, or dissipate. All of these changes could have a significant impact on the future business landscape. Scenario planning therefore offers a clear advantage to strategy/policy makers, since it helps them foresee this new landscape, and their plans can accordingly be more realistic, more flexible, and more credible. Working in teams, students will delve deep into the scenarios they have devised in the previous term and elaborate strategic recommendations for each one. They will then assess these strategies in terms of operational and financial planning. (Prerequisite: PROF-732 or equivalent course. Co-requisite: PROF-705 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

PROF-734

Analytics and Artificial Intelligence

Leveraging big data to deliver solutions to complex challenges requires an organizational leadership that is responsible for understanding and directing these approaches to achieve their business goals. Rather, organizational leadership is responsible for understanding and directing these approaches to achieve business goals. Toward this end, this course provides students with the knowledge and confidence needed to imbue organizations with innovative, efficient, and sustainable aspects that will carry them into the future through an understanding and application of business analytics and artificial intelligence (AI). Students will gain a theoretical and working knowledge of data science, enabling the identification of the challenges that analytics, machine learning, and artificial intelligence can address. An introduction to the ethical and social implications of analytics and AI in terms of guiding an organization's strategic assets for the future will also be presented. (Co-requisite: PROF-705 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

PROF-736

Strategic Planning

Drawing on the principles of systems thinking and complex adaptive systems, this course provides students with a complete guide for writing and implementing a strategic plan with special emphasis on the unique requirements of development in the Middle East and North Africa (MENA) region. In particular, the UAE's extensive experience and special focus on long-range planning in various sectors, enabling it to become a competitive leader in the world, will be a highlight of this course. Developing mission and vision statements that communicate values and serve as a guiding force within an organization; framing new and flexible approaches for planning; comparing business, long-term, and strategic plans; and understanding the importance of formal and informal mandates will be addressed. Particular emphasis will be placed on effective strategy development specifically for complex and uncertain policy environments in the public sector. (Co-requisite: PROF-705 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

PROF-740

Fundamentals of Data Analytics

This course introduces students to foundational skills in data analytics, with a focus on mathematical foundations. Students will explore topics that form the backbone of modern data analytics such as machine learning, data mining, artificial intelligence and visualization. Tools for statistics will be introduced to students for how to go from raw data to a deeper understanding of the patterns and structures within the data, to support making predictions and decision making. **Lecture 3, Credits 3 (Fall)**

PROF-741

Enterprise Infrastructure for Data Analytics

This course introduces students to the challenges in large and small organizations related to data analysis and storage. Students will be introduced to economic infrastructure approaches for handling data securely. Platforms which are hosted both on-premises of organizations and in the cloud will be covered in this course. **Lecture 3, Credits 3 (Fall)**

PROF-750**Structures of City Systems**

The course provides students with a comparative and analytical view of how different departments within a city are managed and work together. Students will learn about the role of city departments like security and safety, transportation, energy, water, sanitation and waste, how they work together today, and how they will need to interact in a smart city environment. This course will compare and contrast the collaborative nature of city government departments in various regions, including Europe, Asia, India, the Middle East, Africa, and the Americas, and students will analyze how technology can help build a more collaborative structure between these departments in cities of the future. Students will develop a foundational understanding of how urban departments are managed and will be managed in the future. (Prerequisites: PROF-705 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

PROF-751**Resource Contexts for Smart City Development**

In the evolution of cities, the use of technology in cities creates value. With the rise of the smart city and the use of IoT instrumentation (i.e. network-connected devices), robots, AI and so on, how do cities purporting to be “smart” evaluate the investment that goes into these new technologies and where do they raise the finances necessary to implement it? What do we know about the economics of the “smart city”? This course provides students the opportunity to understand how the use of technology supports OPEX (operating expenditures) and CAPEX (capital expenditures) optimization in urban projects. Students will understand where the funding to support this implementation comes from – internal city finances, public-private partnerships, or external sources. With recent data, this course describes the financial feasibility of numerous urban projects from buildings, energy, telecommunications, transportation, water and wastewater, public safety security, and health and human services. The cost savings in projects due to integration of systems, IoT instrumentation, connectivity, interoperability, data management, computing resources and analytics will also be examined. (Prerequisites: PROF-705 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

PROF-770**Proposal Seminar**

This course guides the student through preparation of the Capstone Proposal that is required for the applied final course of his/her MS in professional studies degree - the Capstone Project. Student will determine a Capstone Project concept, and articulate the methods for implementing the Capstone Project. The course concludes with a paper describing the Capstone Project, including background and description, methodology, anticipated outcomes, and probable Capstone Adviser. Student will meet regularly with the course facilitator. Upon successful completion of this course, student will be registered for the Capstone Project. (Pre-requisites: PROF-705 and core coursework; course restricted to MS in professional studies students) **Seminar 3, Credits 0 (Fall, Spring, Summer)**

PROF-775**Capstone Project**

The capstone course for students enrolled in the MS in professional studies degree program. With individualized advising from a faculty adviser, students participate in a real world problem solving project carried out in an organizational setting while also relating to a student's professional concentrations. Course requirements involve completing a literature review, writing a project proposal, engaging in online discussion with faculty adviser and other SOIS capstone students, various kinds of field work, writing full draft and final academic report and making a (Powerpoint) presentation. Registration completed on behalf of students following faculty review of acceptable capstone project proposal. (Prof 770; Department approval) **Project 3, Credits 1 - 6 (Fall, Spring)**

PROF-776**Research and Thesis**

The research and thesis course unfolds over two semesters. Students will receive instruction in standard research methods, as well as the best practices for writing and presenting project findings. The remainder of the course is devoted to students working individually with a faculty supervisor on the research, organization, analysis, and eventual presentation of their project findings. To complete the thesis course, students must successfully defend their work before a committee consisting of a representative sample of the program faculty, the student's supervisor, and the program director. The committee is responsible for determining the student's final grade for the thesis. The course is graded on a pass/fail (R, U, or I) basis with a successful defense of the completed thesis being the deciding factor. Department approval required for enrollment. (Prerequisites: PROF-770 or equivalent course.) **Thesis 90, Credits 6 (Fall, Spring, Summer)**

PROF-780**Continuation of Capstone Proj**

Continuation of Capstone Project (Prerequisites: PROF-775 or equivalent course.) **Cont, Credits 0 (Fall, Spring, Summer)**

PROF-790**Data Analytics for Emerging Technologies**

This course explores the emerging technologies that are driving the acceleration of applications and the data produced by them Big Data and its 5V characteristics – volume, velocity, veracity, variety and value – across industry, research and academia. Students will be introduced to a range of complemented technology disciplines like cybersecurity, virtual content delivery, artificial intelligence, and smart cities where the uses of real-time analysis on big datasets are applied. Particular focus will be paid to a review of a number of industry verticals and data related to how emerging technologies are used with an emphasis on privacy and ethical considerations. (Prerequisites: PROF-705 or equivalent course.) **Lecture 3, Credits 3 (Fall, Summer)**

PROF-798**Independent Study**

Prerequisites: Graduate standing and permission of faculty. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Ind Study 3, Credits 3 (Fall, Spring, Summer)**

PROF-799**Special Topics**

Special topics are experimental courses announced as offered. Variable credit. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 1 - 4 (Fall, Spring, Summer)**

Quality Management
QLTM-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 asset management programs. (Prerequisite: QLTM-340 or STAT-145 or MTSC-211 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

Security
SECU-700**Security Technology Management**

This course examines security threats and technologies, associated research and development processes, and relationships among technology developers, and numerous management concerns pertaining to the adoption, implementation and utilization of security enhancing technologies throughout society. No prerequisite. **Lecture 3, Credits 3 (Fall)**

SECU-701**Security Technology Policy, Law and Ethics**

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. **Lecture 3, Credits 3 (Fall, Spring)**

SECU-702**Managing Cyber Threats and Critical Information Infrastructure**

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. (Prerequisites: SECU-700 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

SECU-703**Security Enhanced 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 a few of the many relatively low-to-high technologies that will be addressed with regard to public and private facilities, landscaping and architecture planning. (Prerequisites: SECU-700 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

SECU-704**Internal Organization 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. (Prerequisites: SECU-700 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

National Technical Institute for the Deaf

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Health Care Interpretation

HCIA-610

Interpreting Research Setting

This online course will prepare graduate interpreters for working in research settings. Students will learn about the lived experience of Deaf scientists and how to effectively work with them by utilizing a variety of tools and strategies. Students will also become familiar with procedures and protocols for interpreting in research settings including lab-based work, meeting with collaborators, and professional conferences. Additionally, students will have the opportunity to build upon their American Sign Language (ASL) and English skills, specifically working on how to translate and interpret complex research related terminology and jargon. Also, students will investigate a topic related to their interest specifically in context of research and science that extends beyond the course materials covered in class and will summarize their findings in both academic ASL and English. This course involves online video lectures in both English and ASL, video observations and case studies, and online group discussions. Grading in the course will be based on students' participation online and performance on their assignments. Students can receive credit for INTP-510 or HCIA-610, not for both. (This course is restricted to HLTHINT-MS Major students.) **Lecture 3, Credits 3 (Summer)**

HCIA-705

Professional Seminar

This course is the first course taken in the MS in Health Care Interpreting degree program. This week long on-campus residency professional seminar will build a foundation of the practical skills and knowledge undergirding the master's degree program. It is intended to provide the learner with an overview of the course management system, webinar software, and sign language health care skills development used throughout the program. This course addresses the theoretical constructs and the approach to the practice of interpreting based on the demand-control schema and reflective practice and the federal regulations and policies impacting communication access and the work of interpreters. The latest research regarding health care disparities in the deaf population will be presented and health care interpreting skill development activities will commence. (This course is restricted to HLTHINT-MS Major students.) **Lecture 3, Credits 3 (Summer)**

HCIA-715

Human Body Systems/Diseases I

This first course in a two-course sequence will help interpreters build a strong foundation in human body systems and diseases. Within each body system topics for discussion include: anatomy and physiology (structure and function), common conditions/diseases, common medications and treatments, specialized terms, health care provider specialties, medical tests, and procedures and equipment. This class is conducted in ASL. (Prerequisites: HCIA-705 or equivalent course and student standing in HLTHINT-MS.) **Lecture 3, Credits 3 (Spring)**

HCIA-719

Theories of Translation and Interpretation

This course will begin with an examination of the scope of practice of spoken language interpreters in health care settings and this will then be compared to the models of professional deportment in sign language interpreting. From there, we will review the major paradigms in the field of translation and interpretation, that of formal or functional (dynamic) equivalence, and how the scope of practice expectations impact the interpretation process. Finally, students will explore the concept of "sense" or meaning and how to convey that in a medical setting. (This course is restricted to HLTHINT-MS Major students.) **Lecture 3, Credits 3 (Summer)**

HCIA-720

Health Care Practical Interpreting I

This interpreting course exposes interpreters to interpreting in mental health, cardiology, OBGYN, and orthopedic outpatient and inpatient settings. This course will expose interpreters to medical professionals, common medical service protocols, typical diagnostic and treatment dialogues or clinical "scripts" of common conditions, diagnoses, and initial presenting complaints. Exposure to this new content knowledge happens via observations of medical student practice dialogues with simulated patients and other problem-based learning activities. In addition to this new knowledge and the unique observation opportunity, participants will be further reinforcing and integrating the Human Body Systems course content in their analyses of medical interpreted cases. English to ASL/ASL to English skill development activities will be employed. (Prerequisites: HCIA-705 or equivalent course and student standing in HLTHINT-MS.) **Lecture 3, Credits 3 (Fall)**

HCIA-730

Human Body Systems/Diseases II

This second course in a two-course sequence in Human Body Systems/Diseases will continue to help interpreters build a strong foundation in human body systems and diseases by addressing the remaining body systems not covered in the first course. Within each body system, topics for discussion include: anatomy and physiology (structure and function), common conditions/diseases, common medications and treatments, specialized terms, health care provider specialties, medical tests, and procedures and equipment. (Prerequisites: HCIA-715 or equivalent course and student standing in HLTHINT-MS.) **Lecture 3, Credits 3 (Spring)**

HCIA-740

Health Care Practical Interpreting II

This course is a continuation of HCIA 720 Health Care Practical Interpreting I. The course content will address interpreting for surgery, end of life care, pediatrics, and cancer inpatient and outpatient settings. It will also advance students' ability to facilitate group supervision based on DC-S constructs. Using reflective practice techniques already employed and demonstrated in the program's courses, students will be expected to emulate similar techniques with their colleagues. Case presentation and case analysis of actual interpreting assignments will form the basis for the course material and activities. Students will be expected to identify and articulate the unique contextual factors of the case (the demands of the job), the decisions made by the interpreting in the case, and discuss all ethical attributes of these demand-control pairings. Students will also be expected to use DC-S constructs to restructure the dialogue that emerges from case analysis discussions. Students will be further reinforcing and integrating the Human Body Systems course content in their analyses of medical interpreted cases. English to ASL/ASL to English skill development activities will be employed. (Prerequisites: HCIA-720 or equivalent course and student standing in HLTHINT-MS.) **Lecture 3, Credits 3 (Fall)**

HCIA-750

Health Care Interpreting Within a Diverse Deaf Community

This course is for health care interpreting students to learn how to work with the diverse Deaf community. The course begins with a discussion of current perspectives in Deaf Studies including the Deaf Gain paradigm and Social Justice Theory relevant to medical interpreting. Current research on deaf individuals' health knowledge, health literacy, and health outcomes are presented. Class discussions will focus on working with deaf individuals fluent in foreign sign languages, minority Deaf populations, deaf individuals with special needs, deaf-blind individuals, deaf interpreters, deaf students, and deaf professionals. Students will develop skills interpreting for some of these deaf individuals. (Prerequisites: HCIA-730 and HCIA-740 or equivalent course and student standing in HLTHINT-MS.) **Lecture 3, Credits 3 (Summer)**

HCIA-760

Research Methods in Interpreting

This is an introductory graduate-level survey course on research design/methods and analysis. The course provides a broad overview of the process and practices of social and linguistic research in translation/interpreting in health care settings. Content includes principles and techniques of research design, data collection, and analysis, including the nature of evidence, types of research, defining research questions, data collection and analysis, issues concerning human subjects from vulnerable groups, and research ethics. This course instructs the learner how to conduct research in real-world contexts of health-care settings, drawing on translation/interpreting theories. The analysis component of the course teaches how to interpret data found in research (including statistics) as well as how to use data analysis software. (This course is restricted to HLTHINT-MS Major students.) **Lecture 3, Credits 3 (Fall, Spring)**

HCIA-770

Capstone Prof Proj/Rsrch Paper

The purpose of this course is to provide students the opportunity to conduct research, develop a plan and evaluation components, or submit a project as a demonstration of final proficiency in the program. The faculty teaching the class will guide the topic selected by the student and it will require the student to coalesce and incorporate into the final project or paper a culmination of their entire course work in the program to date (e.g., if a student is employed in a health care setting a project related to enhancing the provision of Language Access Services could be conducted). (Prerequisites: HCIA-719 and HCIA-730 and HCIA-740 and HCIA-760 or equivalent course and student standing in HLTHINT-MS.) **Lab 3, Credits 3 (Spring, Summer)**

HCIA-789

Special Topics: Health Care Interpretation

The description will be specified in each Special Topic Documentation Form. (This course is restricted to HLTHINT-MS Major students.) **Lecture, Credits 1 - 3 (Fall, Spring)**

HCIA-799**Independent Study: Health Care Interpretation**

The description will be specified on each Independent Study Contract. (This course is restricted to HLTHINT-MS Major students.) **Lecture, Credits 1 - 3 (Fall, Spring, Summer)**

Secondary Education of Students Who Are Deaf or Hard of Hearing

MSSE-700**History of Deaf Educational Thought and Practice**

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. (This class is restricted to SEDDEAF-MS Major students.) **Lecture 3, Credits 3 (Fall)**

MSSE-701**Psychology and Human Development**

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 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. (This class is restricted to SEDDEAF-MS Major students.) **Lecture 3, Credits 3 (Fall)**

MSSE-702**Educational and Cultural Diversity**

This course focuses upon knowledge and understanding of existing diversities within the Deaf and Hard-of-Hearing communities, and ways in which teaching can most effectively meet the needs and interests of these students for effective learning. Readings and discussions will explore the educational needs of Deaf and Hard-of-Hearing students with variations of experience related to culture, race/ethnicity, language, educational and socio-economic backgrounds and settings, communication skills, and learning styles. These concepts will be applied to effective teaching and curriculum development. (This class is restricted to SEDDEAF-MS Major students.) **Lecture 3, Credits 3 (Fall)**

MSSE-703**Special Education in the Social Context**

This course takes a sociological approach to disability and the historical foundations of special education. Three models of disability are introduced: medical, social, and political. These three models provide a foundation for the course, and guide study of three major aspects of disability and special education. First, the class will explore how each of these models has historically guided and, in some cases, continues to guide services and social institutions for persons with disabilities, including educational and rehabilitation services. Second, the course will examine the process through which people with disabilities are so labeled and the interaction between these individuals and others (family, peers, school, community). Third, the course will analyze the changing role of the human service professional (including teachers) and the ways in which professional preparation programs reflect the various models of disability. The course will draw heavily on a variety of philosophical, theoretical, conceptual and methodological perspectives, including phenomenology, symbolic interaction, and human ecology. (This class is restricted to SEDDEAF-MS Major students.) **Lecture 3, Credits 3 (Fall)**

MSSE-704 Teaching Deaf and Hard of Hearing Learners with Special Educational Needs

This course focuses on providing students with basic information regarding the needs of deaf and hard of hearing learners with special educational needs, including (1) developmental disability, (2) emotional or behavioral disorder (3) learning disability, attention deficit disorder or attention deficit hyperactivity disorder, or (4) visual impairment. Topics include incidence, identification, assessment, teaching strategies, and working with parents. The goal is to enable students to see students in a holistic fashion, and thus will include the perspectives of parents, teachers and deaf and hard of hearing learners with special educational needs. Learning strategies may include site visits, presentations, films, and interactive workshop style classes offered by experienced teachers, psychologists, counselors, disability advocates, and parents of learners with special educational needs. The course will regularly incorporate guest lecturers who have specialized expertise in teaching or research in one or more of the topic areas covered in the course. (Prerequisites: MSSE-703 or equivalent course and graduate standing in SEDDEAF-MS.) **Lecture 3, Credits 3 (Spring)**

MSSE-710**General Instructional Methods**

This introductory course provides an overview of the current theories of assessment, curriculum, instruction, and learning across diverse educational settings in the field of deaf education. The course covers the use of educational technologies to enhance the learning experiences of deaf students and options for classroom management, learning environment appropriate to K-12 classrooms, and methods for assessment. Reflection and application of effective instructional practices are demonstrated through microteaching and field-based experiences. To progress to MSSE-714 Practicum, student must obtain a grade of at least B in this course. (This class is restricted to SEDDEAF-MS Major students.) **Lecture 3, Credits 3 (Fall)**

MSSE-712**Practicum**

As required by the New York State Education Department, each MSSE student is required to complete 100 hours of practicum experience during their first year in the program. This practicum experience provides students with opportunities to observe and reflect on their content, professional, pedagogical knowledge, skills and disposition in classroom settings at both schools for the deaf and mainstreamed programs. There will also be course-related observations. Students will also be required to attend selected Deaf culture events. After completion of all of the required observations, the students are required to submit a practicum experience portfolio. Guidelines will be provided to the student. The practicum experience must be completed with a grade of at least a B before the first student teaching assignment. (Prerequisites: MSSE-710 or equivalent course with a minimum grade of B and graduate standing in SEDDEAF-MS.) **Lecture 2, Credits 2 (Spring)**

MSSE-713**Assessment Principles and Practices**

This course addresses assessment as educational decision-making, involving the selection and interpretation of assessment tools as applied to classroom-based student learning. The course focuses on students who are deaf and hard of hearing; including students with diverse learning needs. Assessment and educational planning for students are discussed as part of a cooperative model, including the relevant stakeholders in the decision-making process. This course also addresses the development and interpretation of both formative and summative assessment strategies in light of acceptable criteria of validity and reliability, and the absence of assessment bias. Criteria for evaluating the appropriateness of standardized tests, with emphasis on deaf and hard-of-hearing students, are discussed and practiced. Collection and interpretation of assessment information are applied to the development and revision of Individualized Education Plans (IEPs). (This class is restricted to SEDDEAF-MS Major students.) **Lecture 3, Credits 3 (Spring)**

MSSE-714**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. 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. 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. 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. 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. 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. To progress to MSSE-760, students must obtain a minimum grade of B in this course. (Prerequisites: MSSE-710 and MSSE-712 or equivalent course with a minimum grade of B and graduate standing in SEDDEAF-MS.) **Lecture 3, Credits 3 (Fall)**

MSSE-715**Issues in Mainstreamed Education**

This course will prepare students to work with Deaf and Hard of Hearing children and youth with a broad range of disabilities and educational needs in mainstreamed school settings. The course is designed to foster acceptance of diversity among individuals as well as to develop skills in writing appropriate Individualized Education Programs (IEPs), including behavior modification methods, communication strategies, and psycho-educational approaches. (This class is restricted to SEDDEAF-MS Major students.) **Lecture 3, Credits 3 (Fall)**

MSSE-722**Educational Audiology and Spoken Language Development**

This course provides a basic understanding of the mechanisms of hearing and speech and causes of hearing loss. Emphasis is placed on development of a functional understanding of speech perception, speech development, hearing aids, cochlear implants, and assistive listening devices. Procedures for audiological and speech/language assessment are examined, together with strategies for supporting use and development of spoken language in the classroom. (This class is restricted to SEDDEAF-MS Major students.) **Lecture 3, Credits 3 (Fall)**

MSSE-725 Structures of American Sign Language and English
This course concentrates on the linguistic structures of American Sign Language (ASL) and English. This course introduces students to the structural description of ASL and English languages at various levels (phonology, morphology, syntax, semantics, and discourse/pragmatics). Issues related to language change and variation, language use in contact situations (for example, code-mode switching), and language use in education will be discussed. (This class is restricted to SEDDEAF-MS Major students.) **Lecture 3, Credits 3 (Fall)**

MSSE-726 Language Acquisition and Learning
This course introduces students to current theories of language acquisition and learning in educational settings. The stages of acquisition and learning, and variables that influence these processes will be included. Bilingual and second language acquisition and learning will also be addressed. Implications for instruction with Deaf students will be discussed. (Prerequisites: MSSE-725 or equivalent course and graduate standing in SEDDEAF-MS.) **Lecture 3, Credits 3 (Spring)**

MSSE-727 American Sign Language in Instructional Delivery
This course is designed to improve the ASL proficiencies of classroom teachers. It provides students strategies and skill building to teach content areas in and through ASL. Students will enhance their ASL skills for the purpose of conveying concepts to Deaf students accurately. Topics include ASL instructional strategies, curriculum development in ASL, assessment modifications, student products in ASL, and vocabulary/phrases for effective communication and instructional delivery. (Prerequisites: MSSE-725 or equivalent course and graduate standing in SEDDEAF-MS.) **Lecture 3, Credits 3 (Spring)**

MSSE-728 Literacy and the Deaf Adolescent
This course is designed to familiarize students with the process involved in English literacy development. Particular emphasis is placed on the literacy development of deaf and hard-of-hearing students in grades 7-12. Students learn about various language and literacy instructional methods and how to incorporate literacy instruction into all secondary content area classrooms. (Prerequisites: MSSE-726 or equivalent course and graduate standing in SEDDEAF-MS.) **Lecture 3, Credits 3 (Fall)**

MSSE-760 Student Teaching I
This first assignment consists of 8 weeks (40 days or 250 hours) of teaching and observation. Teacher candidates are placed with cooperating teachers in residential schools for the Deaf or mainstreamed programs. They develop lesson and unit plans and teach in the content area in which they plan to receive New York State certification. To progress to MSSE-761, students must pass this student teaching assignment with a minimum grade of B and submit a student teaching portfolio. (Prerequisites: MSSE-714 or equivalent course with a minimum grade of B and MLAS-202 or equivalent course with a minimum grade of C- and graduate standing in SEDDEAF-MS.) **Lec/Lab 6, Credits 6 (Spring)**

MSSE-761 Student Teaching II
This second assignment consists of 8 weeks (40 days or 250 hours) of teaching and observation. Student teachers are placed with cooperating teachers in residential schools for the Deaf or mainstreamed program. They develop lesson and unit plans and teach in the content area in which they plan to receive New York State certification. Students must pass this student teaching assignment with a minimum grade of B and submit a student teaching portfolio. (Prerequisites: MSSE-760 or equivalent course with a minimum grade of B and graduate standing in SEDDEAF-MS.) **Lec/Lab 6, Credits 6 (Spring)**

MSSE-785 Foundations of Educational Research
This course is an introduction to research and inquiry in education. The course includes the evaluation of selected Deaf education research studies, including methodologies, data collection and analyses, and implications of the studies to teaching and learning. Action research in the classroom is examined in depth. Students will prepare a review of literature and an action research plan related to a specific curriculum topic or problem in the learning/teaching of their content areas. The focus of the course is upon the student as a consumer rather than a practitioner of research, however the student will exit the course with basic practitioner knowledge, especially in the area of teacher research. (This class is restricted to SEDDEAF-MS Major students.) **Lecture 3, Credits 3 (Spring)**

MSSE-789 Special Topics: MSSE
Special topics courses will be developed based on student interest and demand as well as faculty interest and availability. These courses are usually taken on an elective basis. (This class is restricted to SEDDEAF-MS Major students.) **Ind Study, Credits 1 - 3 (Fall, Spring, Summer)**

MSSE-790 Professional Portfolio
The professional portfolio presents a clear picture of pre-service professional growth and accomplishments in the complex teaching field. It demonstrates a teacher candidate's reflective and constructive professional performance. The performance includes, but is not limited to, the teacher candidate's actual teaching, reflecting on learning and teaching, developing and implementing lessons, conducting qualitative and quantitative research projects, and applying theory and research to practice. The portfolio includes extensive evidence of teaching and learning experience, including teaching philosophy, pedagogy, classroom management, and the integration of research and teaching. Professional portfolios will be reviewed by a committee of program faculty for approval. (Prerequisites: MSSE-714 and MSSE-785 or equivalent course with a minimum grade of B and graduate standing in SEDDEAF-MS.) **Lecture 3, Credits 3 (Spring)**

MSSE-794 Inquiry in Teaching
This is an elective enrichment course that facilitates development of scholarship skills in conjunction with the completion of an independent project on an important educational topic. The project may be an experimental study that creates new knowledge, curriculum development that results in a novel and tangible product, a comprehensive review and analysis of a body of literature, or a grant proposal suitable for submission to funding sources. Students will seek a project mentor by the end of their first semester and will work independently under the guidance of that mentor. A committee of program faculty will evaluate the final written report for level of critical thinking, integration of concepts, clarity of expression, and adherence to the principles of scientific inquiry. (Prerequisites: MSSE-785 or equivalent course and graduate standing in SEDDEAF-MS.) **Ind Study 3, Credits 3 (Spring)**

MSSE-799 Independent Study: MSSE
Independent study courses will be developed based on student interest and demand as well as faculty interest and availability. These courses are usually taken on an elective basis. (Enrollment in this course requires permission from the department offering the course.) **Ind Study, Credits 1 - 3 (Fall, Spring, Summer)**

College of Science

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Astrophysical Sciences and Technology

ASTP-601

Graduate Seminar I

This course is the first in a two-semester sequence intended to familiarize students with research activities, practices, and ethics in the university research environment and to introduce students to commonly used research tools. As part of the course, students are expected to attend research seminars sponsored by the Astrophysical Sciences and Technology Program and participate in a weekly journal club. The course also provides training in scientific writing and presentation skills. Credits earned in this course apply to research requirements. (Prerequisites: This course is restricted to students in the ASTP-MS and ASTP-PHD programs.) **Seminar 3, Credits 1 (Fall)**

ASTP-602

Graduate Seminar II

This course is the second in a two-semester sequence intended to familiarize students with research activities, practices, and ethics in the university research environment and to introduce students to commonly used research tools. As part of the course, students are expected to attend research seminars sponsored by the Astrophysical Sciences and Technology Program and participate in a weekly journal club. The course also provides training in scientific writing and presentation skills. Credits earned in this course apply to research requirements. (Prerequisites: ASTP-601 or equivalent course. This course is restricted to students in the ASTP-MS and ASTP-PHD programs.) **Seminar 3, Credits 1 (Spring)**

ASTP-608

Fundamental Astrophysics I

This course will provide a basic introduction to modern astrophysics, including the topics of radiation fields and matter, star formation and evolution, and stellar structure. This course will provide the physical background needed to interpret both observations and theoretical models in stellar astrophysics and prepare students for more advanced topics and research in astrophysics. (Prerequisites: This course is restricted to students in the ASTP-MS and ASTP-PHD programs.) **Lecture 3, Credits 3 (Fall)**

ASTP-609

Fundamental Astrophysics II

This course will provide a basic introduction to modern astrophysics, following on from Fundamental Astrophysics I. Topics will include basic celestial mechanics and galactic dynamics, the Milky Way and other galaxies, the interstellar medium, active galactic nuclei, galaxy formation and evolution, and an introduction to cosmology. This course will provide the physical background needed to interpret both observations and theoretical models in galactic and extragalactic astrophysics and cosmology and prepare students for more advanced topics and research in astrophysics. (Prerequisites: ASTP-608 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

ASTP-610

Mathematical Methods for the Astrophysical Sciences

This course is a stand-alone course on mathematical methods for astrophysics covering tensor algebra, group theory, complex analysis, differential equations, special functions, integral transforms, the calculus of variations, and chaos. (Prerequisites: This course is restricted to students in the ASTP-MS and ASTP-PHD programs.) **Lecture 3, Credits 3 (Spring)**

ASTP-611

Statistical Methods for Astrophysics

This course provides an introduction to the statistical techniques used in astrophysics and other observational sciences, including parameter estimation, hypothesis testing, and statistical signal processing. An introduction is given to both Bayesian and frequentist approaches. (Prerequisites: This course is restricted to students in the ASTP-MS and ASTP-PHD programs.) **Lecture 3, Credits 3 (Spring)**

ASTP-612

Mathematical and Statistical Methods for Astrophysics

This course provides an introduction to the applied mathematical and statistical tools used frequently in astrophysics including modeling, data reduction, analysis, and computational astrophysics. Topics will include Special Functions, Differential Equations, Probability and Statistics, and Frequency Domain Analysis. (Prerequisites: This course is restricted to students in the ASTP-MS and ASTP-PHD programs.) **Lecture 3, Credits 3 (Spring)**

ASTP-613

Astronomical Observational Techniques and Instrumentation

This course will survey multi-wavelength astronomical observing techniques and instrumentation. The design characteristics and function of telescopes, detectors, and instrumentation in use at the major ground based and space based observatories will be discussed as will common observing techniques such as imaging, photometry and spectroscopy. The principles of cosmic ray, neutrino, and gravitational wave astronomy will also be briefly reviewed. (Prerequisites: This course is restricted to students in the ASTP-MS and ASTP-PHD programs.) **Lecture 3, Credits 3 (Fall)**

ASTP-615

Radiative Processes for Astrophysical Sciences

This course will cover classical continuum radiation emission mechanisms that commonly occur in astrophysical environments. Topics will include properties of astrophysical radiation, radiative transfer, blackbody radiation, radiation from moving charges, bremsstrahlung, synchrotron, and inverse Compton radiation. (Prerequisites: This course is restricted to students in the ASTP-MS and ASTP-PHD programs.) **Lecture 3, Credits 3 (Spring)**

ASTP-617

Astrophysical Dynamics

This course provides an introduction to advanced classical dynamics starting from an action principle, and its applications to astrophysical systems. Topics include Lagrangian and Hamiltonian mechanics, the two-body system, perturbation theory applied to Keplerian orbits, motion near black holes and the many-body problem. (Prerequisites: This course is restricted to students in the ASTP-MS and ASTP-PHD programs.) **Lecture 3, Credits 3 (Fall)**

ASTP-618

Fundamentals of Theoretical Astrophysics I

This course will provide students with an in-depth theoretical background on those astrophysical phenomena where matter and electromagnetic fields play a major role. This includes stellar cores, relativistic plasmas, accretion physics, and jet production. Topics will include elements of electromagnetism, classical and relativistic fluids, magnetohydrodynamics, and radiation. (Prerequisites: ASTP-608 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

ASTP-619

Fundamentals of Theoretical Astrophysics II

This course will provide students with the in-depth background on Classical, Statistical, and Nuclear physics required for modeling many astrophysical systems. Particular attention is paid to topics related to the physics of stellar remnants (e.g., white dwarfs, neutron stars, and black holes) and the physics of compact object mergers. (Prerequisites: ASTP-608 and ASTP-618 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

ASTP-660

Introduction to Relativity and Gravitation

This course is the first in a two-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. The target audience is graduate students in the astrophysics, physics, and mathematical modeling (geometry and gravitation) programs. (This course is restricted to students in the ASTP-MS, ASTP-PHD, MATHML-PHD and PHYS-MS programs.) **Lecture 3, Credits 3 (Fall)**

ASTP-699

Astrophysical Sciences and Technology Graduate Co-op

This course is a cooperative education experience for graduate astrophysical sciences and technology students. **CO OP, Credits 0 (Fall, Spring, Summer)**

ASTP-711

Advanced Statistical Methods for Astrophysics

This is an advanced course in statistical inference and data analysis for the astrophysical sciences. Topics include Bayesian and frequentist methods of parameter estimation, model selection and evaluation using astrophysical data. Specific applications, such as parameter estimation from gravitational wave signals, or analysis of large data sets from imaging, spectroscopic or time domain surveys will be discussed. Computational methods including Markov Chain Monte Carlo, with other topics such as machine learning, and time series analysis included at the discretion of the instructor. (Prerequisite: ASTP-610 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

ASTP-720

Computational Methods for Astrophysics

This course surveys the different ways that scientists use computers to address problems in astrophysics. The course will choose several common problems in astrophysics; 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. (Prerequisites: This course is restricted to students in the ASTP-MS and ASTP-PHD programs.) **Lecture 3, Credits 3 (Fall)**

ASTP-730

Stellar Atmospheres and Evolution

An overview of the physical principles and observational phenomenology describing stellar atmospheres and stellar evolution. Topics covered include: atmospheric temperature structure and line formation; atmosphere models and spectral type determination; observational (spectral) diagnostics of stellar masses, abundances, ages and evolutionary states; and a survey of contemporary topics in star formation and pre- and post-main sequence stellar evolution, with emphasis on the physical processes governing stellar accretion, mass loss, and the effects of binary companions on these processes. (Prerequisites: ASTP-608 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

ASTP-740

Galactic Astrophysics

This course surveys our current knowledge of the Milky Way galaxy, and the processes that shape its structure and evolution. Topics will include the structure and kinematics of the Milky Way; stellar populations; theory of orbits; Jean's theorem and equilibrium of stellar systems; the virial theorem; the Jean's equations; gravitational instabilities; tidal interactions; the central black hole; the Local Group and chemical evolution. (Prerequisite: ASTP-609 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

ASTP-750

Extragalactic Astrophysics

This course will cover objects in the universe beyond our own Milky Way galaxy, with an emphasis on the observational evidence. Topics will include properties of ordinary and active galaxies; galaxy clusters; the extragalactic distance scale; evidence for dark matter; cosmological models with and without the cosmological constant (Λ). (Prerequisite: ASTP-609 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

ASTP-789

Special Topics

This is a masters-level course on a topic that is not part of the formal curriculum. This course is structured as an ordinary course and has specific prerequisites, contact hours, and examination procedures. (This course requires permission of the Instructor to enroll.) **Lecture, Credits 1 - 3**

ASTP-790

Research and Thesis

Masters-level research by the candidate on an appropriate topic as arranged between the candidate and the research advisor. (Enrollment in this course requires permission from the department offering the course.) **Thesis, Credits 1 - 3 (Fall, Spring, Summer)**

ASTP-791

Continuation of Thesis

Continuation of Thesis **Cont, Credits 0 (Fall, Spring, Summer)**

ASTP-799

ASTP 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. **Ind Study, Credits 1 - 4 (Fall, Spring, Summer)**

ASTP-831

Stellar Evolution and Environments

A survey of contemporary topics in star formation and pre- and post-main sequence stellar evolution, with emphasis on the physical processes governing stellar accretion, mass loss, and the effects of binary companions on these processes. (Prerequisites: ASTP-730 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

ASTP-835

High-Energy Astrophysics

This course will survey violent astrophysical phenomena including supernovae, compact stellar remnants, X-ray binaries, gamma ray bursts, and supermassive black holes in active galactic nuclei. It will examine physical processes associated with the emission of high-energy radiation, production of high-energy particles, accretion discs around compact objects, and production and propagation of astrophysical jets. It will review current models for the sources of high-energy phenomena. (Prerequisite: ASTP-609 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

ASTP-841

The Interstellar Medium

This course provides a detailed overview of the physical processes and properties of the interstellar medium in our Galaxy and other galaxies. The course explores the fundamental physical basis of the observed properties of low-density astrophysical gases observed throughout the universe. Topics may include HII regions, planetary nebulae, HI clouds, molecular clouds, photodissociation regions, supernova remnants, and multi-phase models of the interstellar medium. (Prerequisite: ASTP-609 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

ASTP-851

Cosmology

This course will cover the evolution of the universe from the big bang to the present, with an emphasis on the synergy between theory and observations. Topics will fall under three general headings: classical and relativistic cosmology, the early universe, and structure formation. (Prerequisite: ASTP-609 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

ASTP-861

Advanced Relativity and Gravitation

This course is the second in a two-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, neutron stars, and methods for solving the Einstein equations. The target audience is graduate students in the astrophysics, physics, and mathematical modeling (geometry and gravitation) programs. (Prerequisite: ASTP-660 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

ASTP-889

Special Topics

This is a PhD-level course on a topic that is not part of the formal curriculum. This course is structured as an ordinary course and has specific prerequisites, contact hours, and examination procedures. (This course requires permission of the Instructor to enroll.) **Lecture, Credits 1 - 3**

ASTP-890

Research and Thesis

Dissertation research by the candidate for an appropriate topic as arranged between the candidate and the research advisor. (Enrollment in this course requires permission from the department offering the course.) **Thesis, Credits 1 - 6 (Fall, Spring, Summer)**

ASTP-891

Continuation of Thesis

Continuation of Thesis **Cont, Credits 0 (Fall, Spring, Summer)**

ASTP-899

AST Independent Study

This course is a faculty-directed tutorial of appropriate topics that are not part of the formal curriculum. The level of study is appropriate for a PhD-level student. (Enrollment in this course requires permission from the department offering the course.) **Ind Study, Credits 1 - 3**

Biological Sciences

BIOL-601

Genetic Diseases and Disorders

The identification of genetic causes of disease has been one of the major modern scientific breakthroughs. This course examines a range of inherited diseases, how causative genetic variations were or are being identified, and what this means for the treatment of the diseases. Scientific literature will be utilized, both current and historical. (Prerequisites: BIOL-321 or equivalent course or graduate student standing.) **Lecture 3, Credits 3 (Spring)**

BIOL-625

Ethics in Bioinformatics

This course will be focused on individual and organizational responsibilities in bioinformatics research, product development, product commercialization and clinical and consumer genetic testing. (This course is restricted to students in the BIOINFO-MS, BIOINFO-BS/MS program.) **Lecture 3, Credits 3 (Fall)**

BIOL-630

Bioinformatics Algorithms

Bioinformatics Algorithms 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 through computer programming. (This course is restricted to students in the BIOINFO-MS, BIOINFO-BS/MS program.) **Lab 3, Credits 3 (Fall)**

BIOL-630

Bioinformatics Algorithms

Bioinformatics Algorithms 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 through computer programming. (This course is restricted to students in the BIOINFO-MS, BIOINFO-BS/MS program.) **Lecture 2, Credits 3 (Fall)**

BIOL-635

Bioinformatics Seminar

The course provides opportunities for students and faculty to develop and share professional interests while discussing current trends and developments in bioinformatics. Material for this course will be drawn from the current scientific literature. (This course is restricted to students in the BIOINFO-MS, BIOINFO-BS/MS program.) **Lecture 3, Credits 3 (Fall)**

BIOL-650**High Throughput Sequencing Analysis**

Students will utilize commonly used bioinformatics tools to analyze a real High Throughput Sequencing data set starting with raw data, proceeding with quality control, either aligning to a reference genome or performing de novo assembly, assessing differential gene expression determination, and finally annotating their results. Weekly lab reports will be required, and a group manuscript is expected at the end of the semester. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lab 2, Credits 3 (Spring)**

BIOL-650**High Throughput Sequencing Analysis**

Students will utilize commonly used bioinformatics tools to analyze a real High Throughput Sequencing data set starting with raw data, proceeding with quality control, either aligning to a reference genome or performing de novo assembly, assessing differential gene expression determination, and finally annotating their results. Weekly lab reports will be required, and a group manuscript is expected at the end of the semester. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 2, Credits 3 (Spring)**

BIOL-655**Biogeography**

This course is the study of the distribution of biodiversity on the earth. Patterns of past and present animal and plant distributions are used to help understand the mechanisms of basic biological processes including speciation, dispersal, divergence and extinction. This course will cover the character and history of the science of biogeography, as well as its basic principles and applications. We will also examine the assumptions, methods and conclusions of historically significant biogeographic studies. (Prerequisites: BIOL-240 or BIOL-265 or graduate student standing in the ENVS-MS program.) **Lecture 3, Credits 3 (Spring)**

BIOL-671**Database Management for the Sciences**

Students will learn to create and maintain efficient relational databases for use in modeling and analysis in the sciences. Topics will include an introduction to relational algebra, SQL, and advanced relational designs. (Graduate Science) **Lecture 2, Credits 3 (Spring)**

BIOL-671**Database Management for the Sciences**

Students will learn to create and maintain efficient relational databases for use in modeling and analysis in the sciences. Topics will include an introduction to relational algebra, SQL, and advanced relational designs. (Graduate Science) **Studio 2, Credits 3 (Spring)**

BIOL-672**Computational Statistics and Data Science Methods**

This course will introduce traditional multivariate statistical methods and multi-model inference, as well as iterative computational algorithms (i.e. Bayesian methods and machine learning) appropriate for graduate students conducting or planning to conduct a graduate research project. The course will focus on the proper application of methods to a sample data sets using statistical programming software and graphics and will forego the more in-depth analytical mathematical exposition that you might see in a math course, so that we can cover a larger variety of methods and spend more time implementing them in code. Practical examples will often derive from the fields of biology, environmental science, or medicine, however the statistical methods we cover will also have much broader application within modern data science. The ultimate goal will be to learn when and where to correctly apply a given method to real questions about real data. Class time will be devoted to introductory lecture, programming language demonstrations with a common dataset, and open discussions of potential applications, including in-class studio hours to help with homework. Students should be prepared to learn to write code scripts that will manipulate statistical tests and graphical output. However, no background experience with programming is assumed. All software used in the course is open-source and students will be required to set up and run weekly assignments on their own laptop computer or on a computer borrowed from the library or RIT's computer lab. (Prerequisites: STAT-145 or equivalent course or graduate student standing.) **Lecture 2, Credits 3 (Fall, Spring)**

BIOL-672**Computational Statistics and Data Science Methods**

This course will introduce traditional multivariate statistical methods and multi-model inference, as well as iterative computational algorithms (i.e. Bayesian methods and machine learning) appropriate for graduate students conducting or planning to conduct a graduate research project. The course will focus on the proper application of methods to a sample data sets using statistical programming software and graphics and will forego the more in-depth analytical mathematical exposition that you might see in a math course, so that we can cover a larger variety of methods and spend more time implementing them in code. Practical examples will often derive from the fields of biology, environmental science, or medicine, however the statistical methods we cover will also have much broader application within modern data science. The ultimate goal will be to learn when and where to correctly apply a given method to real questions about real data. Class time will be devoted to introductory lecture, programming language demonstrations with a common dataset, and open discussions of potential applications, including in-class studio hours to help with homework. Students should be prepared to learn to write code scripts that will manipulate statistical tests and graphical output. However, no background experience with programming is assumed. All software used in the course is open-source and students will be required to set up and run weekly assignments on their own laptop computer or on a computer borrowed from the library or RIT's computer lab. (Prerequisites: STAT-145 or equivalent course or graduate student standing.) **Studio 2, Credits 3 (Fall, Spring)**

BIOL-673**Marine Biology**

This course explores marine biology by focusing on the diversity of life and influence of oceanographic phenomena on the various ecosystems. Morphological and physiological adaptations along with environmental threats will also be investigated. The course will explore marine conservation issues, in depth. (Prerequisites: BIOL-240 or equivalent course or graduate student standing in the ENVS-MS program.) **Lecture 4, Credits 4 (Fall)**

BIOL-675**Advanced Conservation Biology**

This course focuses 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. Students will explore a topic in depth through writing a review paper of published literature. (Prerequisites: BIOL-240 or equivalent course or graduate student standing in the ENVS-MS program.) **Lecture 3, Credits 3 (Spring)**

BIOL-689**Graduate Special Topics**

This is a graduate course on a topic that is not part of the formal curriculum. This course is structured as an ordinary course and has specific prerequisites, contact hours, and examination procedures. **Lec/Lab, Credits 1 - 4 (Fall, Spring, Summer)**

BIOL-694**Molecular Modeling and Proteomics**

This course will explore two facets of protein molecules: their separation and their structure. The structure component will build upon information from earlier bioinformatics courses. Protein separation techniques will be addressed in lectures with descriptions of 2D gel electrophoresis and chromatography. Algorithms of protein secondary structure prediction will be implemented. Experimental techniques for tertiary structure determination such as NMR will be covered. The course will also include the analysis of inter-molecular interactions, such as ligand/receptor pairing, by employing software that permits modeling of molecular docking experiments. (Prerequisite: BIOL-327 or equivalent course or student standing in BIOINFO-MS.) **Lab 2, Credits 3 (Spring)**

BIOL-694**Molecular Modeling and Proteomics**

This course will explore two facets of protein molecules: their separation and their structure. The structure component will build upon information from earlier bioinformatics courses. Protein separation techniques will be addressed in lectures with descriptions of 2D gel electrophoresis and chromatography. Algorithms of protein secondary structure prediction will be implemented. Experimental techniques for tertiary structure determination such as NMR will be covered. The course will also include the analysis of inter-molecular interactions, such as ligand/receptor pairing, by employing software that permits modeling of molecular docking experiments. (Prerequisite: BIOL-327 or equivalent course or student standing in BIOINFO-MS.) **Lecture 2, Credits 3 (Spring)**

BIOL-789**Graduate Special Topics**

This is a graduate course on a topic that is not part of the formal curriculum. This course is structured as an ordinary course and has specific prerequisites, contact hours, and examination procedures. **Lec/Lab, Credits 1 - 4 (Fall, Spring, Summer)**

BIOL-790**Research and Thesis**

Masters-level research by the candidate on an appropriate topic as arranged between the candidate and the research advisor. (This course requires permission of the Instructor to enroll.) **Thesis, Credits 1 - 6 (Fall, Spring, Summer)**

BIOL-791**Continuation of Thesis**

Continuation of Thesis Cont, Credits 0

BIOL-798**Grad Biology Independent Study**

This course is a faculty-directed, graduate level tutorial of appropriate topics that are not part of the formal curriculum. (Enrollment in this course requires permission from the department offering the course.) **Ind Study, Credits 1 - 4 (Fall, Spring, Summer)**

Chemistry**CHEM-670****Graduate Chemistry Writing**

Chemists are required to communicate information about their research, laboratory, and themselves in writing. This course is designed to develop these skills. Students will learn how to write a curriculum vitae, resume, laboratory overview, short and long research abstracts, and scientific research articles using the various formats and styles used by chemists. An integral part of the writing of a research article is the initial formulation of the research hypothesis and design of experiments to test the hypothesis. This course will also review and stress the importance of these components. (Prerequisites: Graduate standing in CHEM-MS.) **Lecture 1, Credits 1 (Fall)**

CHEM-699**Chemistry Graduate Co-op**

Cooperative work experience for graduate chemistry students. Credit 0 **CO OP, Credits 0 (Fall, Spring, Summer)**

CHEM-771**Graduate Chemistry Seminar I**

Chemists are required to communicate information about their research, laboratory, and themselves orally. Graduate Chemistry Seminar I is the first in a series of four courses designed to develop the ability to assimilate useful information and organize a chemistry seminar while increasing a student's breadth and depth of knowledge of chemical research topics. This seminar requires the students to attend weekly chemistry seminars and write seminar summaries. Additionally, each student will present a seminar on their proposed research that also summarizes the scientific literature related to the research. (Prerequisites: Graduate standing in CHEM-MS.) **Lecture 1, Credits 1 (Fall)**

CHEM-772**Graduate Chemistry Seminar II**

Chemists are required to communicate information about their research, laboratory, and themselves orally. Graduate Chemistry Seminar II is the second in a series of four courses designed to develop the ability to assimilate useful information and organize a chemistry seminar while increasing a student's breadth and depth of knowledge of chemical research topics. This seminar requires the students to attend weekly chemistry seminars and write seminar summaries. (Prerequisites: CHEM-771 or equivalent course.) **Lecture 1, Credits 1 (Spring)**

CHEM-773**Graduate Chemistry Seminar III**

Chemists are required to communicate information about their research, laboratory, and themselves orally. Graduate Chemistry Seminar III is the third in a series of four courses designed to develop the ability to assimilate useful information and organize a chemistry seminar while increasing a student's breadth and depth of knowledge of chemical research topics. This seminar requires students to attend weekly chemistry seminars and write seminar summaries throughout the four semesters. Additionally, each student must invite, organize, host, and introduce an external seminar speaker to participate in the Chemistry Seminar Series. (Prerequisites: CHEM-772 or equivalent course.) **Lecture 1, Credits 1 (Fall)**

CHEM-774**Graduate Chemistry Seminar IV**

Professional chemists are required to communicate information about their research, laboratory, and themselves orally. Graduate Chemistry Seminar IV is the fourth in a series of four courses designed to develop the ability to assimilate useful information and organize a chemistry seminar while increasing a student's breadth and depth of knowledge of chemical research topics. This seminar requires the students to attend weekly chemistry seminars and write seminar summaries. Additionally, each student will present a seminar summarizing their thesis research at RIT which serves as the public portion of their thesis defense. (Prerequisites: CHEM-773 or equivalent course.) **Lecture 1, Credits 1 (Spring)**

CHEM-780**Chemistry Project**

Chemistry project accomplished by the MS student for an appropriate topic as arranged between the candidate and the project advisor. (Enrollment in this course requires permission from the department offering the course.) **Project, Credits 1 - 4 (Fall, Spring, Summer)**

CHEM-781**Continuation of Project**

This course is a graduate course for students enrolled in the Project track of the MS Chemistry Program. (Enrollment in this course requires permission from the School of Chemistry and Materials Science offering the course.) **Project, Credits 0 (Fall, Spring, Summer)**

CHEM-789**Graduate Special Topics**

This is a master-level course on a topic that is not part of the formal curriculum. This course is structured as an ordinary course and has specific prerequisites, contact hours, and examination procedures. (This course requires permission of the Instructor to enroll.) **Lecture, Credits 1 - 3 (Fall, Spring, Summer)**

CHEM-790**Research and Thesis**

Dissertation research by the candidate for an appropriate topic as arranged between the candidate and the research advisor. (Enrollment in this course requires permission from the department offering the course.) **Thesis, Credits 1 - 6 (Fall, Spring, Summer)**

CHEM-791**Continuation of Thesis**

Continuation of Thesis **Cont, Credits 0**

CHEM-799**Independent Study**

This course is a faculty-directed tutorial of appropriate topics that are not part of the formal curriculum. The level of study is appropriate for a masters-level student. (Enrollment in this course requires permission from the department offering the course.) **Ind Study, Credits 1 - 3 (Fall, Spring, Summer)**

CHMA-621**Advanced Instrumental Analysis Lab**

This is a capstone course requiring students to develop experimental protocols involving advanced techniques in instrumental analysis. This course is intended to give an opportunity to develop innovative skills and writing proficiency. Library, literature and textbook research will be required. (Prerequisites: CHMB-405 or CHMP-445 or Graduate Standing in CHEM-MS.) **Lab 6, Credits 3 (Spring)**

CHMA-650**Separations and Mass Spectroscopy in Biological Chemistry**

This course will teach state of the art chemical separations and methods which are coupled to mass spectroscopy for the modern analysis of pharmaceutical and biotechnology samples in industrial and academic laboratories. These include gas chromatography (GC, GC-MS), high performance liquid chromatography (HPLC, LC-MS), solid phase extraction (SPE and SPME), size exclusion/gel permeation (SEC, GPC), and ion exchange chromatography (IXC). Aspects of mass spectroscopy including ionization methods of electron impact (EI), chemical ionization (CI), positive and negative electrospray (ES+, ES-), APCI, and MALDI and techniques involving single and multiple ion/reaction methods (SIM, SRM, MRM) will be included. The separation and analysis of peptides, proteins and pharmaceuticals by LC and LC-MS will be a major focus. Isolation of drug metabolites from serum by SPE followed by HPLC analysis or using size exclusion chromatography to separate biomolecules, or labeling a peptide with a near infrared (NIR) dye are examples of important skills that are learned. (Prerequisites: (CHMG-111 or CHMG-131 or CHMG-141 or CHEM-151) and (CHMG-145 or CHEM-155) and (CHMO-231 or CHMO-331) or equivalent courses.) **Lab 3, Credits 3 (Spring)**

CHMA-650**Separations and Mass Spectroscopy in Biological Chemistry**

This course will teach state of the art chemical separations and methods which are coupled to mass spectroscopy for the modern analysis of pharmaceutical and biotechnology samples in industrial and academic laboratories. These include gas chromatography (GC, GC-MS), high performance liquid chromatography (HPLC, LC-MS), solid phase extraction (SPE and SPME), size exclusion/gel permeation (SEC, GPC), and ion exchange chromatography (IXC). Aspects of mass spectroscopy including ionization methods of electron impact (EI), chemical ionization (CI), positive and negative electrospray (ES+, ES-), APCI, and MALDI and techniques involving single and multiple ion/reaction methods (SIM, SRM, MRM) will be included. The separation and analysis of peptides, proteins and pharmaceuticals by LC and LC-MS will be a major focus. Isolation of drug metabolites from serum by SPE followed by HPLC analysis or using size exclusion chromatography to separate biomolecules, or labeling a peptide with a near infrared (NIR) dye are examples of important skills that are learned. (Prerequisites: (CHMG-111 or CHMG-131 or CHMG-141 or CHEM-151) and (CHMG-145 or CHEM-155) and (CHMO-231 or CHMO-331) or equivalent courses.) **Lecture 2, Credits 3 (Spring)**

CHMA-670**Advanced Concepts of Environmental Chemistry**

This course will build on previous chemistry courses to expand knowledge of biogeochemical cycles, environmental toxicology and applied methods of environmental analysis. The course will be conducted in a workshop format at the graduate level. (Prerequisites: CHMO-231 and CHMO-235 or CHMO-331 and CHMO-335 or equivalent courses.) **Lecture 3, Credits 3 (Spring)**

CHMA-711**Advanced Instrumental Analysis**

The theory, applications, and limitations of selected instrumental methods in qualitative, quantitative and structural analysis will be discussed. This course is also intended to give an opportunity to develop writing and revising abilities, as well as communication skills. Library, literature, and textbook research will be required. (Prerequisite: CHMA-261 or equivalent course or graduate student standing.) **Lecture 3, Credits 3 (Fall)**

CHMA-725**The Magnetic Resonance Family**

This course presents the magnetic resonance family of techniques. General techniques include nuclear magnetic resonance (NMR), electron spin resonance (ESR), nuclear quadrupole resonance (NQR), and muon spin resonance (μSR). Each technique will be presented in enough detail to give the student an appreciation of its capabilities and an understanding the theory of the spectroscopy. (Prerequisites: Graduate standing in CHEM-MS.) **Lecture 3, Credits 3 (Fall)**

CHMA-740**Practical NMR**

A graduate level lecture and laboratory course designed to teach a student how to use a Bruker high-resolution NMR spectrometer to perform a variety of chemical analyses. Students are presented a series of brief descriptions of how to perform various functions and experiments on a Bruker NMR. Students then receive hands-on training and perform the experiment. Specific operations taught include: file management, magnet shimming, probe tuning, parameter optimization, pulse sequence development, one-dimensional and two-dimensional acquisitions, variable temperature studies, data processing, diffusion measurements, and measuring relaxation times. This course serves as mechanism to gain different levels of access to the Chemistry Department's NMR spectrometers. (Prerequisites: CHMO-332 or CHMA-221 or equivalent course or graduate standing in CHEM-MS.) **Lecture 5, Credits 3 (Spring)**

CHMA-750**NMR Spectrometer Maintenance**

This course is designed to introduce the technical aspects of keeping a magnetic resonance system operating. The theory of operation of the magnet, radio frequency, pulse programmer, computer, and supporting subsystems of a magnetic resonance instrument will be studied. Emphasis is placed on relating theory to achievable practice and the consequences of differences between the two. Techniques for troubleshooting problems will be presented and developed. (Prerequisites: CHMA-725 and CHMP-747 and CHMA-740 or equivalent courses.) **Lecture 3, Credits 3 (Fall)**

CHMB-610**Advanced Protein Biochemistry: Structure and Function**

This course analyzes protein structure function relationships. Students will investigate how proteins function and how the structure relates to that function. The principles that explain enzyme rate enhancements and mechanistic enzymology will be examined. Additionally, protein superfamilies for phylogenetic relationships will be explored to enhance understanding of protein structure-function relationships. Students will read and discuss the current scientific literature and classic papers. (Prerequisites: CHMB-402 or equivalent course or degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Spring)**

CHMB-702**Protein Conformation and Dynamics**

An advanced study of the structure and function of proteins and enzymes. Biophysical and mechanistic aspects of enzyme function will be examined. Applications of computation to protein structure will also be discussed. (Prerequisites: CHMB-402 or equivalent course or degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall)**

CHMB-704**Advanced Nucleic Acids Biochemistry: Structure and Function**

This course will cover nucleic acid structures as determined by NMR and X-ray crystallography and nucleic acid catalysis, especially that of ribozymes. Genomics, specifically whole-genome sequencing papers, will be analyzed. Current RNA topics including the RNA World, Ribozymes, RNAi, and Riboswitches will be discussed. Current DNA topics including Lateral/Horizontal DNA Transfer, Genome Duplication, Alternate Gene Expression and Synthetic Life will also be discussed. (Prerequisites: CHMB-402 or equivalent course or degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall, Spring)**

CHMI-664**Modern Inorganic Chemistry**

This course will apply molecular structure and bonding theory to explain inorganic coordinate complex structure and function, and coordination reaction chemistry. The topics discussed in this course are molecular structure, symmetry, bonding theory, d-block electronic structure and properties, and the reaction mechanisms controlling coordinate complexes. Students will be expected to translate the concepts learned in class to solving analytical and structural analysis problems inorganic systems. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall)**

CHMO-636**Spectrometric Identification of Organic Compounds**

This course covers the theory and application of proton, carbon-13, and correlation nuclear magnetic resonance, infrared, and mass spectrometry for organic structure determination. (Prerequisites: CHMO-332 with a grade of C- or better or equivalent course or Graduate Standing in CHEM-MS.) **Lecture 3, Credits 3 (Fall)**

CHMO-637**Advanced Organic Chemistry**

This course will revisit many of the reactions covered in the first year of organic chemistry with an emphasis on stereochemical control. Students will be introduced to the technique of retrosynthesis. The course will introduce more reactions with an emphasis on current topics from the literature. Students will hone their skills in writing electron pushing mechanisms and the use of protecting groups while practicing the art of designing synthetic strategies for making natural products. (Prerequisites: Graduate standing or CHMO-332 or CHMO-232 with a grade of B or better or equivalent course. Grad or CHMO-332 or CHMO) **Lecture 3, Credits 3 (Fall)**

CHMO-640**Mechanisms of Drug Interactions**

Drugs are naturally occurring or synthetic substances that upon exposure to a living organism form complexes with biological targets. These complexes result in a characteristic pharmacological effect which alter physiological functions or counteract environmental insults. The goal of this course is to systematically study drug discovery, lead optimization, drug-receptor interactions, and bioavailability. Historically important drug classes and their mechanism of action will receive special consideration. (Prerequisites: CHMO-637 or equivalent course or Graduate Standing in CHEM-MS.) **Lecture 3, Credits 3 (Spring)**

CHMO-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 the synthesis of 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. This course may be repeated for credit. (Prerequisites: CHMO-637 or equivalent course.) **Lecture 1, Credits 1 (Fall, Spring)**

CHMO-739**Advanced Physical Organic Chemistry**

This course covers topics in physical organic chemistry including: techniques for elucidation of mechanism (kinetic, and linear free energy relationships); isotope effects; molecular orbital theory; and electrocyclic reactions. (Prerequisites: CHMO-332 and CHMP-441 or equivalent course or Graduate Standing in CHEM-MS.) **Lecture 3, Credits 3 (Spring)**

CHMO-750**Survey of Organic Named Reactions**

The course will explore a litany of named organic reactions with an emphasis on the reaction mechanisms. Learning the mechanism to the named reactions is a classical way to teach organic chemistry students the rules of mechanism writing. Having a dictionary type recall of the named reactions is a fundamental tool for success in organic chemistry. This course will introduce the students to new reagents and reactions by surveying named organic reactions with an emphasis on the reaction mechanisms. The goal of the course is to generate an understanding of the reaction mechanism and use that understanding to predict the reactivity of substrates in organic chemical reactions. (Prerequisites: Graduate standing or CHMO-332 or CHMO-232 with a grade of B or better or equivalent course. Grad or CHMO-332 or CHMO) **Lecture 3, Credits 3 (Fall, Spring)**

CHMP-747**Principles of Magnetic Resonance**

This course is designed to present the theory of magnetic resonance from a physical chemistry perspective. Students will learn about isotropic and anisotropic proton-electron hyperfine, proton-electron dipolar, and proton-proton dipolar interactions; choosing basis functions and eigenfunctions for energy states; setting up the Hamiltonian; and solving for the energies of the states in both the rigid (solid) and rapidly tumbling (liquid) states. The dynamic nature of magnetic resonance will be developed from a kinetic perspective and focus on relaxation times, observable phenomena on the magnetic resonance timescale, and line broadening. Pulsed NMR will be presented from a classical perspective emphasizing spin packets, net magnetization, and rotation matrices through the Bloch equations. (Prerequisites: CHMP-442 or equivalent course or Graduate Standing in CHEM-MS.) **Lecture 3, Credits 3 (Fall)**

CHMP-751**Colloid and Interface Science**

The parallel growth of nanotechnology and a molecular perspective in the medical and life sciences has focused attention on the colloidal domain structures of dimension 1 nm to 1 μm . This course will introduce colloid and interface science that will allow for an appreciation of the role of colloids in biological systems, industrial processes and commercial products. (Prerequisites: CHMP-441 or equivalent course or Graduate Standing in CHEM-MS.) **Lecture 3, Credits 3 (Fall)**

CHMP-752**Molecular Photophysics and Photochemistry**

This course provides a comprehensive and clear description of the concepts and principles of molecular photophysical processes and photochemistry. The practical methods required for associated photophysical characterization and measurement are presented along with important applications of molecular photonics in cutting-edge research. A review of quantum mechanics is given with the photochemist in mind such that the student is encouraged to make more use of quantum mechanical terms, quantities and concepts. The course covers the interaction of light with molecular orbitals to form an excited state, and its subsequent deactivation. Applications such as lasers, spectroscopy, photoinduced charge transfer in modern organic photovoltaics and photosynthesis are described. (Prerequisites: CHMP-442 or equivalent course or Graduate Standing in CHEM-MS.) **Lecture 3, Credits 3 (Spring)**

CHMP-753**Computational Chemistry**

This course will introduce students to an in-depth investigation into the computational theories and applications used to model complex physical and chemical phenomena. Computational methods are used to provide synergy linking experiment with theory involving such chemical processes as reaction mechanisms, docking, energy transfer and conformational conversions. Predicting spectral and thermodynamic properties of molecular systems and ensembles will also be treated. (Prerequisites: CHMP-442 or equivalent course or Graduate Standing in CHEM-MS.) **Lecture 3, Credits 3 (Fall)**

CHPO-706**Polymer Synthesis**

This course is mainly about the chemistry applied to synthesize polymers. It includes initially the introduction on the naming and classification and some relevant properties of polymers. We will then discuss the two main methods of synthesizing polymers, namely step-growth polymerization and chain-addition polymerization. Among the step-growth polymerizations, syntheses of different types of polyesters, polyamides, polyurethanes etc. including the reaction mechanisms will be covered. Under chain-addition polymerizations, those by four different initiators (radical, cationic, anionic or coordinative) will be explained. The mechanisms of these types of reactions will be discussed in more detail and, where feasible, effects of stereochemistry or regiochemistry will be included. In addition to the commodity polymers in each category, also the syntheses of some specialty step-growth and chain addition polymers will be included. A few examples of reactions to obtain more reactive monomers will be mentioned. Some specialty type of polymerizations, such as living free radical types, or ring-opening and cyclization polymerizations, will also be discussed. We will include examples of post-polymerization reactions. Finally, we will discuss methods to resolve environmental issues with polymers by developing more sustainable polymers. (Prerequisite: CHMG-201 or MTSE-602 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

CHPO-707**Polymer Chemistry II**

This course further investigates the contemporary chemistry of high molecular weight polymers and macromolecules and the relationships between their structure, functionality, and utility. The course focuses on fundamental principles that govern swollen gels and soft matter. Mechanisms of the formation of polymers containing heteroatoms in their chains are examined in detail. Specific attention is given to the synthesis of polymers of controlled architecture and self-assembly, and of polymers and macromolecules. Dendrimers, hyper-branched polymers, functional polymers, polymeric reagents, polyelectrolytes, and biopolymers are also discussed. (Prerequisites: CHPO-706 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

CHPO-708**Polymer Synthesis and Characterization Lab**

Students will synthesize about eight polymers and characterize them carry by specific methods. In about half of those experiments step-growth polymerizations and in the other half chain-addition polymerizations will be performed. Among the polymers produced will be Nylon 6-10, Nylon 11, polystyrene, high-density polyethylene, linear low density polyethylene, copolymer of styrene and methyl methacrylate and polyurethane. The most specific types of polymerizations and reactions introduced will be cross-linking polymer, interfacial and bulk step-growth polymerizations, cyclopolymerization, radical, ionic and coordinative chain polymerizations. The methods of characterization which will be applied are infrared (IR) and nuclear magnetic resonance (NMR) spectroscopy, titrations, thermal gravimetric analysis (TGA), differential scanning calorimetry (DSC), measurement of swelling, and viscometry. (Prerequisites: CHMO-336 or equivalent course or Graduate Standing in CHEM-MS.) **Lab 8, Credits 3 (Fall)**

Cognitive Neuroscience

CGNS-601**Cognitive Neuroscience**

Cognitive neuroscience is concerned with the study of the biological processes that underlie cognition with a specific focus on neural systems in the brain that are involved in mental processes. This course provides the foundation of cognitive neuroscience including neuroanatomy, neural signaling, motor and sensory pathways, experimental methods employed in cognitive neuroscience, and discusses the neural bases of complex cognitive functions such as attention, perception, learning, memory, emotional regulation, executive control, decision making and language. Critical analysis of primary research and research projects employed in the course foster an in-depth understanding of main areas of cognitive neuroscience and its recent advances. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Spring)**

CGNS-689**Neuroscience Graduate Special Topics**

This course is a faculty-developed exploration of appropriate graduate-level neuroscience topics that are not part existing courses. The level of study is appropriate for student in their final two years of study. **Lecture, Credits 1 - 4 (Fall, Spring, Summer)**

CGNS-710**Design Thinking and Cognition**

Design thinking refers to the cognitive, strategic, and practical processes involved in problem solving and creation of innovative design concepts, which can lead to the development of new products and to aid scientific exploration. Several key concepts and aspects of design thinking have been pinpointed through studies of design cognition, focusing on understanding of how designers think when they are trying to find creative and original solutions for vague, ill-defined problems. Currently, cognitive neuroscientists are becoming increasingly interested in identified brain mechanisms of design thinking. This course focuses on the principles, processes, and scientific underpinnings of design thinking and their applications to real-life innovative problem solving. (Prerequisite: CGNS-601 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

CGNS-799**Neuroscience Graduate Independent Study**

This course is a faculty-directed exploration of appropriate advanced multi-disciplinary topics that are not part of the formal curriculum. The level of study is appropriate for student in their final two years of study. **Ind Study, Credits 1 - 4 (Fall, Spring, Summer)**

Color Science

CLRS-600**Fundamentals of Color Science**

This asynchronous online course provides a technical introduction to color science and the CIE system of colorimetry. Topics covered include color perception, color measurement, color spaces, and applications. The course is intended for students with a technical background who are interested in adding an elective course in color science to their graduate program and for practitioners in the color field interested in a more thorough understanding of the science behind colorimetry. Cannot be taken for program credit by Color Science MS and PhD students. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Summer)**

CLRS-601**Principles of Color Science**

This course covers the principles of color science including theory, application, and hands-on experience incorporated into the lectures. Topics include color appearance (hue, lightness, brightness, chroma, saturation, colorfulness), colorimetry (spectral, XYZ, xyY, $L^*a^*b^*$, L^*C^*ab , ΔE^*ab , $\Delta E00$), the use of linear algebra in color science and color imaging, metamerism, chromatic adaptation, color inconstancy, color rendering, color appearance models (CIECAM02), and image appearance models (S-CIELAB, iCAM). (Prerequisites: Graduate standing in CLRS-MS, IMGS-MS, CLRS-PHD or IMGS-PHD.) **Lecture 3, Credits 3 (Fall)**

CLRS-602**Color Physics and Applications**

This course explores the relationship between a material's color and its constituent raw materials such as colorants, binding media, substrates, and overcoats. These can be determined using a variety of physical models based on absorption, scattering, luminescence, and interference phenomena. These models enable the production of paints, plastics, colored paper, printing, and others to have specific colors. Accompanying laboratories will implement and optimize these models using filters, artist opaque and translucent paints and varnishes including metallic and pearlescent colorants, and inkjet printing. Statistical techniques include principal component analysis and linear and nonlinear optimization. (Prerequisites: CLRS-601 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

CLRS-689**Special Topics**

This is an introductory graduate course on a topic that is not part of the formal curriculum. This course is structured as an ordinary course and has specific prerequisites, contact hours, and examination procedures. **Lec/Lab, Credits 1 - 4 (Fa/sp/su)**

CLRS-699**Color Science Graduate Co-op**

Cooperative work experience for graduate color science students. **CO OP, Credits 0 (Fall, Spring, Summer)**

CLRS-720**Computational Vision Science**

Computational Vision Science This course provides an introduction to modern computer-based methods for the measurement and modeling of human vision. Lectures will introduce the experimental techniques of visual psychophysics including threshold measurement, psychometric functions, signal detection theory, and indirect, direct, and multidimensional scaling. Lectures will also introduce the MATLAB technical computing environment and will teach how to use MATLAB to run computer-based psychophysical experiments and to analyze experimental data and visualize results. Laboratory exercises will provide practical experience in using computer-based tools to conduct psychophysical experiments and to develop computational models of the results. Prior experience in vision science and/or scientific computing will be helpful but is not required. (Prerequisites: Graduate standing in CLRS-MS, IMGS-MS, CLRS-PHD or IMGS-PHD.) **Lecture 3, Credits 3 (Fall)**

CLRS-750**Historical Research Perspectives**

Historical Research Perspectives is a weekly forum in which students will learn about historical and classic topics in color science. The course focuses on journal club discussions of papers selected by the students and faculty. It also includes oral presentations from students, laboratory staff, and faculty as well as visiting speakers from within and external to RIT. Students will prepare their own oral presentations and written assignments based on the course readings and independent research. Students will develop professional skills required for formal scientific presentations and writing. (Prerequisites: Graduate standing in CLRS-MS or CLRS-PHD.) **Seminar 1, Credits 1 (Fall)**

CLRS-751**Research and Publication Methods**

Color Science Seminar II is a weekly forum in which students will learn about current research topics in color science. The course focuses on journal club discussions of papers selected by the students and faculty. It also includes oral presentations from students, laboratory staff, and faculty as well as visiting speakers from within and external to RIT. Students will prepare their own oral presentations and written assignments based on the course readings and independent research. Students will further develop professional skills required for formal scientific presentations and writing. A draft thesis or dissertation proposal will also be prepared. (Prerequisites: CLRS-750 or equivalent course.) **Seminar 2, Credits 2 (Spring)**

CLRS-780**Color Science Graduate Project**

This course is a faculty-directed exploration of appropriate advanced multi-disciplinary topics that are not part of the formal curriculum. The level of study is appropriate for student in their final two years of study. **Project, Credits 1 - 4 (Fall, Spring, Summer)**

CLRS-789**Special Topics**

This is an advanced graduate course on a topic that is not part of the formal curriculum. This course is structured as an ordinary course and has specific prerequisites, contact hours, and examination procedures. (This course requires permission of the Instructor to enroll.) **Lec/Lab, Credits 1 - 4 (Fall, Spring, Summer)**

CLRS-790**Research and Thesis**

Masters-level research by the candidate on an appropriate topic as arranged between the candidate and the research advisor. (Enrollment in this course requires permission from the department offering the course.) **Thesis, Credits 1 - 6 (Fall, Spring, Summer)**

CLRS-791**Continuation of Thesis**

Continuation of Thesis **Cont, Credits 0 (Fall, Spring, Summer)**

CLRS-799**Color Science Independent Study**

Ind Study, Credits 1 - 4 (Fall, Spring, Summer)

CLRS-820**Modeling Visual Perception**

This course presents the transition from the measurement of color matches and differences to the description and measurement of color appearance in complex visual stimuli. This seminar course is based mainly on review and student-led discussion of primary references. Topics include: appearance terminology, appearance phenomena, viewing conditions, chromatic adaptation, color appearance modeling, image appearance, image quality, and material appearance. (Prerequisites: CLRS-601 and CLRS-720 or equivalent courses.) **Lecture 3, Credits 3 (Spring)**

CLRS-889**Special Topics**

This is an Ph.D.-level advanced graduate course on a topic that is not part of the formal curriculum. This course is structured as an ordinary course and has specific prerequisites, contact hours, and examination procedures. (This course requires permission of the Instructor to enroll.) **Lec/Lab, Credits 1 - 4 (Fall, Spring, Summer)**

CLRS-890**Research and Thesis**

Masters-level research by the candidate on an appropriate topic as arranged between the candidate and the research advisor. (Enrollment in this course requires permission from the department offering the course.) **Thesis, Credits 1 - 6 (Fall, Spring, Summer)**

CLRS-891**Continuation of Thesis**

Continuation of Thesis **Cont, Credits 0 (Fall, Spring, Summer)**

Environmental Science

ENVS-601**Environmental Science Graduate Studies I**

This course helps graduate 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 effective communication to a diverse audience. This course will introduce students to careers in environmental science, to graduate studies in environmental science at RIT, and to the process of defining, conducting, presenting, and defending a thesis proposal. (This course is restricted to students in the ENVS-MS, ENVS-BS/MS program.) **Lecture 2, Credits 2 (Fall)**

ENVS-602**Environmental Science Graduate Studies II**

A continuation of Grad Studies I, which helps graduate students learn how to assess journal articles, government reports, whitepapers, and essays as well as other relevant sources of information. Students will continue to refine their discussion and presentation skills and gain experience in clarifying their comments and responding to questions from an audience. Student will complete the process of defining, creating, presenting, and defending a thesis proposal. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 1, Credits 1 (Spring)**

ENVS-615**Aquatic Ecology Seminar**

This graduate seminar course in aquatic ecology will focus on reading and critical evaluation of the peer-reviewed literature, formal and informal communication skills, and discussion of ongoing research in aquatic ecology. This discussion-based course is student lead, and may be retaken for credit. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 1, Credits 1 (Fall, Spring)**

ENVS-631**Climate Change: Science Technology and Policy**

This multidisciplinary course will provide students with diverse perspectives on global climate change issues, providing a survey of important aspects of the problem augmented by readings in the primary literature. Topics include atmospheric chemistry, climate modeling, ecological impacts and feedbacks, economics of climate change, international climate policies, and social and environmental justice. The course will include a variety of instructors and guest lecturers, providing an overview of the complex and inter-related nature of global climate change. The course will culminate in a project based on finding solutions to the real-world problem of climate change. Students will be required to take a leadership role in bridging the multiple disciplines presented (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Spring)**

ENVS-650**Hydrologic Applications of Geographic Information Systems**

Aerial photography, satellite imagery, Global Positioning Systems (GPS), and Geographic Information Systems (GIS) are extremely useful tools in hydrologic modeling and environmental applications such as rainfall runoff modeling, pollution loading, landscape change analyses, and terrain modeling. This course will: 1) introduce students to spatial analysis theories, techniques and issues associated with hydrologic and environmental applications; 2) provide hands-on training in the use of these spatial tools and models while addressing a real problem; 3) provide experience linking GIS and model results to field assessments and monitoring activities; 4) enable students to solve a variety of spatial and temporal hydrologic and environmental problems; and 5) provide tools useful for addressing environmental problems related to the graduate thesis or project. (Prerequisites: ENVS-250 or equivalent course or graduate standing in the ENVS-MS program.) **Lec/Lab 6, Credits 4 (Spring)**

ENVS-670**Advanced Concepts of Environmental Chemistry**

This course will build on previous chemistry courses to expand knowledge of biogeochemical cycles, environmental toxicology and applied methods of environmental analysis. The course will be conducted in a workshop format at the graduate level. (Prerequisites: CHMO-231 and CHMO-235 or CHMO-331 and CHMO-335 or equivalent courses.) **Lec/Lab 3, Credits 3 (Spring)**

ENVS-689**Graduate Special Topics**

This is a graduate course on a topic that is not part of the formal curriculum. This course is structured as an ordinary course and has specific prerequisites, contact hours, and examination procedures. **Lec/Lab, Credits 1 - 4 (Fall, Spring, Summer)**

ENVS-780**Environmental Science Project**

This course will result in an Environmental Science project accomplished by the MS student for an appropriate topic as arranged between the candidate and the project advisor. Credit 1-6 (This course requires permission of the Instructor to enroll.) **Project, Credits 1 - 6 (Fall, Spring, Summer)**

ENVS-789**Graduate Special Topics**

This is a graduate course on a topic that is not part of the formal curriculum. This course is structured as an ordinary course and has specific prerequisites, contact hours, and examination procedures. **Lec/Lab, Credits 1 - 4 (Fall, Spring, Summer)**

ENVS-790**Environmental Science 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. A written thesis and oral defense are required at the completion of the thesis research. (Enrollment in this course requires permission from the department offering the course.) **Thesis, Credits 1 - 4 (Fall, Spring, Summer)**

ENVS-791**Continuation of Thesis**

Continuation of Thesis **Cont, Credits 0**

ENVS-795**Environmental Science Graduate Research**

This course is a graduate level, faculty-directed, student project or research involving laboratory or field work, computer modeling, or theoretical calculations that could be considered of an original nature. The level of study is appropriate for students in Environmental Science graduate program. **Thesis, Credits 1 - 4 (Fall, Spring, Summer)**

ENVS-798**Advanced Environmental Science Independent Study**

This course is a faculty-directed tutorial of appropriate topics that are not part of the formal curriculum. The level of study is appropriate for student in the Environmental Science graduate program. (Enrollment in this course requires permission from the department offering the course.) **Ind Study, Credits 1 - 4 (Fall, Spring, Summer)**

Imaging Science

IMGS-606**Graduate Seminar I**

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. (This class is restricted to graduate students in the IMGS-MS or IMGS-PHD programs.) **Seminar I, Credits 1 (Fall)**

IMGS-607**Graduate Seminar II**

This course is a continuation of the topics addressed in the preceding course Imaging Science Graduate Seminar I. 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 addresses issues and practices associated with technical presentations. Credits earned in this course apply to research requirements. (Prerequisites: IMGS-606 or equivalent course.) **Seminar I, Credits 1 (Spring)**

IMGS-609**Graduate Laboratory I**

This laboratory course is intended to familiarize graduate students with many concepts, tools, and techniques necessary for completion of the Imaging Science graduate curriculum. Students will work in a variety of areas including scientific programming, numerical analysis, imaging system analysis, and characterization. (Pre-requisite: Graduate standing in Imaging Science or permission of the instructor.) (This class is restricted to graduate students in the IMGS-MS or IMGS-PHD programs.) **Lab 4, Credits 2 (Fall)**

IMGS-610**Graduate Laboratory II**

This laboratory course is intended to familiarize students with the concepts considered in the required Optics and Digital Image Processing courses. Students work with a variety of optical hardware in a laboratory to perform measurements and experiments in topics such as ray tracing, diffraction, optical filtering, polarization, interferometry, and holography. (Co-requisites: IMGS-633 and IMGS-682 or equivalent courses.) **Lab 3, Credits 1 (Spring)**

IMGS-613**Probability, Noise, and System Modeling**

This course develops models of 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. (Prerequisites: IMGS-616 and IMGS-619 or equivalent courses.) **Lecture 3, Credits 3 (Spring)**

IMGS-616**Fourier Methods for Imaging**

This course develops the mathematical methods required to describe continuous and discrete 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, development and use of the convolution integral, Fourier methods as applied to the analysis of linear systems. The physical meaning and interpretation of transform methods are emphasized. (This class is restricted to graduate students in the IMGS-MS or IMGS-PHD programs.) **Lecture 3, Credits 3 (Fall)**

IMGS-619**Radiometry**

This course is focused on the fundamentals of radiation propagation as it relates to making quantitative measurements with imaging systems. The course 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. The course also includes an introduction to detector figures of merit and noise concepts. (This class is restricted to graduate students in the IMGS-MS or IMGS-PHD programs.) **Lecture 3, Credits 3 (Fall)**

IMGS-620**The Human Visual System**

This course describes the underlying structure of the human visual system, the performance of those structures and the system as a whole, and introduces psychophysical techniques used to measure them. 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. (This class is restricted to graduate students in the IMGS-MS or IMGS-PHD programs.) **Lecture 3, Credits 3 (Fall)**

IMGS-622**Vision Sciences Seminar**

This seminar course provides a forum in which students, faculty, and researchers with an interest in the Vision Sciences (visual neuroscience, perception psychology, computational vision, computer graphics) can interact through reading, presentation, and discussion of classic texts and contemporary research papers in the field. Students will read and summarize weekly readings in writing and will periodically prepare presentations and lead discussions. (This class is restricted to graduate students in the IMGS-MS or IMGS-PHD programs.) **Lecture 1, Credits 1 (Fall, Spring)**

IMGS-624**Interactive Virtual Env**

This course provides experience in the development of real-time interactive three-dimensional environments, and in the use of peripherals, including virtual reality helmets, motion tracking, and eye tracking in virtual reality. Students will develop expertise with a contemporary Game Engine, along with an understanding of the computations that facilitate 3D rendering for interactive environments. Projects will cover topics such as lighting and appearance modelling, mathematics for vertex manipulation, 3D to 2D projection, ray tracing, the integration of peripherals via software development kits, and the spatial and temporal calibration of an eye tracker embedded within a head-worn display. Students will complete homework tutorials on game/application development in a contemporary computer gaming engine. This course involves a substantial programming component, and prior programming experience is required. (This class is restricted to graduate students in the IMGS-MS or IMGS-PHD programs.) **Lab 4, Credits 3 (Fall)**

IMGS-624**Interactive Virtual Env**

This course provides experience in the development of real-time interactive three-dimensional environments, and in the use of peripherals, including virtual reality helmets, motion tracking, and eye tracking in virtual reality. Students will develop expertise with a contemporary Game Engine, along with an understanding of the computations that facilitate 3D rendering for interactive environments. Projects will cover topics such as lighting and appearance modelling, mathematics for vertex manipulation, 3D to 2D projection, ray tracing, the integration of peripherals via software development kits, and the spatial and temporal calibration of an eye tracker embedded within a head-worn display. Students will complete homework tutorials on game/application development in a contemporary computer gaming engine. This course involves a substantial programming component, and prior programming experience is required. (This class is restricted to graduate students in the IMGS-MS or IMGS-PHD programs.) **Lecture 1, Credits 3 (Fall)**

IMGS-628**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. (This course is restricted to students with graduate standing in the College of Science or the Kate Gleason College of Engineering or Graduate Computing and Information Sciences.) **Lab 6, Credits 3 (Fall)**

IMGS-628**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. (This course is restricted to students with graduate standing in the College of Science or the Kate Gleason College of Engineering or Graduate Computing and Information Sciences.) **Lecture 1, Credits 3 (Fall)**

IMGS-632**Advanced Environmental Applications of Remote Sensing**

This course will focus on a broader selection of analytical techniques with an application-centric presentation. These techniques include narrow-band indices, filtering in the spatial and frequency domains, principal component analysis, textural analysis, hybrid and object-oriented classifiers, change detection methods, and structural analysis. All of these techniques are applied to assessment of natural resources. Sensing modalities include imaging spectroscopy (hyperspectral), multispectral, and light detection and ranging (lidar) sensors. Applications such as vegetation stress assessment, foliar biochemistry, advanced image classification for land use purposes, detecting change between image scenes, and assessing topography and structure in forestry and grassland ecosystems (volume, biomass, biodiversity) and built environments will be examined. Real-world remote sensing and field data from international, US, and local sources are used throughout this course. Students will be expected to perform a more comprehensive final project and homework assignments, including literature review and discussion and interpretation of results. (This course requires permission of the Instructor to enroll.) **Lab 3, Credits 3 (Spring)**

IMGS-632 Advanced Environmental Applications of Remote Sensing

This course will focus on a broader selection of analytical techniques with an application-centric presentation. These techniques include narrow-band indices, filtering in the spatial and frequency domains, principal component analysis, textural analysis, hybrid and object-oriented classifiers, change detection methods, and structural analysis. All of these techniques are applied to assessment of natural resources. Sensing modalities include imaging spectroscopy (hyperspectral), multispectral, and light detection and ranging (lidar) sensors. Applications such as vegetation stress assessment, foliar biochemistry, advanced image classification for land use purposes, detecting change between image scenes, and assessing topography and structure in forestry and grassland ecosystems (volume, biomass, biodiversity) and built environments will be examined. Real-world remote sensing and field data from international, US, and local sources are used throughout this course. Students will be expected to perform a more comprehensive final project and homework assignments, including literature review and discussion and interpretation of results. (This course requires permission of the Instructor to enroll.) **Lecture 2, Credits 3 (Spring)**

IMGS-633 Optics for Imaging

This course provides the requisite knowledge in optics needed by a student in the graduate program in Imaging Science. The topics covered include the ray and wave models of light, diffraction, imaging system resolution. (Prerequisites: IMGS-616 and IMGS-619 or equivalent courses.) **Lecture 3, Credits 3 (Spring)**

IMGS-635 Optical System Design and Analysis

The primary objectives of this course are to teach critical optics and system concepts, and skills to specify, design, simulate, and evaluate optical components and systems. A modern optical design program and various types of optical systems will be used to illustrate how to solve real-world optical engineering problems. The course is not a traditional lens design course, which usually focuses on designing and optimizing individual lens elements. Instead the course will emphasize analyzing systems, which are often made with off-the-shelf optical components. (Prerequisites: IMGS-321 or IMGS-633 or (EEEE-505 & EEEE-705) or (IMGS-322 or PHYS-365) or equivalent course.) **Lecture 1, Credits 3 (Spring)**

IMGS-639 Principles of Solid State Imaging Arrays

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 CMOS and infrared arrays. (This course is restricted to students with graduate standing in the College of Science or the Kate Gleason College of Engineering or Graduate Computing and Information Sciences.) **Lecture 3, Credits 3 (Fall)**

IMGS-640 Remote Sensing Systems and Image Analysis

This course introduces the students to the governing equations for radiance reaching aerial or satellite based imaging systems. It then covers the temporal, geometric, spectral, and noise properties of these imaging systems with an emphasis on their use as quantitative scientific instruments. This is followed by a treatment of methods to invert the remotely sensed image data to measurements of the Earth's surface (e.g. reflectance and temperature) through various means of inverting the governing radiometric equation. The emphasis is on practical implementation of multidimensional image analysis and examining the processes governing spatial, spectral and radiometric image fidelity. (Prerequisite: IMGS-251 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

IMGS-642 Testing of Focal Plane Arrays

This course is an introduction to the techniques used for the testing of solid state imaging detectors such as CCDs, CMOS and Infrared Arrays. 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. (This course is restricted to students with graduate standing in the College of Science or the Kate Gleason College of Engineering or Graduate Computing and Information Sciences.) **Lab 6, Credits 3 (Spring)**

IMGS-642 Testing of Focal Plane Arrays

This course is an introduction to the techniques used for the testing of solid state imaging detectors such as CCDs, CMOS and Infrared Arrays. 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. (This course is restricted to students with graduate standing in the College of Science or the Kate Gleason College of Engineering or Graduate Computing and Information Sciences.) **Lecture 1, Credits 3 (Spring)**

IMGS-682**Image Processing and Computer Vision**

This course will cover a wide range of current topics in modern image processing and computer vision. Topics will include introductory concepts in supervised and unsupervised machine learning, linear and nonlinear filtering, image enhancement, supervised and unsupervised image segmentation, object classification, object detection, feature matching, image registration, and the geometry of cameras. Assignments will involve advanced computational implementations of selected topics from the current literature in a high-level language such as Python, MATLAB, or Julia and will be summarized by the students in written technical papers. The course requires computer programming, linear algebra, and calculus. **Lecture 3, Credits 3 (Spring)**

IMGS-684**Deep Learning for Vision**

This course will review neural networks and related theory in machine learning that is needed to understand how deep learning algorithms work. The course will include the latest algorithms that use deep learning to solve problems in computer vision and machine perception, and students will read recent papers on these systems. Students will implement and evaluate one or more of these systems and apply them to problems that match their interests. Students are expected to have taken multiple computer programming courses and to be comfortable with linear algebra and calculus. No prior background in machine learning or pattern recognition is required. (This course is restricted to students with graduate standing in the College of Science or the Kate Gleason College of Engineering or Graduate Computing and Information Sciences.) **Lecture 3, Credits 3 (Fall)**

IMGS-689**Graduate Special Topics**

This course is a faculty-developed exploration of appropriate graduate-level imaging topics that are not part existing courses. The level of study is appropriate for upper-class undergraduates or graduate level students. **Lecture 3, Credits 1 - 4 (Fall, Spring, Summer)**

IMGS-699**Imaging Science Graduate Co-op**

This course is a cooperative education experience for graduate imaging science students. **CO OP, Credits 0 (Fall, Spring, Summer)**

IMGS-711**Computational Methods for Imaging Science**

This course addresses computational topics that are important in a variety of applications in imaging science. Examples of topics that may be included are: vector space operations, including matrix factorizations and solutions of systems of equations (used in hyperspectral target detection and image compression, among many other applications); linear and nonlinear optimization (used for the design of detectors, camera calibration, bundle adjustment, etc.); iterative methods and dynamic systems (Kalman filtering, tracking, optical flow, etc.); random number generation and use (Monte Carlo methods, system performance evaluation, etc.); and energy minimization techniques applied to image processing (used for image enhancement, segmentation, etc.) (Prerequisites: IMGS-616 or IMGS-682 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

IMGS-712**Multi-view Imaging**

Images are 2D projections gathered from scenes by perspective projection. By making use of multiple images it is possible to construct 3D models of the scene geometry and of objects in the scene. The ability to derive representations of 3D scenes from 2D observations is a fundamental requirement for applications in robotics, intelligence, medicine and computer graphics. This course develops the mathematical and computational approaches to modeling of 3D scenes from multiple 2D views. After completion of this course students are prepared to use the techniques in independent research. (Prerequisites: IMGS-616 or IMGS-682 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

IMGS-715**Computational Photography**

Computational photography is an emerging field that aims to overcome the limitations of conventional digital imaging and display devices by using computational techniques and novel programmable sensors and optical devices. In this course, we will study start-of-the-art techniques for capturing, modeling, and displaying complex appearance phenomena. We will cover topics such as computational sensor with assorted pixel designs, mobile camera control, light field capture and rendering, computational flash photography, computational illumination for appearance modeling and 3D reconstruction, light transport analysis, and light sensitive display and printing techniques. We will integrate the latest smart imaging devices into the course for homework and term projects. (This course is restricted to students with graduate standing in the College of Science or the Kate Gleason College of Engineering.) **Lecture 3, Credits 3 (Fall)**

IMGS-719**Radiative Transfer I**

This course is the first course in a two-semester course sequence that covers the theory of radiative transfer in disordered media. The course begins with a brief review of basic electromagnetism and models for scattering and absorption by single particles and progresses to the theory of radiative transfer in semi-infinite media. Various approximations that allow closed-form solutions are presented, and related phenomenology, such as the shadow-hiding opposition effect and coherent backscatter opposition effects, are described in terms of these models. (Prerequisites: IMGS-619 and IMGS-633 or ASTP-615 or equivalent courses.) **Lecture 3, Credits 3 (Spring)**

IMGS-720**Radiative Transfer II**

This course covers advanced topics related to the theory of radiative transfer in disordered media. The course begins with a review of topics presented in the first semester course, including the radiative transfer solutions due to Hapke's solution for a semi-infinite medium and the opposition effect. Students will complete a project focused on one or more advanced topics related to radiative transfer in disordered media, such as effects of surface roughness, scattering in layered media, oriented scattering layers, more advanced treatments of multiple scattering or polarization, or radiative transfer in the water column. (Prerequisites: IMGS-719 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

IMGS-722**Remote Sensing: Systems, Sensors, and Radiometric Image Analysis**

This course introduces the governing equations for radiance reaching an aerial or satellite based imaging systems. The course also covers the properties of these imaging systems with an emphasis on their use as quantitative scientific instruments. It also includes a treatment of methods to invert the remotely sensed image data to measurements of the Earth's surface (e.g. reflectance and temperature) through various means of inverting the governing radiometric equation. The emphasis is on multidimensional image analysis (e.g., multispectral, polarimetric, and multirate) and includes issues such as image registration to support image analysis. Based on the previous treatment, the 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. (Prerequisites: IMGS-619 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

IMGS-723**Remote Sensing: Spectral Image Analysis**

This course is focused on analysis of high-dimensional remotely sensed data sets. It begins with a review of the properties of matter that control the spectral nature of reflected and emitted energy. It then introduces three mathematical ways to characterize spectral data and methods to perform initial analysis of spectral data to characterize and preprocess the data. These include noise characterization and mitigation, radiometric calibration, atmospheric compensation, dimensionality characterization, and reduction. Much of the course focuses on spectral image analysis algorithms employing the three conceptual approaches to characterizing the data. These analytical tools are aimed at segmentation, subpixel or pixel unmixing approaches and target detection including treatment of signal processing theory and application. There is also a significant emphasis on incorporation of physics based algorithms into spectral image analysis. The course concludes with an end-to-end treatment of image fidelity incorporating atmospheres, sensors, and image processing effects. (Prerequisites: IMGS-619 and IMGS-722 or equivalent courses.) **Lecture 3, Credits 3 (Fall)**

IMGS-724**Introduction to Electron Microscopy**

The course will introduce the basic concepts and practice of electron microscopy, including transmission electron microscopy (TEM), scanning electron microscopy (SEM) and x-ray microanalysis. During the second half of the course students will do an 8-10 hour hands-on project in SEM or TEM or both, including a project paper and a poster presentation. Laboratory demonstrations will be held in the NanoImaging Lab to reinforce the lecture material. (This course is restricted to students with graduate standing in the College of Science or the Kate Gleason College of Engineering.) **Lecture 3, Credits 3 (Spring)**

IMGS-730**Magnetic Resonance Imaging**

This course is designed to teach the principles of the imaging technique called 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. (This class is restricted to graduate students in the IMGS-MS or IMGS-PHD programs.) **Lecture 3, Credits 3 (Spring)**

IMGS-731**Ultrasound Imaging**

This course is an overview of the physics and signal processing principles of ultrasound as applied to the different medical imaging modalities such as B-mode, M-mode, Doppler, and 3D imaging. Tissue characterization methods are introduced. (Prerequisites: IMGS-616 and IMGS-682 or equivalent courses.) **Lecture 3, Credits 3 (Spring)**

IMGS-733**Medical Imaging Systems**

This course is an introduction to the physics, instrumentation, and signal processing methods used in different imaging modalities such as X-ray CT, MRI, PET/SPECT and ultrasound. (Prerequisites: IMGS-616 and IMGS-682 or equivalent courses.) **Lecture 3, Credits 3 (Fall)**

IMGS-737**Physical Optics**

This course covers the wave properties of light, its interaction with matter, and the application of these principles to imaging systems. Topics include polarization of light, birefringence, interference and interferometers, spatial and temporal coherence, and scalar diffraction theory. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lab 3, Credits 3 (Spring)**

IMGS-737**Physical Optics**

This course covers the wave properties of light, its interaction with matter, and the application of these principles to imaging systems. Topics include polarization of light, birefringence, interference and interferometers, spatial and temporal coherence, and scalar diffraction theory. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 2, Credits 3 (Spring)**

IMGS-740**Imaging Science MS Systems Project Paper**

The analysis and solution of imaging science systems problems for students enrolled in the MS Project capstone paper option. **Research 3, Credits 3 (Fall, Spring, Summer)**

IMGS-754**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 its structure, adaptive properties, and specifics of the application. Particular structures developed and analyzed include Bayes decision theory, parametric and non-parametric 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. (Prerequisites: IMGS-613 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

IMGS-756**Advanced Digital Image Processing**

This course investigates algorithms and techniques for a variety of imaging applications. The techniques build on the background from IMGS-682. 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. (Prerequisites: IMGS-682 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

IMGS-765**Performance Modeling and Characterization of Remote Sensing Systems**

This course introduces the techniques utilized for system performance predictions of new imaging platforms during their design phase. Emphasis will be placed on systems engineering concepts and their impact on final product quality through first principles modeling. In addition, the student will learn techniques to characterize system performance during actual operation to monitor compliance to performance specifications and monitor system health. Although the focus of the course will be on electro-optical collection systems, some modality specific concepts will be introduced for LIDAR, broadband infrared, polarimetric, and hyperspectral systems. (Prerequisites: IMGS-616 and IMGS-619 or equivalent courses.) **Lecture 3, Credits 3 (Spring)**

IMGS-766**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 and examples carried out on a number of types of lenses to illustrate how the process of design is carried out. (Prerequisites: IMGS-633 or equivalent course.) **Lab 2, Credits 3 (Fall)**

IMGS-766**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 and examples carried out on a number of types of lenses to illustrate how the process of design is carried out. (Prerequisites: IMGS-633 or equivalent course.) **Lecture 2, Credits 3 (Fall)**

IMGS-789**Graduate Special Topics**

This is a graduate-level course on a topic that is not part of the formal curriculum. This course is structured as an ordinary course and has specific prerequisites, contact hours, and examination procedures. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lec/Lab, Credits 1 - 3 (Fall, Spring, Summer)**

IMGS-790**Research and Thesis**

Masters-level research by the candidate on an appropriate topic as arranged between the candidate and the research advisor. (Enrollment in this course requires permission from the department offering the course.) **Thesis, Credits 1 - 6 (Fall, Spring, Summer)**

IMGS-791**Continuation of Thesis**

Continuation of Thesis **Cont, Credits 0 (Fall, Spring, Summer)**

IMGS-799**Imaging Science Independent Study**

This course is a faculty-directed tutorial of appropriate topics that are not part of the formal curriculum. The level of study is appropriate for student in their graduate studies. (Enrollment in this course requires permission from the department offering the course.) **Ind Study, Credits 1 - 4 (Fall, Spring, Summer)**

IMGS-830**Advanced Topics in Remote Sensing**

This course is an in-depth examination of emerging techniques and technologies in the field of remote sensing at an advanced level. Examples of topics, which will differ each semester, are typically formed around a specific remote sensing modality such as lidar, polarimetry, radar, and hyperspectral remote sensing. (Prerequisites: IMGS-723 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

IMGS-890**Research and Thesis**

Doctoral-level research by the candidate on an appropriate topic as arranged between the candidate and the research advisor. (Enrollment in this course requires permission from the department offering the course.) **Thesis, Credits 1 - 6 (Fall, Spring, Summer)**

IMGS-891**Continuation of Thesis**

Continuation of Thesis **Cont, Credits 0 (Fall, Spring, Summer)**

Interdisciplinary Science

ITDS-611**STEM Education: Concepts and Practice**

This course is an introduction to concepts and practices that support effective STEM education. The course will emphasize concrete applications: specific pedagogical techniques, how they support a wide range of learning objectives, and why they are effective. Specific pedagogical techniques include: flipped classrooms, small-group workshops, think-pair-share methodologies, elicit/confront/resolve approaches, and project-based curricula. Students will learn how to connect specific pedagogical approaches with sophisticated course objectives that support diverse student populations to achieve conceptual, epistemological, communication, critical thinking, problem solving, and affective goals. Students will read foundational papers that describe concepts of how people learn to provide a theoretical understanding of why particular approaches are more effective. Students will also be introduced to "action research" methods by which STEM educators can assess effectiveness in their own classrooms. **Lecture 3, Credits 3 (Biannual)**

ITDS-613**STEM Education: Research Methods and Theory**

This course is an introduction to major research themes, methodology, theories of learning, and research ethics relevant to discipline-based education research (DBER) in biology, chemistry, and physics. Research methods related to studying learning and development of expertise in science will include: the design of quantitative studies (surveys, assessments, and statistical analysis methods) and the design of qualitative studies (interviews, observations, coding). Relevant theories of learning will include cognitivist, developmental, and social/cultural perspectives. The course will use case studies from current literature on biology, chemistry, and physics education research to introduce these topics. Students will apply their understanding to develop and execute a semester-long research project in STEM education research. As part of the research project, students will develop a research question, become familiar with procedures to satisfy RIT's Institutional Review Board (IRB) and ethical requirements, and apply a quantitative, qualitative or mixed-methods approach. The project will include learning appropriate software, e.g. R (quantitative) or NVivo (qualitative). **Lecture 3, Credits 3 (Biannual)**

ITDS-689**Special Topics**

This is a graduate-level course on a topic that is not part of the formal curriculum. This course is structured as an ordinary course and has specific prerequisites, contact hours, and examination procedures. **Lec/Lab, Credits 1 - 3 (Fall, Spring, Summer)**

Materials Science and Engineering

MTSE-601**Materials Science**

This course provides an understanding of the relationship between structure and properties necessary for the development of new materials. Topics include atomic and crystal structure, crystalline defects, diffusion, theories, strengthening mechanisms, ferrous alloys, cast irons, structure of ceramics and polymeric materials and corrosion principles. Term paper on materials topic. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall)**

MTSE-602**Polymer Science**

Polymers are ubiquitous. They are used in everyday applications as well as for specialty and cutting-edge technologies. This course is an introduction to the chemistry and physics of synthetic polymers, which include plastics, elastomers and fibers. The synthesis of polymers, their fundamental properties, and the relations between their syntheses, structure, and properties will be studied. Among the topics discussed are the morphology, thermal behavior, solubility, viscoelasticity and characterization of polymers. Copolymerization, tacticity and sustainability of polymers will also be covered. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Spring)**

MTSE-617**Material Degradation**

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 with demonstrations. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall)**

MTSE-632**Solid State Science**

This course is an introduction to the physics of the solid state including crystal structure, x-ray diffraction by crystals, crystal binding, elastic waves and lattice vibrations, thermal properties, the free electron model of solids, and band theory and its applications. (This course is restricted to MSEN-MS Major students.) **Lecture 3, Credits 3 (Fall)**

MTSE-689**Graduate Special Topics**

This is a master-level course on a topic that is not part of the formal curriculum. This course is structured as an ordinary course and has specific prerequisites, contact hours, and examination procedures. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lec/Lab 6, Credits 1 - 6 (Fall, Spring, Summer)**

MTSE-699**Materials Science Graduate Co-op**

This course is a cooperative education experience for materials science and engineering masters-level students. **CO OP, Credits 0 (Fall, Spring, Summer)**

MTSE-704**Theoretical Methods in Materials Science and Engineering**

This course includes the treatment of vector analysis, special functions, waves, and fields; Maxwell Boltzmann, Bose-Einstein and Fermi-Dirac distributions, and their applications. Selected topics of interest in electrodynamics, fluid mechanics, and statistical mechanics will also be discussed. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall)**

MTSE-705**Experimental Techniques**

The course will introduce the students to laboratory equipment for hardness testing, impact testing, tensile testing, X-ray diffraction, SEM, and thermal treatment of metallic materials. Experiments illustrating the characterization of high molecular weight organic polymers will be performed. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lab 3, Credits 3 (Spring)**

MTSE-777**Graduate Project**

This course is a capstone project using research facilities available inside or outside of RIT. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Project, Credits 1 - 4**

MTSE-780**Theory of Microsensors and Actuators**

This course introduces the theory and development of sensors at the molecular and ionic levels. Mechanism details for operation of the sensors and actuators will be discussed. Fundamental aspects related to chemical, biochemical, piezoresistive, magnetic, thermal, and luminescent sensors will be discussed with an emphasis on the development of innovative products. Control systems based on ion selectivity for biomedical applications will be covered in detail. Neurotransmitters, neural network, and directional selectivity using conducting polymers will also be covered. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Spring)**

MTSE-789**Graduate Special Topics**

This is a master-level course on a topic that is not part of the formal curriculum. This course is structured as an ordinary course and has specific prerequisites, contact hours, and examination procedures. (This course requires permission of the Instructor to enroll.) **Lecture, Credits 1 - 4 (Fall, Spring)**

MTSE-790**Research and Thesis**

Dissertation research by the candidate for an appropriate topic as arranged between the candidate and the research advisor. (Enrollment in this course requires permission from the department offering the course.) **Thesis, Credits 1 - 9 (Fall, Spring, Summer)**

MTSE-791

Seminar

This seminar course is designed to develop the ability to assimilate useful information while increasing a student's breadth and depth of knowledge of materials science and engineering research topics. This seminar requires the students to attend weekly seminars and present a seminar summarizing their thesis research at RIT which serves as the public portion of their thesis defense. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Seminar 1, Credits 1 (Spring)**

MTSE-792

External Research

Research conducted off-site by the candidate for an appropriate topic as arranged between the student, the RIT advisor, and the off-site research mentor. (Enrollment in this course requires permission from the department offering the course.) **Research, Credits 1 - 4 (Fall, Spring, Summer)**

MTSE-793

Continuation of Thesis

Continuation of Thesis **Cont, Credits 0 (Fall, Spring)**

MTSE-799

Independent Study

This course is a faculty-directed tutorial of appropriate topics that are not part of the formal curriculum. The level of study is appropriate for a masters-level student. (Enrollment in this course requires permission from the department offering the course.) **Ind Study, Credits 1 - 4 (Fall, Spring, Summer)**

Mathematics

MATH-601

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. (Prerequisites: MATH-221 and MATH-231 or equivalent courses or students in the ACMTH-MS or MATHML-PHD programs.) **Lecture 3, Credits 3 (Spring)**

MATH-602

Numerical Analysis I

This course covers numerical techniques for the solution of nonlinear equations, interpolation, differentiation, integration, and matrix algebra. (Prerequisites: ((MATH-241 or MATH-241H) and MATH-431) or equivalent courses or graduate standing in ACMTH-MS or MATHML-PHD programs.) **Lecture 3, Credits 3 (Fall)**

MATH-603

Optimization Theory

This course provides a study of the theory of optimization of linear and nonlinear functions of several variable with or without constraints. The theory is applied to solve problems in business, management, engineering, and the sciences. Algorithms for practical applications will be analyzed and implemented. Students taking this course will be expected to complete applied projects and/or case studies. (This course is restricted to students in the ACMTH-MS or MATHML-PHD programs.) **Lecture 3, Credits 3 (Spring)**

MATH-605

Stochastic Processes

This course is an introduction to stochastic processes and their various applications. It covers the development of basic properties and applications of Poisson processes and Markov chains in discrete and continuous time. Extensive use is made of conditional probability and conditional expectation. Further topics such as renewal processes, reliability and Brownian motion may be discussed as time allows. (Prerequisites: ((MATH-241 or MATH-241H) and MATH-251) or equivalent courses or graduate standing in ACMTH-MS or MATHML-PHD or APPSTAT-MS programs.) **Lecture 3, Credits 3 (Spring)**

MATH-606

Graduate Seminar I

The course prepares students to engage in activities necessary for independent mathematical research and introduces students to a broad range of active interdisciplinary programs related to applied mathematics. (This course is restricted to students in the ACMTH-MS or MATHML-PHD programs.) **Lecture 2, Credits 1 (Fall)**

MATH-607

Graduate Seminar II

This course is a continuation of Graduate Seminar I. It prepares students to engage in activities necessary for independent mathematical research and introduces them to a broad range of active interdisciplinary programs related to applied mathematics. (Prerequisite: MATH-606 or equivalent course or students in the ACMTH-MS or MATHML-PHD programs.) **Lecture 2, Credits 1 (Spring)**

MATH-622

Mathematical Modeling I

This course will introduce graduate students to the logical methodology of mathematical modeling. They will learn how to use an application field problem as a standard for defining equations that can be used to solve that problem, how to establish a nested hierarchy of models for an application field problem in order to clarify the problem's context and facilitate its solution. Students will also learn how mathematical theory, closed-form solutions for special cases, and computational methods should be integrated into the modeling process in order to provide insight into application fields and solutions to particular problems. Students will study principles of model verification and validation, parameter identification and parameter sensitivity and their roles in mathematical modeling. In addition, students will be introduced to particular mathematical models of various types: stochastic models, PDE models, dynamical system models, graph-theoretic models, algebraic models, and perhaps other types of models. They will use these models to exemplify the broad principles and methods that they will learn in this course, and they will use these models to build up a stock of models that they can call upon as examples of good modeling practice. (This course is restricted to students in the ACMTH-MS or MATHML-PHD programs.) **Lecture 3, Credits 3 (Fall)**

MATH-625

Applied Inverse Problems

Most models in applied and social sciences are formulated using the broad spectrum of linear and nonlinear partial differential equations involving parameters characterizing specific physical characteristics of the underlying model. Inverse problems seek to determine such parameters from the measured data and have many applications in medicine, economics, and engineering. This course will provide a thorough introduction to inverse problems and will equip students with skills for solving them. The topics of the course include existence results, discretization, optimization formulation, and computational methods. (Prerequisites: MATH-431 or equivalent course or graduate student standing.) **Lecture 3, Credits 3 (Fall)**

MATH-631

Dynamical Systems

This course is a study of dynamical systems theory. Basic definitions of dynamical systems are followed by a study of maps and time series. Stability theory of solutions of differential equations is studied. Asymptotic behavior of solutions is investigated through limit sets, attractors, Poincaré-Bendixson theory, and index theory. The notion of local bifurcation is introduced and investigated. Chaotic systems are studied. (Prerequisites: (MATH-231 and (MATH 241 or MATH-241H)) or equivalent courses or graduate standing in ACMTH-MS or MATHML-PHD programs.) **Lecture 3, Credits 3 (Fall)**

MATH-633

Measure Theory of Elements and Functional Analysis

This course will provide a general introduction to Lebesgue measure as applied to the real numbers, real-valued functions of a real variable, and the Lebesgue integral of such functions. It also covers topics in functional analysis relevant to application of measure theory to real-world problems. Students will be expected to read and understand proofs, and to demonstrate their understanding of topics by writing their own proofs of various facts. (Prerequisites: Graduate student standing in COS, GCCIS or KGCOE or B+ or better in MATH 432 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

MATH-641

Logic, Set Theory, and Computability

This course studies Peano's axioms for the natural numbers, induction principles, and recursive definitions. The topics in set theory include axiomatic set theory and the Cantor Bernstein theorem. The topics in logic are propositional logic and First-order logic. The section on computability covers formulation of the family of the computable functions and a discussion of the halting problem (This course is restricted to students in the ACMTH-MS, ACMTH-BS/MS program.) **Lecture 3, Credits 3 (Spring)**

MATH-645

Graph Theory

This course introduces the fundamental concepts of graph theory. Topics to be studied include graph isomorphism, trees, network flows, connectivity in graphs, matchings, graph colorings, and planar graphs. Applications such as traffic routing and scheduling problems will be considered. (This course is restricted to students with graduate standing in the College of Science or Graduate Computing and Information Sciences.) **Lecture 3, Credits 3 (Fall)**

MATH-646

Combinatorics

This course introduces the fundamental concepts of combinatorics. Topics to be studied include counting techniques, binomial coefficients, generating functions, partitions, the inclusion-exclusion principle and partition theory. (This course is restricted to students in the ACMTH-MS or MATHML-PHD programs.) **Lecture 3, Credits 3 (Spring)**

MATH-655

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 sample parametric and nonparametric inference, censoring, one and two way analysis of variance, and multiple and logistic regression analysis. (This class is restricted to graduate students in COS, KGCOE, GCCIS, CHST or CLA.) **Lecture 3, Credits 3 (Spring)**

MATH-671**Number Theory**

This course is an introduction to the standard results and techniques of number theory. Topics include divisibility, congruences, Diophantine equations, Moebius inversion, quadratic reciprocity, and primitive roots. Cryptography and other applications will be discussed. Projects may be required. (This course is restricted to students in the ACMTH-MS, ACMTH-BS/MS program.) **Lecture 3, Credits 3 (Fall)**

MATH-689**Advanced Special Topics**

Special Topics courses cover content that is not represented in the main curriculum on an experimental or trial basis. **Lecture 3, Credits 1 - 4 (Fall, Spring, Summer)**

MATH-699**Math and Stats Graduate Co-op**

This course is a cooperative education experience for graduate math and stats students. **CO OP, Credits 0 (Fall, Spring, Summer)**

MATH-702**Numerical Analysis II**

This course covers the solutions of initial value problems and boundary value problems, spectral techniques, simulation methods, optimization and techniques employed in modern scientific computing. (Prerequisite: MATH-602 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

MATH-712**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, especially those arising in applications. Topics include: finite difference methods for hyperbolic, parabolic, and elliptic partial differential equations, consistency, stability and convergence of finite difference schemes. (Prerequisite: MATH-702 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

MATH-722**Mathematical Modeling II**

This course will continue to expose students to the logical methodology of mathematical modeling. It will also provide them with numerous examples of mathematical models from various fields. (Prerequisite: MATH-622 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

MATH-731**Advanced Dynamical Systems**

This course covers an analysis of iterations of maps, symbolic dynamics, their uses, and fractals. It includes methods for simplifying dynamical systems (center manifolds and normal forms), Melnikov's method, and applications. (Prerequisites: MATH-631 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

MATH-735**Mathematics of Finance I**

This is the first course in a sequence that examines mathematical and statistical models in finance. By taking a mathematical viewpoint the course provides students with a comprehensive understanding of the assumptions and limitations of the quantitative models used in finance. Topics include probability rules and distributions, the binomial and Black-Scholes models of derivative pricing, interest and present value, and ARCH and GARCH time series techniques. The course is mathematical in nature and assumes a background in calculus (including Taylor series), linear algebra and basic probability. Other mathematical concepts and numerical methods are introduced as needed. (Prerequisites: ((MATH-241 or MATH-241H) and MATH-251) or equivalent courses or graduate standing in the ACMTH-MS or MATHML-PHD or CMPFNC-MS programs.) **Lecture 3, Credits 3 (Fall)**

MATH-736**Mathematics of Finance II**

This is the second course in a sequence that examines mathematical and statistical models in finance. By taking a mathematical viewpoint the course provides students with a comprehensive understanding of the assumptions and limitations of the quantitative models used in finance. Topics include delta hedging, introduction to Ito calculus, interest rate models and Monte Carlo simulations. The course is mathematical in nature and assumes a background in calculus (including Taylor series), linear algebra and basic probability. Other mathematical concepts and numerical methods are introduced as needed. (Prerequisites: MATH-735 or equivalent course or students in ACMTH-MS or MATHML-PHD or CMPFNC-MS programs.) **Lecture 3, Credits 3 (Spring)**

MATH-741**Partial Differential Equations I**

This course uses methods of applied mathematics in the solution of problems in physics and engineering. Models such as heat flow and vibrating strings will be formulated from physical principles. Characteristics methods, maximum principles, Green's functions, D'Alembert formulas, weak solutions and distributions will be studied. (Prerequisites: MATH-231 or equivalent course or graduate student standing in ACMTH-MS or MATHML-PHD programs.) **Lecture 3, Credits 3 (Spring)**

MATH-742**Partial Differential Equations II**

This is a continuation of Partial Differential Equations I and deals with advanced methods for solving partial differential equations arising in physics and engineering problems. Topics to be covered include second order equations, Cauchy-Kovalevskaya theorem, the method of descent, spherical means, Duhamels principle, and Greens function in higher dimensions. (Prerequisites: MATH-741 or equivalent course or students in ACMTH-MS or MATHML-PHD programs.) **Lecture 3, Credits 3 (Spring)**

MATH-751**High-performance Computing for Mathematical Modeling**

Students in this course will study high-performance computing as a tool for solving problems related to mathematical modeling. Two primary objectives will be to gain experience in understanding the advantages and limitations of different hardware and software options for a diverse array of modeling approaches and to develop a library of example codes. The course will include extensive hands-on computational (programming) assignments. Students will be expected to have a prior understanding of basic techniques for solving mathematical problems numerically. (Prerequisite: MATH-602 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

MATH-761**Mathematical Biology**

This course introduces areas of biological sciences in which mathematics can be used to capture 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. (Graduate Science) **Lecture 3, Credits 3 (Fall)**

MATH-771**Mathematics of Cryptography**

This course is an introduction to the mathematical problems and techniques that serve as a foundation for modern cryptosystems. The topics include: classical cryptosystems computational number theory, primality tests, finite fields, private and public key encryption scheme (RSA, El-Gamal), and applications such as digital signatures, one way functions, and zero knowledge proofs. Use of elliptic curves in cryptography will also be covered. (Prerequisites: MATH-371 or MATH-671 or equivalent course or students in ACMTH-MS or MATHML-PHD programs.) **Lecture 3, Credits 3 (Fall)**

MATH-789**Special Topics**

This is a master-level course on a topic that is not part of the formal curriculum. This course is structured as an ordinary course and has specific prerequisites, contact hours, and examination procedures. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture, Credits 1 - 6**

MATH-790**Research and Thesis**

Masters-level research by the candidate on an appropriate topic as arranged between the candidate and the research advisor. (This course is restricted to students in the ACMTH-MS or MATHML-PHD programs.) **Thesis, Credits 0 - 9 (Fall, Spring, Summer)**

MATH-791**Continuation of Thesis**

Continuation of Thesis **Cont, Credits 0**

MATH-799**MATH GRADUATE Independent Study**

Independent Study (This course requires permission of the Instructor to enroll.) **Ind Study, Credits 1 - 3 (Fall, Spring, Summer)**

MATH-831**Mathematical Fluid Dynamics**

The study of the dynamics of fluids is a central theme of modern applied mathematics. It is used to model a vast range of physical phenomena and plays a vital role in science and engineering. This course provides an introduction to the basic ideas of fluid dynamics, with an emphasis on rigorous treatment of fundamentals and the mathematical developments and issues. The course focuses on the background and motivation for recent mathematical and numerical work on the Euler and Navier-Stokes equations, and presents a mathematically intensive investigation of various models equations of fluid dynamics. (Prerequisite: MATH-741 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring, Summer)**

Physics**PHYS-601****Graduate Physics Seminar I**

This course is the first in a two-semester sequence intended to familiarize students with research activities, practices, and ethics in university, government, industry, and other professional research environments and to introduce students to research tools and skill sets important in various professional environments. As part of the course, students are expected to attend research seminars sponsored by the School of Physics and Astronomy and participate in regular journal club offerings. The course also provides training in scientific writing and presentation skills. Credits earned in this course apply to research requirements. **Seminar 2, Credits 1 (Fall)**

PHYS-602**Graduate Physics Seminar II**

This course is the second in a two-semester sequence intended to familiarize students with research activities, practices, ethics in university, government, industry, and other professional research environments and to introduce students to research tools and skill sets important in various professional environments. The course is intended to help students develop a broad awareness of current professional and funding opportunities. As part of the course, students are expected to attend research seminars sponsored by the School of Physics and Astronomy, to participate in regular journal club offerings, to engage in outreach activities, and to participate in visits to regional laboratories and companies. The course provides training in proposal writing and presentation skills. Credits earned in this course apply to research requirements. **Seminar 2, Credits 1 (Spring)**

PHYS-610**Mathematical Methods for Physics**

This graduate-level course in mathematical physics covers partial differential equations, Bessel, Legendre and related functions, Fourier series and transforms. **Lecture 3, Credits 3 (Fall)**

PHYS-611**Classical Electrodynamics I**

This course is a systematic treatment of electro- and magneto-statics, charges, currents, fields and potentials, dielectrics and magnetic materials, Maxwell's equations and electromagnetic waves. Field theory is treated in terms of scalar and vector potentials. Wave solutions of Maxwell's equations, the behavior of electromagnetic waves at interfaces, guided electromagnetic waves, and simple radiating systems will be covered. (Prerequisites: PHYS-412 or equivalent course or Graduate standing.) **Lecture 3, Credits 3 (Fall)**

PHYS-612**Classical Electrodynamics II**

This course is an advanced treatment of electrodynamics and radiation. Classical scattering theory including Mie scattering, Rayleigh scattering, and the Born approximation will be covered. Relativistic electrodynamics will be applied to charged particles in electromagnetic fields and magnetohydrodynamics. (Prerequisites: PHYS-611 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

PHYS-614**Quantum Theory**

This course is a graduate level introduction to the modern formulation of quantum mechanics. Topics include Hilbert space, Dirac notation, quantum dynamics, Feynman's formulation, representation theory, angular momentum, identical particles, approximation methods including time-independent and time-dependent perturbation theory. The course will emphasize the underlying algebraic structure of the theory with an emphasis on current applications. (Prerequisites: This course is restricted to students in the PHYS-MS, ASTP-MS and ASTP-PHD programs.) **Lecture 3, Credits 3 (Fall)**

PHYS-616**Data Analysis for the Physical Sciences**

This course is an introductory graduate-level overview of techniques in and applications of data analysis in physics and related fields. Topics examined include noise and probability, model fitting and hypothesis testing, signal processing, Fourier methods, and advanced computation and simulation techniques. Applications are drawn from across the contemporary physical sciences, including soft matter, solid state, biophysics, and materials science. The subjects covered also have applications for students of astronomy, signal processing, scientific computation, and others. (Prerequisites: PHYS-316 or equivalent course or Graduate standing.) **Lecture 3, Credits 3 (Biannual)**

PHYS-630**Classical Mechanics**

This course is a systematic presentation of advanced topics in Newtonian kinematics and dynamics. Topics include Lagrangian and Hamiltonian formulations of dynamics, central force problems, rigid body kinematics and dynamics, theory of small oscillations, canonical transformations, and Hamilton-Jacobi theory. **Lecture 3, Credits 3 (Spring)**

PHYS-640**Statistical Physics**

This course is a graduate-level study of the concepts and mathematical structure of statistical physics. Topics include the microcanonical, canonical, and grand-canonical ensembles and their relationships to thermodynamics, including classical, Fermi, and Bose-Einstein statistics. The course includes illustrations and applications from the theories of phase transitions, solids, liquids, gases, radiation, soft condensed matter, and chemical and electrochemical equilibria. The course also treats non-equilibrium topics including the kinetic theory of transport processes, the theory of Brownian motion, and the fluctuation-dissipation theorem. **Lecture 3, Credits 3 (Spring)**

PHYS-667**Quantum Optics**

This course explores the fundamental nature of electromagnetic radiation. This course will introduce the student to the second quantized description of light with special attention to its role in a modern understanding of and far reaching utility in emerging technologies. Starting with an appropriate formulation for the quantum mechanical electromagnetic radiation field, we will study quantum mechanical models for interactions with matter, and we will test these models through a series of experiments. (Prerequisites: PHYS-411 and PHYS-414 or equivalent course or Graduate standing.) **Lab 3, Credits 3 (Spring)**

PHYS-667**Quantum Optics**

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PHYS-670**Teaching and Learning Physics**

This course covers the fundamentals of how students learn and understand key ideas in physics and how theory can inform effective pedagogical practice. Through examination of physics content, pedagogy and problems, through teaching, and through research in physics education, students will explore the meaning and means of teaching physics. Topics include: misconceptions, resources and phenomenological primitives, theoretical foundations for active-learning, constructivism, epistemological, affective, and social-cultural issues that affect learning, guided and unguided reflection strategies, design-oriented curricula, and effective uses of educational labs and technology. Useful for all students, especially for those in interested in physics, teaching and education research. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Spring)**

PHYS-689**Graduate Special Topics**

This is a graduate course on a topic that is not part of the formal curriculum. This course is structured as an ordinary course and has specific prerequisites, contact hours, and examination procedures. **Lec/Lab 3, Credits 1 - 3 (Fall, Spring, Summer)**

PHYS-715**Advanced Quantum Theory**

This course is a graduate-level introduction to quantum mechanics that is a continuation of COS-PHYS-614. Topics include review and expansion of approximation methods, mixed states and density operators, identical particles, scattering theory, quantization of the nonrelativistic string, quantization of the electromagnetic field, interaction of radiation with matter, the Klein-Gordon and Dirac equations, and second quantization. (Prerequisite: PHYS-614 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

PHYS-720**Computational Methods for Physics**

This hands-on course introduces students to the different ways that scientists use computers to address problems in physics. The course covers root finding, interpolation, numerical differentiation and integration, numerical linear algebra, the solution of ordinary and partial differential equations, fast Fourier transforms, numerical statistics, and optional topics drawn from areas of current physics research. In each of these areas, students will write their own codes in an appropriate language. **Lecture 3, Credits 3 (Biannual)**

PHYS-732**Advanced Solid State Physics**

This is an advanced graduate course in the physics of the solid state. Topics include crystal structure and scattering, models involving non-interacting and interacting electrons, solid-state physics of electronic components, cohesion and elasticity of solids, theory of phonons, and magnetic properties of solids. **Lecture 3, Credits 3 (Spring)**

PHYS-751**Soft Matter Physics**

This course is a graduate-level study of the physics of soft matter systems. Topics include the forces between molecules and surfaces, statistical models of soft matter solutions, self-assembly, elasticity, and viscoelasticity. The course includes illustrations and applications to polymers, colloids, surfactants, liquid crystals, and gels. **Lecture 3, Credits 3 (Biannual)**

PHYS-752**Biological Physics**

This graduate-level course in biological physics provides an introductory survey of biological physics, followed by the topics of (i) forces between atoms, molecules, particles, and surfaces important for living systems; (ii) equilibrium statistical physics solution models relevant for biological systems; (iii) self-assembling systems in living cells and organisms; (iv) elasticity and viscoelasticity in cells and organisms; and (v) examples of active matter. **Lecture 3, Credits 3 (Biannual)**

PHYS-760**Radiation Interactions and Scattering Probes of Matter**

This course is a graduate-level study of the radiation-matter interactions with a particular focus on scattering as a probe of materials and condensed-matter systems. Topics include a classical treatment of electromagnetic radiation and scattering, quantum aspects of electromagnetic interactions, a survey of various types of photon and neutron scattering experiments, the physical basis of double-differential scattering cross-sections, and scattering as a probe of structure and dynamics. **Lecture 3, Credits 3 (Biannual)**

PHYS-767**Optical Coherence and Light-Matter Interactions**

This graduate-level introduction to optics helps prepare students for research in cutting-edge optics laboratories and theoretical groups at RIT. Topics include diffraction, nature and propagation of temporal and spatial classical coherence, polarimetry, applications of second-order coherence, two-level systems, classical and semi-classical treatments of light-matter interaction, and selected topics from nonlinear optics. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Biannual)**

PHYS-770**Advanced Methods in Physics Education Research**

This course provides an understanding of advanced quantitative and qualitative methods in physics education research, including statistical analysis of quantitative data, developing and conducting surveys and interviews in various formats analysis approaches for qualitative data, needs assessments, and program evaluation. The course is designed to prepare researchers to conduct high quality physics education research using various approaches; including case study, ethnography, mixed methods, and outcome-based research. Attention will also be paid to developing a research question that matches one's access to data and methodology, progressive hypothesis refinement, and crafting sound interpretations from rigorous data analysis. Students will also be introduced to institutional requirements, including Institutional Review Board (IRB) procedures and commonly used ethical trainings. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Biannual)**

PHYS-780**Graduate Physics Project**

This course is a graduate capstone project for students enrolled in the Professional Master's track of the MS Physics Program. (This course requires permission of the Instructor to enroll.) **Lecture, Credits 1 - 4 (Fall, Spring, Summer)**

PHYS-789**Graduate Special Topics**

This is a graduate-level course on a topic that is not part of the formal graduate physics curriculum. This course is structured as an ordinary course and has specific prerequisites, contact hours, and examination procedures. **Lec/Lab, Credits 1 - 4 (Fall, Spring, Summer)**

PHYS-790**Graduate Research and Thesis**

Graduate-level research by the candidate on an appropriate topic as arranged between the candidate and the research advisor. (This course requires permission of the Instructor to enroll.) **Thesis, Credits 1 - 4 (Fall, Spring, Summer)**

PHYS-791**Continuation of Thesis**

Graduate-level research by the candidate on an appropriate topic as arranged between the candidate and the research advisor. **Cont, Credits 0 (Fall, Spring, Summer)**

PHYS-799**Physics Independent Study**

This course is a faculty-directed tutorial of appropriate topics that are not part of the formal curriculum. The level of study is appropriate for a graduate-level student. **Ind Study, Credits 1 - 4 (Fall, Spring, Summer)**

PHYS-889**PHYS Advanced Special Topics**

This is a PhD-level course on a topic that is not part of the formal curriculum. This course is structured as an ordinary course and has specific prerequisites, contact hours, and examination procedures. (This course requires permission of the Instructor to enroll.) **Lecture, Credits 1 - 3 (Fall, Spring, Summer)**

PHYS-890**Research and Thesis**

Dissertation research by the candidate for an appropriate topic as arranged between the candidate and the research advisor. (This course requires permission of the Instructor to enroll.) **Cont, Credits 0 (Fall, Spring, Summer)**

PHYS-891**Continuation of Thesis**

Continuation of dissertation research. (This course requires permission of the Instructor to enroll.) **Cont, Credits 0 (Fall, Spring, Summer)**

PHYS-899**Independent Study**

This course is a faculty-directed tutorial of appropriate topics that are not part of the formal curriculum. The level of study is appropriate for a PhD-level student. (This course requires permission of the Instructor to enroll.) **Ind Study, Credits 1 - 3 (Fall, Spring, Summer)**

Statistics**STAT-611****Statistical Software - R**

This course is an introduction to the statistical-software package R, which is often used in professional practice. Some comparisons with other statistical-software packages will also be made. Topics include: data structures; reading and writing data; data manipulation, subsetting, reshaping, sorting, and merging; conditional execution and looping; built-in functions; creation of new functions; graphics; matrices and arrays; simulations and app development with Shiny. (This course is restricted to students in APPSTAT-MS or SMPPI-ACT.) **Lecture 3, Credits 3 (Fall, Spring)**

STAT-614**Applied Statistics**

Statistical tools for modern data analysis can be used across a range of industries to help you guide organizational, societal and scientific advances. This course is designed to provide an introduction to the tools and techniques to accomplish this. Topics covered will include continuous and discrete distributions, descriptive statistics, hypothesis testing, power, estimation, confidence intervals, regression, one-way ANOVA and Chi-square tests. (This class is restricted to degree-seeking graduate students or those with permission from instructor.) **Lecture 3, Credits 3 (Fall)**

STAT-621**Statistical Quality Control**

A practical course designed to provide in-depth understanding of the principles and practices of statistical process control, process capability, and acceptance sampling. Topics include: statistical concepts relating to processes, Shewhart charts for attribute and variables data, CUSUM charts, EWMA charts, process capability studies, attribute and variables acceptance sampling techniques. (This class is restricted to students in the APPSTAT-MS, SMPPI-ACT, STATQL-ACT or MMSI-MS programs.) **Lecture 3, Credits 3 (Fall, Spring)**

STAT-631**Foundations of Statistics**

This course introduces principles of probability and statistics with a strong emphasis on conceptual aspects of statistical inference. Topics include fundamentals of probability, probability distribution functions, expectation and variance, discrete and continuous distributions, sampling distributions, confidence intervals and hypothesis tests. (This course is restricted to students in APPSTAT-MS or SMPPI-ACT.) **Lecture 3, Credits 3 (Fall, Spring)**

STAT-641**Applied Linear Models - Regression**

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 provide 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, polynomial models, influence diagnostics, dummy variables, selection of best linear models, nonlinear estimation, and model building. (This course is restricted to students in APPSTAT-MS or SMPPI-ACT.) **Lecture 3, Credits 3 (Fall, Spring)**

STAT-642**Applied Linear Models - ANOVA**

This course introduces students to analysis of models with categorical factors, with emphasis on interpretation. Topics include the role of statistics in scientific studies, fixed and random effects, mixed models, covariates, hierarchical models, and repeated measures. (This class is restricted to students in the APPSTAT-MS, SMPPI-ACT, STATQL-ACT or MMSI-MS programs.) **Lecture 3, Credits 3 (Fall, Spring)**

STAT-670**Design of Experiments**

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. **Lecture 3, Credits 3 (Fall, Spring)**

STAT-672**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 and service design, and evaluating marketing effectiveness. Data collection methods to be discussed will include face-to-face, mail, Internet and telephone. (This course is restricted to students in APPSTAT-MS or SMPPI-ACT.) **Lecture 3, Credits 3 (Summer)**

STAT-699**Graduate Co-op**

See the graduate program coordinator or RIT's Office of Cooperative Education for further details. **CO OP, Credits 0 (Fall, Spring, Summer)**

STAT-720

Mathematics for Statistics

This is a survey of the mathematical tools of some of the more mathematically 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. (This course is restricted to students in APPSTAT-MS or SMPPI-ACT.) **Lecture 2, Credits 2 (Summer)**

STAT-745

Predictive Analytics

This course is designed to provide the student with solid practical skills in implementing basic statistical and machine learning techniques for the purpose of predictive analytics. Throughout the course, many real world case studies are used to motivate and explain the strengths and appropriateness of each method of interest. In those case studies, students will learn how to apply data cleaning, visualization, and other exploratory data analysis tools to a variety of real world complex data. Students will gain experience with reproducibility and documentation of computational projects and with developing basic data products for predictive analytics. The following techniques will be implemented and then tested with cross-validation: regularization in linear models, regression and smoothing splines, k-nearest neighbor, and tree-based methods, including random forest. (Prerequisite: This class is restricted to students in APPSTAT-MS and SMPPI-ACT who have successfully completed STAT 611 and STAT-741 or equivalent courses.) **Lecture 3, Credits 3 (Spring)**

STAT-774

Principles of Statistical Data Mining

This course covers topics such as clustering, classification and regression trees, multiple linear regression under various conditions, logistic regression, PCA and kernel PCA, model-based clustering via mixture of gaussians, spectral clustering, text mining, neural networks, support vector machines, multidimensional scaling, variable selection, model selection, k-means clustering, k-nearest neighbors classifiers, statistical tools for modern machine learning and data mining, naïve Bayes classifiers, variance reduction methods (bagging) and ensemble methods for predictive optimality. (Prerequisites: This class is restricted to students in APPSTAT-MS or SMPPI-ACT who have successfully completed STAT-611, STAT-731 and STAT-741 or equivalent courses.) **Lecture 3, Credits 3 (Fall, Spring)**

STAT-753

Nonparametric Statistics and Bootstrapping

The emphasis of this course is how to make valid statistical inference in situations when the typical parametric assumptions no longer hold, with an emphasis on applications. This includes certain analyses based on rank and/or ordinal data and resampling (bootstrapping) techniques. The course provides a review of hypothesis testing and confidence-interval construction. Topics based on ranks or ordinal data include: sign and Wilcoxon signed-rank tests, Mann-Whitney and Friedman tests, runs tests, chi-square tests, rank correlation, rank order tests, Kolmogorov-Smirnov statistics. Topics based on bootstrapping include: estimating bias and variability, confidence interval methods and tests of hypothesis. (This course is restricted to students in APPSTAT-MS or SMPPI-ACT.) **Lecture 3, Credits 3 (Summer)**

STAT-756

Multivariate Analysis

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 principal components, factor analysis, clustering, and discriminant analysis. (Prerequisites: This class is restricted to students in APPSTAT-MS or SMPPI-ACT who have successfully completed STAT-611 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

STAT-758

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 experimental design and analysis, 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. This course is not intended for CQAS students unless they have particular interest in imaging science. CQAS students should be taking the course STAT-756-Multivariate Analysis. (Prerequisites: This class is restricted to students in APPSTAT-MS, SMPPI-ACT, IMGS-MS, IMGS-PHD, CLRS-MS or CLRS-PHD.) **Lecture 3, Credits 3 (Summer)**

STAT-762

SAS Database Programming

This course focuses on the SAS programming language to read data, create and manipulate SAS data sets, using Structured Query Language (SQL), creating SAS macros, and SAS programming efficiency. This course covers the material required for "SAS Base Programming" and "SAS Advanced Programming" certification exams. (Prerequisites: This class is restricted to students in APPSTAT-MS or SMPPI-ACT who have successfully completed STAT-611 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

STAT-773

Time Series Analysis and Forecasting

This course is designed to provide the student with a solid practical hands-on introduction to the fundamentals of time series analysis and forecasting. Topics include stationarity, filtering, differencing, time series decomposition, time series regression, exponential smoothing, and Box-Jenkins techniques. Within each of these we will discuss seasonal and nonseasonal models. (Prerequisites: This class is restricted to students in APPSTAT-MS or SMPPI-ACT who have successfully completed STAT-741 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

STAT-775

Design and Analysis of Clinical Trials

This is a graduate level survey course that stresses the concepts of statistical design and analysis for clinical trials. Topics include the design, implementation, and analysis of trials, including treatment allocation and randomization, factorial designs, cross-over designs, sample size and power, reporting and publishing, etc. SAS for Windows statistical software will be used throughout the course for data analysis. (This course is restricted to students in APPSTAT-MS or SMPPI-ACT.) **Lecture 3, Credits 3 (Fall, Spring)**

STAT-784

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. (Prerequisites: This class is restricted to students in APPSTAT-MS or SMPPI-ACT who have successfully completed STAT-741 or equivalent course.) **Lecture 3, Credits 3 (Fall, Spring)**

STAT-786

Advanced Programming in R

This course is a continuation of the R programming language that was begun in STAT-611. Topics include: more on function writing; ggplot2 graphics; changing text to commands or functions; handling larger data sets, efficiency considerations; simulations; select statistical applications. (Prerequisites: This class is restricted to students in APPSTAT-MS or SMPPI-ACT who have successfully completed STAT-611 or equivalent course.) **Lecture 1, Credits 1 (Summer)**

STAT-787

Advanced Statistical Computing

This project-based course introduces students to advanced concepts of statistical computing. We will work in the environment of R—one of the most common and powerful statistical computing languages that are used in professional practice. Topics include: object-oriented features of R, function writing, using environments, non-local assignments (closures), and connections; converting text to code, speeding up processing, advanced features in regular expressions, introduction to the Grammar of Graphics (ggplot2) and lattice methods for graphics, R markdown, computing on large datasets (without reading all data into RAM memory), cleaning and reshaping of messy data, web scraping, interactive web applications (with Shiny), advanced reading from files and writing to files, simulations, select statistical applications. (Prerequisite: This class is restricted to students in APPSTAT-MS and SMPPI-ACT who have successfully completed STAT 611 and STAT-741 or equivalent courses.) **Lecture 3, Credits 3 (Summer)**

STAT-789

Special Topics

This course provides for the presentation of subject matter of specialized value in the field of applied statistics not offered as a regular part of the program. (This course is restricted to students in APPSTAT-MS or SMPPI-ACT.) **Lec/Lab, Credits 1 - 3 (Fall, Spring)**

STAT-790

Capstone Thesis/Project

This course is a graduate course for students enrolled in the Thesis/Project track of the MS Applied Statistics Program. (Enrollment in this course requires permission from the Director of Graduate Programs for Applied Statistics.) (Enrollment in this course requires permission from the department offering the course.) **Thesis, Credits 1 - 6 (Fall, Spring, Summer)**

STAT-791

Continue of Capstone Thesis/Project

This course is a graduate course for students enrolled in the Thesis/Project track of the MS Applied Statistics Program. (Enrollment in this course requires permission from the Director of Graduate Programs for Applied Statistics.) (Enrollment in this course requires permission from the department offering the course.) **Cont, Credits 0 (Fall, Spring, Summer)**

STAT-792

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 coursework. (Enrollment in this course requires permission from the department offering the course.) **Lecture 3, Credits 3 (Fall, Spring)**

STAT-795

Graduate Seminar

This course provides for one or more semesters of study and research activity. This course is required for all first-year full-time funded students in the MS program. (Enrollment in this course requires permission from the department offering the course.) **Lecture 1, Credits 0 (Fall, Spring, Summer)**

STAT-799**Independent Study**

Credit will be assigned at the discretion of the department. A written proposal of the work involved will be required of the candidate, and may be modified at the discretion of the faculty involved before approval is given to proceed. (Enrollment in this course requires permission from the department offering the course.) **Ind Study, Credits 1 - 3 (Fall, Spring, Summer)**

Golisano Institute for Sustainability

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Course numbering: RIT courses are generally referred to by their alphanumeric registration label. The four alpha characters indicate the discipline within the college. The final three digits are unique to each course and identify whether the course is noncredit (less than 099), lower division (100-299), upper division (300-599), or graduate level (600 and above).

Unless otherwise noted, the following courses are offered annually. Specific times and dates can be found in each semester's schedule of courses. Prerequisites/corequisites are noted in parentheses near the end of the course description.

Architecture

ARCH-611 Architectural Representation I
Introduction to the range of architectural representation skills necessary to effectively document basic architectural form and space. Skill development will be both manual and digital. Class 2, Studio 4, Credit 3 (F) (This class is restricted to students in the ARCH-MARCH program.) **Studio 2, Credits 3 (Fall)**

ARCH-612 Architectural Representation II
Further study of architectural representation skills necessary to effectively document more complex architectural form and space. Skill development will be both manual and digital. (Pre-requisite ARCH-611 Architectural Representation I) Class 2, Studio 4, Credit 3 (S) (Prerequisites: ARCH-611 or equivalent course.) **Studio 4, Credits 3 (Spring)**

ARCH-621 Architectural History I
Students study global architecture from pre-history to the 15th century, including form, technology, urban context, and how architecture reflects social, cultural, and political concerns. Class 3, Credit 3 (F) (This class is restricted to students in the ARCH-MARCH program.) **Lecture 3, Credits 3 (Fall)**

ARCH-622 Architectural History II
Students study global architecture from the 15th to the 21st century, including form, technology, urban context, and how architecture reflects social, cultural, and political concerns. (This class is restricted to students in the ARCH-MARCH program.) **Lecture 3, Credits 3 (Spring)**

ARCH-631 Architectural Design I
Exploration of basic architectural space and form through studio design problems. Problems require understanding of elements such as spatial relationships, circulation, light, and orientation. (Co-requisite, ARCH-611 Architectural Representation I). Classroom 3, Studio 9, Credit 6 (F) (Co-requisites: ARCH-611 or equivalent course.) **Studio 12, Credits 6 (Fall)**

ARCH-632 Architectural Design II
Students will analyze and solve building based architectural design problems with a focus on residential design and other wood based structures. (Pre-requisite, ARCH-631 Architectural Design I, Corequisite, ARCH-621 Architectural Representation II). Classroom 3, Studio 9, Credit 6 (S) ARCH- (Co-requisites: ARCH-641 or equivalent course.) **Studio 12, Credits 6 (Spring)**

ARCH-641 Fundamentals of Building Systems
Students will receive an overview of the various passive and active architectural and engineering systems that comprise a building project while focusing on wood frame construction. (Co-requisite ARCH- 632 Architectural Design II) Class 3, Credit 3 (S) (Co-requisites: ARCH-632 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

ARCH-698 Global Experience
Masters-level Global Experience by the candidate under the direction of an RIT instructor, a program with another academic institution, or an independent travel experience for no credit. Students may enroll once for a maximum of 3 credits towards their degree requirement. The subject of each offering varies depending on the location and focus of the faculty member's or student's interest. **Study Abroad 3, Credits 0 - 3 (Fall, Spring, Summer)**

ARCH-699 Coop Architecture
ARCH-699 Co-op Architecture This course provides a ten-week (350 hour min.) work experience in the field. (Second year program status) Credit 0 (Su) (This class is restricted to students in the ARCH-MARCH program.) **CO OP, Credits 0 (Summer)**

ARCH-731 Architectural Studio I: Site
Building on the 1st year studios that explored basic communications between form and space this introduction to the 2nd year will investigate in greater depth the complexity and integrated nature of the architectural object and design process. Students will explore the artistic, conceptual, creative, and experiential side of architecture as a way of developing a rigorous process of architectural form-making. By developing methods, parameters, and alternatives of form-making, issues such as expression, perception, and representation will be explored. Although site design will be the focus of the course, full building designs will be examined in response to site parameters. Students will be expected to work in teams to explore communally a broad spectrum of design strategies at every opportunity. (Prerequisites: ARCH-632 or equivalent course. Co-requisites: ARCH-741 or equivalent course.) **Studio 12, Credits 6 (Fall)**

ARCH-732 Architectural Studio II: Tectonic
This foundation studio considers architecture both as a representation and as a built form. It will expand student horizons beyond the confines of the studio by bridging the gap between theory (representation) and practice (action). Architects are responsible for shaping the built environment and this studio will provide students with a first-hand experience of the professional responsibility to the public. Through the process of design students will be making strong connections between drawing/representation and the finished building produced. (Prerequisites: ARCH-731 or equivalent course. Co-requisites: ARCH-743 or equivalent course.) **Studio 3, Credits 6 (Spring)**

ARCH-733 Architectural Studio III: Adaptive
This course examines the adaptive reuse of existing spaces, with implicit exposure to the basics of historic preservation. Students will examine and document an existing "real" space within the region, and propose coherent and rational architectural interventions for that space. (Prerequisites: ARCH-734 or equivalent course. Co-requisites: ARCH-743 or equivalent course.) **Studio 12, Credits 6 (Fall)**

ARCH-734 Architecture Studio II: Urban
Investigation of architectural design as a response to the modern urban context. This includes an understanding of urban design and planning, as well as community involvement. (Prerequisites: ARCH-731 or equivalent course. Co-requisites: ARCH-742 or equivalent course.) **Studio 12, Credits 6 (Spring)**

ARCH-735 Architecture Studio IV: Integrative
This studio provides the opportunity for students to execute a comprehensive and integrative project from schematic design through design development. (Prerequisites: ARCH-733 or equivalent course. Co-requisites: ARCH-744 or equivalent course.) **Studio 12, Credits 6 (Spring)**

ARCH-741 Integrated Bldg Systems I
This course presents the various systems that comprise a project's site work; architectural materials/methods, civil engineering, and landscaping architecture as well as site constraints. (Prerequisites: ARCH-641 or equivalent course. Co-requisite: ARCH-731 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

ARCH-742 Integrated Building Systems II
The major tectonic components of a building will be studied in this course focusing on the building envelope and typical structural configurations. Structural inquiry will fully cover the field of statics. (Prerequisites: ARCH-741 or equivalent course. Co-requisites: ARCH-734 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

ARCH-743 Integrated Building Systems III
Typical interior building components will be studied in this course from subdivision of space down to selection of material finishes as they relate to building code regulations. Structural inquiry will continue with full coverage of strength of materials. (Prerequisites: ARCH-742 or equivalent course. Co-requisites: ARCH-733 or equivalent course.) **Lecture 3, Credits 3 (Fall)**

ARCH-744 Integrated Building Systems IV
In conjunction with the co-requisite course, students will document a building design with design development drawings, including MEP with a focus on environmental systems and lighting. (Pre-requisite ARCH-743 Integrated Building Systems III, Co-requisite ARCH-733 Architectural Studio IV: Comprehensive) Class 3, Credit 3 (S) (Prerequisites: ARCH-743 or equivalent course. Co-requisites: ARCH-733 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

ARCH-751 Architectural Theory
A survey of architectural theory and criticism with emphasis on contemporary architecture. Students will investigate, learn, and apply critical thinking, as well as communicate it to others. (Prerequisites: ARCH-621 and ARCH-622 or equivalent courses.) **Lecture 3, Credits 3 (Fall)**

ARCH-752**Urban and Regional Planning**

This course immerses students in the field of urban and regional planning by studying and actively engaging in the planning process through projects with community agencies. (Prerequisite, ARCH-632 Architectural Design II) Class 3, Credit 3 (S) (Prerequisites: ARCH-621, ARCH-622 and ARCH-632 or equivalent courses.) **Lecture 3, Credits 3 (Spring)**

ARCH-753**Research Seminar/Thesis Prep**

Students frame individual thesis proposals through various research approaches, critical readings, presentations and examinations of architecture; physicality, socially, culturally, historically and technologically. (Prerequisite, 60 credit hours in the program) Class 3, Credit 3 (F) (This class is restricted to students in the ARCH-MARCH program.) **Lecture 3, Credits 3 (Fall)**

ARCH-761**Understanding Sustainability**

Students will study the interaction between industrial, environmental/ecological and social systems in the built environment by introduction of systems thinking and the multiple disciplines comprising sustainability. (acceptance into M. Arch. program or permission of instructor) Class 3, Credit 3. (F) (This class is restricted to graduate students in the Golisano Institute for Sustainability (ARCH-MARCH, SUSTSY-MS, SUST-PHD).) **Lecture 3, Credits 3 (Fall)**

ARCH-762**Industrial Ecology Fundm**

Students will learn how to assess the impact and interrelations of built environments on the natural environment by utilizing life cycle assessment tools and principles of sustainability. (ARCH-761 Understanding Sustainability) Class 3, Credit 3 (S) (Prerequisites: ARCH-761 or equivalent course.) **Lecture 3, Credits 3 (Spring)**

ARCH-763**Sustainable Building Metrics**

The measurement science, performance metrics, assessment tools, and fundamental data critical for the development and implementation of building systems associated with life-cycle operation of buildings while maintaining a healthy indoor environment. (This class is restricted to graduate students in the Golisano Institute for Sustainability (ARCH-MARCH, SUSTSY-MS, SUST-PHD).) **Lecture 3, Credits 3 (Fall)**

ARCH-764**Race to Net Zero**

Students will participate in "The Race to Zero" competition and may enter their projects in the NY State Pollution Prevention Institute Research and Development Student Competition. **Lecture 3, Credits 3 (Spring)**

ARCH-771**Professional Practice**

Students will study the roles of stakeholders involved in architecture within the context of project management and business practices including legal responsibilities, and professional ethics. (Second year courses) Class 3, Credit 3 (S) (This class is restricted to students in the ARCH-MARCH program.) **Lecture 3, Credits 3 (Spring)**

ARCH-781**Graduate Scholarship**

Masters-level scholarship by the candidate under the direction of the instructor. Students may enroll multiple times for a maximum of 9 credits towards their degree requirement. The subject of each offering varies depending on the nature and stage of the faculty member's work. **Research 3, Credits 1 - 6 (Fall, Spring)**

ARCH-789**Architecture Special Topics**

A Critical examination of issues in some area of sustainability not covered in other Golisano Institute for Sustainability courses. Topic depends on specific offering. **Lecture 3, Credits 1 - 6 (Fall, Spring)**

ARCH-790**Thesis**

Students will propose, design, and defend an architectural design or research problem, while working closely with a selected faculty committee. (Prerequisite, ARCH-753 Research Methods/Thesis Preparation) Class 3, Studio 9, Credit 6 (F, W, Su) (Prerequisites: ARCH-753 or equivalent course.) **Thesis 6, Credits 6 (Fall)**

ARCH-791**Continuation of Thesis**

This course is for Master of Architecture students who require additional time to complete their thesis. Students should enroll for one credit unless otherwise instructed. (Prerequisites: ARCH-790 or equivalent course.) **Cont, Credits 0 (Fall, Spring, Summer)**

ARCH-799**Independent Study**

Ind Study 4, Credits 1 - 4 (Fall, Spring, Summer)

Sustainability**ISUS-600****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 preposals, and as well as teaching skills, will also be covered. **Seminar 1, Credits 1 (Fall, Spring)**

ISUS-619**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 applications to thesis / dissertation research. **Lecture 3, Credits 3 (Fall)**

ISUS-699**Sustainability Co-op**

The Sustainability Co-Op is designed to provide Capstone research experience for MS students or enhance the educational experience of PhD students through full-time employment. **CO OP, Credits 0 (Fall, Spring, Summer)**

ISUS-700**Special Topics**

A critical examination of issues in some area of sustainability not covered in other Golisano Institute for Sustainability courses. Topic depends on specific offering. **Lecture 3, Credits 3 (Fall, Spring, Summer)**

ISUS-701**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. **Ind Study, Credits 1 - 3 (Fall, Spring, Summer)**

ISUS-702**Fundamentals of Sustainability Science**

This course prepares students to conduct original research related to sustainable production and consumption systems and apply the scientific method in an integrative, team-based approach to graduate research. This course introduces the fundamental concepts of industrial ecology, ecological economics, ecosystem health and social ecology that are essential to understanding the interaction of industrial and ecological systems. Successful students will understand multiple perspectives on 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. It is a core course within the Sustainability Ph.D. program. **Lecture 3, Credits 3 (Fall)**

ISUS-704**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 interrelations of production systems on the natural environment by mastering fundamental concepts of ecology as a metaphor for industrial systems and the resultant tools from industrial ecology, including life cycle assessment, material flow analysis, and energy and greenhouse gas accounting. This is a core course within the Sustainability Ph.D. program. **Lecture 3, Credits 3 (Fall)**

ISUS-705**Technology, Policy, and Sustainability**

Public policy is a multidisciplinary field aimed at understanding how policy and regulation can be used to achieve certain social goals. These goals may include the notion of sustainability, whereby society's present needs are met without compromising the ability to meet society's future needs. 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. **Lecture 3, Credits 3 (Fall)**

ISUS-706**Economics of Sustainable Systems**

The goal of this course is to introduce students to economic concepts and analysis pertaining to sustainable systems. This course offers a nontechnical introduction, but based on rigorous economic reasoning. Additionally, a thorough treatment of models relevant to each topic is provided. The over-arching goal is for students to gain an appreciation for the logic of economic reasoning while teaching economics as it pertains to sustainable systems. **Lecture 3, Credits 3 (Fall)**

ISUS-708

Sustainability Practice

This course covers theoretical and practical issues associated with analysis and progress towards sustainability. Methods and concepts covered include optimization, stochastic analysis, multicriteria decision-making and resource economics. Societal perception and response to sustainability is covered sector by sector (industry, government, academia and civil society) and through integrative case studies of particular sustainability issues (e.g. natural gas fracking). Emerging sustainability governance mechanisms are explored, in particular environmental certifications and standards (e.g. LEED, EnergyStar) and multilateral agreements. (This class is restricted to students in the SUSTSY-MS and SUST-PHD programs.) **Lecture 3, Credits 3 (Spring)**

ISUS-710

Sustainable Product Design

The application of sustainability and product design methods. Lectures and projects will incorporate strategies such as effective sustainability methods and life-cycle assessment; enhancement of product value and prolonged use; and balance between recycling, reusing and repurposing. Sustainable Product Design enables an interdisciplinary collaboration between Sustainability and Industrial Design. Both areas will offer their unique approach while learning and integrating knowledge from each other. **Lec/Lab 6, Credits 3 (Fall)**

ISUS-712

Sustainable Product Realization

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. **Lecture 3, Credits 3 (Spring)**

ISUS-718

Sustainable Energy Systems

Energy will play an increasingly vital role in economic, environmental and political developments around the world. This course first investigates the current trends in energy production, distribution, and consumption associated with the primary incumbent energy system technologies: fossil fuel combustion and nuclear power. An understanding of the economic, environmental and social limitations of these technologies will lead to analysis of the potential benefits of 3 key renewable technologies: solar (including wind), biomass and hydrogen/fuel cells. Potential paths to market penetration for these technologies will be introduced, including geographical variations expected to occur globally and within the United States. **Lecture 3, Credits 3 (Fall)**

ISUS-780

Capstone

An independent project in sustainability serving as a capstone experience for students completing the non-thesis option. This course requires a formal proposal and a faculty sponsor. **Lecture, Credits 1 - 6 (Fall, Spring, Summer)**

ISUS-790

Thesis

Independent research in sustainability leading to the completion of the MS thesis. This course requires a formal proposal and a faculty sponsor. **Thesis, Credits 1 - 6 (Fall, Spring, Summer)**

ISUS-791

Continuation of Thesis

MS or PHD students requiring additional time to complete their thesis **Cont, Credits 0 (Fall, Spring, Summer)**

ISUS-806

Risk Analysis

This course examines risk identification, quantification, and management from the standpoint of the three key components of sustainability science (economics, environment, and society). Economic subjects include cost-benefit analysis, value of information, time value of money, basic decision analysis, value functions, monetizing challenges for ecosystem services, and sustainability risk management. Environmental subjects include toxicological perspectives such as fate and transport and dose-response relationships including an overview of EPA's current practice. Policy and societal subjects include utility theory and lotteries, risk perception, ethical issues in risk quantification, and impact statements. **Lecture 3, Credits 3 (Fall)**

ISUS-807

Research

Research in fulfillment of Sustainability Ph.D. dissertation or M.S. capstone requirements. **Thesis, Credits 1 - 9 (Fall, Spring, Summer)**

ISUS-808

Multicriteria Sustainable Systems

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. **Lecture 3, Credits 3 (Spring)**

ISUS-809

Data Analysis for Sustainability

This course will introduce students to the study and practice of data analysis in sustainability and expand on core concepts from probability and statistics. Analysis methods presented will be applied to datasets ranging from energy consumption at the household and commercial building levels, to other national datasets, such as the national household travel survey (NHTS) and pollutant or vehicle emissions data from the EPA. Topics include (i) numerical and graphical summaries of data, (ii) hypothesis testing, (iii) confidence intervals, (iv) counts and tables, (v) analysis of variance, (vi) regression, (vii) principal components, and (viii) cluster analysis. Additionally, topics in data collection and survey design will also be introduced. These include: (a) sampling and weighting; (b) questionnaire design; and (c) design of experiments. At the end of this course, students should be able to think critically about data and apply standard statistical inference procedures to draw conclusions from such analyses. This course will be computationally, not mathematically, intensive and will use the R language and environment for statistical computing and graphics. **Lecture 3, Credits 3 (Spring)**

ISUS-810

Thermodynamics for Sustainability

As energy plays a fundamental role in the system sustainability framework, it is essential that students and practitioners have an understanding of the laws of thermodynamics which govern the processes of energy usage and conversion. This course investigates the differences between energy and exergy analysis, where the latter includes not only the quantities of energy exchanged, but also the quality of the energy relative to some reference state. After establishing the fundamentals of exergy analysis, this concept is applied to practical sustainability problems associated with sustainable development, industrial systems and energy policy. Specific examples are also explored, including thermal storage and fuel cell systems, and life cycle assessment. **Lecture 3, Credits 3 (Spring)**

ISUS-821

Applied Life Cycle Assessment

Life cycle assessment (LCA) is a tool used in the field of industrial ecology to evaluate the environmental impacts of products or processes over their entire life cycle – from raw material extraction, manufacturing, use, and end-of-life management. This course will build on fundamental principles of LCA by allowing students to conduct project-based studies on the application of LCA to real-world sustainability issues. Students will apply process, economic input-output, and hybrid methodologies to evaluate technological systems for opportunities of environmental improvement. **Lecture 3, Credits 3 (Spring)**

ISUS-822

Materials 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 (selective precipitation, leaching, ion exchange), biotechnological (biosorption, sulfate reduction), and pyrometallurgical (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.) **Lab 3, Credits 3 (Fall)**

ISUS-877

Research Internship

The Research Internship is designed to enhance the educational experience of PhD students through full-time employment. (This class is restricted to students in the SUSTSY-MS and SUST-PHD programs.) **Internship, Credits 0 (Fall, Spring, Summer)**

ISUS-890

Dissertation Research

Research fulfillment of Sustainability Ph.D. dissertation requirements. **Thesis, Credits 1 - 9 (Fall, Spring, Summer)**