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Information Technology and Computing Topics and Their Relevance to Medical Undergraduate and Graduate Program Curricula at RIT

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ABSTRACT

Two healthcare domain related programs in which this author has curricular relationships are the undergraduate Diagnostic Ultrasound (DU), and the graduate Master of Science in Health Informatics (MSHI). He teaches one course in the former and is the program coordinator for the latter. The undergraduate course is titled, "Computers in Medicine", and is a rough 50% combination of a first-semester computing hardware course taught to our IT undergrads and another 50% of material from a textbook covering all the ways in which computing has benefitted various healthcare domains like, surgery, pharmacy, imaging, dentistry, psychiatry, remote medicine and the like. The MSHI program is a 30 semester credit hour program offered in an online format with a capstone experience (no thesis required) that was designed for professionals expecting to retool themselves for continued employment in a healthcare setting. This paper will discuss the details of the DU course and the MSHI program, the kind of computing content covered in each, and the rationale for and program design input of each. In conclusion, the reader will be left with an understanding of the what, when, how and why computing topics are necessarily required by these curricula, our justification for such, and how we might use that information in the development of future healthcare-related computing courses and potential programs. Course definition and program outline documents will be attached as appendices to the paper.

INTRODUCTION

It is an undeniable fact that computing, in its many forms and domains, has irreversibly changed, enhanced and augmented every field of scientific endeavor since its appearance to the masses in the mid-1960s (mainframe and minicomputer technology), the early 1980s (personal computer technology), and the 2000s (personal device technology). The ability, at one's fingertips, anytime and anywhere, to search and share the world's resources for needed information, combined with the incredible speed at which analyses, simulation and research itself can be carried out by scientists, academicians, physicians, engineers and the like has enabled mankind to develop new techniques for implementing old and new research methodologies, human and machine-automated processes for the design and manufacture of almost any product imaginable, and the gathering of vast amounts of knowledge that today overwhelms man's ability to deal with it all.

Nowhere has this transformation in research, knowledge, and practical implementation of new processes been evident as in the healthcare, medicine and medical science domains. New ways of non-invasive diagnostic techniques, imaging, advances in remote and robotic surgery, automation of hospital and health insurance clerical processes that reduce or even eliminate human errors in the recording and recovery of patient data, the electronic health record and its numerous application software systems, implementation of computer-controlled pharmaceutical dispensation systems, and research in the body and body systems that have given us the ability to gain deep understanding of disease processes and treatments never before deemed possible has all been a direct result of the use computing and information technology in its many forms. Included here are the pillars of Information Technology (IT) as defined by the Association of Computing Machinery (ACM) and one of its special interest groups, the Special Interest Group in Information Technology Education (SIGITE). These pillars are, in no defined order, programming, database, networking and data communications, web design and development, and human-computer interaction. [1]

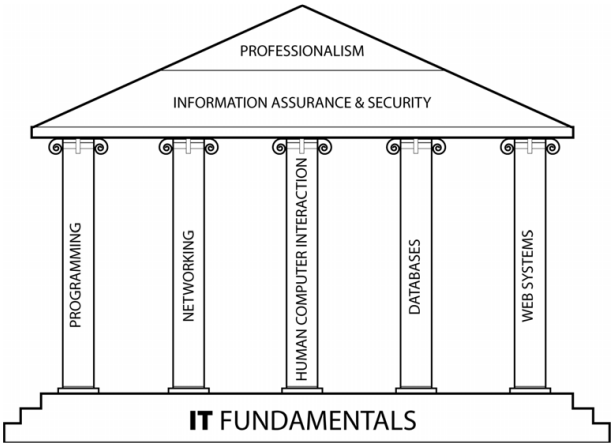

Figure 1. The SIGITE defined "Pillars of IT" [1]

The core pillars are capped by information assurance and professionalism, distinct areas that must be a part of any implementation of what is referred to as "IT".

Even though computing was responsible for the creation of any of the modern imaging techniques used by DU, the vast majority of the DU students have had no exposure to anything computing-related in their college program. If they had no significant high school exposure it's possible that they have zero knowledge of the very domain that makes their chosen career even possible!

The MS program was designed for two types of incoming candidates with very different backgrounds. The first type is the medical professional (nurse, physician, NP, PA, or even clerical staff with some years of clinical experience). Most of these students have little or no knowledge of computing save the ways in which they use them as tools in their daily routines. The second group is the opposite, those with computing knowledge that could come from the programming domain (developers), database administrators, systems designers and the like, with little or no knowledge of anything clinical. The MS program consists of a generic core set of courses, followed by a choice of one out of two professional tracks. One track provides the non-technical types with that information, and the second providing the clinical information. At the end of the program the graduates are well-rounded in both domains but will choose, as a career path, the alignment with their chosen course track as those would have been the advanced courses completed.

THE COMPUTERS IN MEDICINE COURSE

This course is a first-year core course in the DU program. Most contemporary incoming freshman students coming into the program historically have demonstrated a profound lack of knowledge about the underpinnings of computing ("IT") considering that they have been exposed to the paradigm since kindergarten. It is clear that, while they are very proficient *users* of and *consumers* in IT, enabling them to accomplish social engagement and messaging (social media), research (surfing the web), entertainment (streaming), determining location (GPS and triangulation), wireless connectivity, and using traditional applications like word processing and spreadsheets to succeed in their studies (and the list goes on and on), they most likely had no interest in and/or weren't taught about the hardware and software integration that facilitated those processes. Most of them had no ideas about the structure and the "guts" of a computer, and especially none about the ways in which computing resources communicate over wired and wireless networks. Of course, in the latter, communication is what it's all about! Without that, we'd have absolutely no computing paradigm as we enjoy it today.

The first focus then is to familiarize them with these concepts and show specifically how the computers, data communication, and system resources function. The discussion of these topics consumes about one third of the semester. There are four labs in the course, the first being a "take apart the PC and reassemble it" exercise with the intention that it boots up after they complete the lab. The second lab is a literature search exercise where they are exposed to the MEDLINE dataset and must start with a broad topic and modify their search criteria to get down to less than 25 hits on their final topic. Doing a real literature search was difficult for some of the students. The third lab was a spreadsheet exercise. Most of them excel (no pun intended) at this lab since they were exposed to spreadsheets in high school. The fourth and final lab was a database exercise. Almost none of the students were familiar with databases and this lab turned out to be a challenge for most. That rounds out the technical description and standard office application uses of PCs. The following is a list of technical topics covered by the course. [2, 3]

- Inside the PC
- Binary math
- Character codes and data transfer
- Computer peripherals
- Different platforms and their uses (PCs, portable devices, mainframes, supercomputers)
- Hardware/software interaction
- Software types (firmware, application, operating system)
- Microsoft Access databases (relational vs. hierarchical)
- Microsoft Excel spreadsheets
- Basics of data security and privacy (including legislation like HIPAA)

The second focus is to relate computing to various healthcare domains. Although the students readily grasped these concepts as we progressed through the remainder of the semester, it was surprising to witness how little they actually knew beforehand and how much they simply took for granted in their somewhat limited interaction with the healthcare system as only a few had health issues serious enough to require more than average frequencies of encounters in their mostly healthy youth. The concept of the electronic health record (EHR) and the need make it universally sharable was completely foreign to them. The following is a list of healthcare related topics covered by the course. [2, 3]

- Clinical computer peripherals (direct patient contact and operating room; infusion pumps, pulse oximeters, sphygmomanometers, blood pressure cuffs, etc.)
- Medical data
- Clinical computer peripherals (direct patient contact and operating room)
- Medical data
- Electronic health record including its history of the EHR including regulatory agencies and legislation
- Healthcare domains augmented by computing (Telemedicine, Radiology, Telesurgery,

Telepharmacy, Teledentistry, Public and population health)

THE MS in HEALTH INFORMATICS PROGRAM

This program was designed by faculty in the Golisano College of Computing and Information Sciences (GCCIS) - Information Sciences and Technologies (IST) department and the College of Health Sciences and Technologies (CHST), both components of RIT. This graduate program was conceived out of a demonstrated necessity in the Rochester, NY area where there are two major competing healthcare systems, one level-one trauma center with helicopter EMS, multiple health insurance firms, four major hospitals and countless outpatient clinics, emergency medicine clinics, and doctors' practices, with many current and potential healthcare and IT professionals seeking to advance their careers in this domain. The program intends to serve two aspects of the professional population, current clinicians with little or no computing experience, and current IT professionals with little or no clinical experience. Upon completion of this program and graduation, the candidates will either be advanced *users* of the EHR and clinical/EHR office management application software products, or *developers* of new EHR and clinical/EHR office management application software products. The program is offered online, two courses per semester, with only a one-week residency requirement that satisfies the outcomes of the Practice of Healthcare course. The program has two major course blocks, a set of six common courses that comprise the core, and a choice of one of two professional tracks each comprised of three courses. A list of the core courses follows. [4]

- MEDI-701 **Intro to Health Informatics** (chst) yr1-sem1A
- MEDI-705 Medical Knowledge Structures (chst) yr1-sem1B
- HCIN-610 **Foundations of Human-Computer Interaction** (gccis-ist) yr1-sem2a
- MEDI-735 Clinical Information Systems (gccis-ist) yr1-sem2b
- MEDI-704 Practice of Healthcare (chst & gccis-ist) yr1-summer
    - Requires one week of on-site participation in hospital physician shadowing
    - RIT provides housing for this experience
- ISTE-764 **Project Management** (gccis-ist) yr2-sem1a

After completion of the core, or before if there are no course prerequisites required, the candidate chooses one of the two tracks to complete their coursework. Lists of the two tracks follows.

- Track 1- clinician (user) no prerequisites for this track
    - ISTE-608 **Intro to Database**
    - MEDI-610 **Scripting Fundamentals**
    - MEDI-731 **System Integration Concepts**
- Track 2 – analyst (developer)
    - ISTE-782 **Visual Analytics** prereq - graduate statistics
    - MEDI-730 **Medical Application Integration** prereqs - MEDI-701, ISTE608, 1 yr java programming (it is assumed that candidates in the developer track would have intro to database ISTE-608 and java skills upon entry into the program)
    - MEDI-766 **Building the Electronic Health Record** prereqs – HCIN-610, MEDI-705

The aforementioned nine courses are administered/taught by faculty in the GCCIS-IST department and the CHST colleges. After completion of all coursework, the candidate then takes the MEDI-788 **Capstone in Medical Informatics** course as a joint effort by GCCIS and CHST.

Note there are courses listed in **boldface** type. These courses are the computing-rich content courses. Those not bolded are the clinically related courses that only peripherally mention computing topics. Of course there is always some overlap between the two domains but clearly this breakdown illustrates the choice of housing of this program in the computing college.

A complete description of the specific topic areas covered in these courses can be found in the excerpts of the course outline forms (topic areas only) in appendix B at the end of this paper.

As can be reasoned, the developer track is highly dependent upon the incoming skills of those candidates. It should be understood that these candidates are expected to be familiar with the software development, information security, documentation, process, and version control domains of application development. The developer-focused courses in this program offer the candidate insight into the specific requirements of the clinical domain and its dependence upon quality, safe, and secure applications that will be used by many.

The user track has just enough computing focus providing these individuals the necessary background information to make them better users of these complex systems and also to enable them to accurately communicate systems requirements to the developers. Healthcare applications are amazingly complex and therefore require the insights of both users and developers. That is the underlying hypothesis in the design of this program.

REFERENCES

[1] **Information Technology 2008-Curriculum Guidelines for Undergraduate Degree Programs in Information Technology,** Lunt, BM, et al, ACM SIGITE, 2008, p 19. Available at www.sigite.org.

[2] **MEDI130 course calendar,** Hill, L, RIT internal document, 2018. Available in appendix A.

[3] **GCCIS-MEDI-130-Computers in Medicine,** Therios, N, RIT internal document, 2011. Available in appendix A.

[4] **Table 1b: MS Health Informatics Graduate Program Schedule,** part of NYSED program application document, HEGIS code 1277.00, RIT GCCIS and CHST, 2016. Available in appendix B.

APPENDIX A

Medi-130 course calendar
GCCIS-MEDI-130-Computers in Medicine

MEDI 130 Computers in Medicine--Fall Semester 2181

Calendar Week	Lecture 1 Topics (Mondays)	Lecture 2 Topics (Wednesdays)	Lecture 3 Topics (Fridays)	Reading/Lab Assignments "MCDB" means the MyCourses dropbox on Fridays BEFORE 8 AM	Quizzes ALL given on Fridays
1 8/26	Course Introduction	Why computers in medicine?	Inside the box I	Beekman ch. 1	
2 9/2	Labor Day RIT is CLOSED LAST DAY to ADD/DROP isTuesday 9/4	Inside the box II	Lab 1: Inspection of a PC	Burke ch. 1 Beekman chs. 2,4	
3 9/9	Lab 1: Inspection of a PC	Medical Informatics I	Medical Informatics II	Burke ch. 2	Quiz #1
4 9/16	Binary math/ Character codes	Binary math/ Character codes	Computer Peripherals	Beekman ch. 3 Lab 1 DUE in MCDB	Quiz #2
5 9/23	Clinical Peripherals	Lab 2: Medline	Lab 2: Medline		Quiz #3
6 9/30	Medical data	Electronic Health Record	Relational Databases	Burke ch. 3 Lab 2 DUE in MCDB	Quiz #4
7 10/7	Columbus Day RIT open M & T but NO CLASSES	Lab 3: Access databases	Exam 1 review	Beekman ch. 7	Quiz #5
8 10/14	Exam 1--part 1	Exam 1--part 2	Telemedicine		
9 10/21	Discuss exam 1	Telemedicine	Radiology	Burke ch. 4 Lab 3 DUE in MCDB	Quiz #6
10 10/28	Radiology	Spreadsheets	Spreadsheets	Burke ch. 6	Quiz #7
11 11/4	Lab4 : MSExcel spreadsheets	Lab4 : MSExcel spreadsheets	Exam 2 review	Beekman chs. 5,7 LAST DAY to WITHDRAW is Friday 11/9	Quiz #8
12 11/11	Exam 2--part 1	Exam 2--part 2	Grade Exam 2 in class		
13 11/18	Telesurgery	Thanksgiving HOLIDAY INSTITUTE CLOSED	Thanksgiving HOLIDAY INSTITUTE CLOSED		
14 11/25	Telesurgery	Telepharmacy	Telepharmacy	Burke ch. 7 Lab 4 DUE in MCDB	Quiz #9
15 12/2	Teledentistry	Teledentistry	Security and Privacy	Burke chs. 8,9 Burke ch. 12	Quiz #10
16 12/9	Final Exam Review	FINALS "WEEK" BEGINS	OUR FINAL EXAM TBD		
FINALS 12/16	Remainder of final exam week (M T W) -- HOLIDAY BREAK begins on Thurs 12/20				

ROCHESTER INSTITUTE OF TECHNOLOGY
COURSE OUTLINE FORM

GOLISANO COLLEGE OF COMPUTING AND INFORMATION SCIENCES

Information Sciences and Technologies

NEW: GCCIS-MEDI-130-ComputersInMedicine

1.0 Course Designations and Approvals

Required course approvals:	**Approval request date:**	**Approval granted date:**
Academic Unit Curriculum Committee		
College Curriculum Committee		

Optional designations:	**Is designation desired?**		***Approval request date:**	****Approval granted date:**
General Education:		No	**12/8/10**	**1/4/11**
Writing Intensive:		No		
Honors		No		

2.0 Course information:

Course title:	Computers in Medicine
Credit hours:	3
Prerequisite(s):	None
Co-requisite(s):	None
Course proposed by:	Nicolas A. Thireos
Effective date:	September 2013

	Contact hours	**Maximum students/section**
Classroom		
Lab		
Active Learning	3	35
Other (specify)		

2.a Course Conversion Designation* (Please check which applies to this course**

X	Semester Equivalent (SE) Please indicate which quarter course it is equivalent to: 4006-230 Computers in Medicine
	Semester Replacement (SR) Please indicate the quarter course(s) this course is replacing:
	New

2.b Semester(s) offered (check)

Fall X	Spring	Summer	Other

All courses must be offered at least once every 2 years. If course will be offered on a bi-annual basis, please indicate here:

2.c Student Requirements

Students required to take this course: (by program and year, as appropriate)

Students in the BS degree in Medical Informatics in the first year

Students in the Diagnostic Medical Imaging program in the first or second year

Students who might elect to take the course:

All pre-Med or Pre-Vet students enrolled in any program

Physician Assistant students

Students majoring in Medical Sciences

Information Technology students

Students in the Undeclared Science Option (SSEG)

3.0 Goals of the course (including rationale for the course, when appropriate):

The main goal is to introduce students to the applications of computer technology to the medical field. The content is appropriate for Medical Informatics students and any students who upon graduation will work in the medical field or attend a professional school (medical, veterinary, dental, etc.)

4.0 Course description

GCCIS-MEDI-130 Computers in Medicine

This course begins with a historical perspective on computing in medicine. It reviews software and hardware from supercomputers to mobile devices, and surveys their use in medical practice, research, and education. Next it studies the nature of medical data, its collection, organization and use. This sets the stage for the major part of the course which studies important applications of computing to medicine, including Hospital Information Systems (HIS), medical imaging, surgery, telemedicine, and pharmacy. **Active Learning 3, Credit 3 (F)**

5.0 Possible resources (texts, references, computer packages, etc.)

5.1 Information Technology for the Health Professions, L. Burk and B. Weill, 3d Edition

5.2 Medcin Software (The Electronic Health Record)

6.0 Topics (outline):

6.1 Computer Technology

- 6.1.1 Historical Perspective in Medicine
- 6.1.2 Supercomputers to Mobile Devices
- 6.1.3 Databases and Storage Devices
- 6.1.4 Networks and the Internet
- 6.1.5 Medical Web Pages and HTML

6.2 Medical Data

- 6.2.1 Broad Types of Medical Data
- 6.2.2 Organization of Medical Data
- 6.2.3 The Electronic Medical Record
- 6.2.4 Security and Privacy

6.3 Computer Applications in Medicine

- 6.3.1 Diagnostic Medical Imaging
- 6.3.2 Computer Assisted Surgery
- 6.3.3 Telemedicine
- 6.3.4 Hospital Information Systems (HIS)
- 6.3.5 Pharmacy
- 6.3.6 CAI, Expert Systems, Health Information Online

7.0 **Intended course learning outcomes and associated assessment methods of those outcomes** (please include as many Course Learning Outcomes as appropriate, one outcome and assessment method per row).

Course Learning Outcome	Assessment Method
7.1 Describe the types of computers used in medicine	Exams
7.2 Explain the nature of databases and storage devices	Exams & Labs
7.3 Demonstrate access to medical information using the Internet	Exams & Labs
7.4 Describe the nature of medical data	Exams
7.5 Describe the types of Hospital Information Systems (HIS)	Exams
7.6 Evaluate and compare major medical imaging modalities	Exams & Labs
7.7 Explain the various roles of computers in surgery	Exams & Labs
7.8 State the importance of computers in telemedicine	Exams
7.9 Describe pharmacy automation	Exams
7.10 Explain the use of mobile computing in medicine	Exams & Labs

8.0 **Program outcomes and/or goals supported by this course**

8.1 Communicate effectively both orally and in writing in English and the language of medicine

8.2 Promote the adoption of the Electronic Health Record (EHR) and support clinicians in its use

8.3 Understand the need for lifelong learning

10.0 **Other relevant information** (such as special classroom, studio, or lab needs, special scheduling, media requirements, etc.)

This course requires an active learning classroom (lab).

APPENDIX B

Excerpts from the course outline forms for the MSHI program.
NYSED Program document.

MEDI-610 Scripting Fundamentals

5.0 Topics

5.1. HyperText Markup Language
5.2. Style Sheet Language
5.3. Foundations of computer programming
  5.3.1 Basic procedural concepts
5.4. Implementation language constructs
  5.4.1 Data types
  5.4.2 Data structures
  5.4.3 Conditional constructs
  5.4.3 Iteration constructs
5.5. Use of current Libraries
  5.5.1 Fetching of live data
  5.5.2 Interactive Implementations

6.0 Possible Resources

6.1 Beginning HTML5 and CSS3: The Web Evolved, Murphy, et al., Apress, 2012.
  Eloquent JavaScript: A Modern Introduction to Programming, Haverbeke, M, No Starch Press, 2014
6.2 Multiple Web Browsers
6.3 Programmer's Text Editor (eg: BBEdit)
6.4 Visual Programming Environment (eg: Android)
6.5 Server Facilities
6.6 Hosting for Information Services to be consumed by student projects

MEDI-701 Introduction to Health Informatics

5.0 Topics

5.1 Overview and Healthcare Policy issues

5.2 Practice of Healthcare (Physicians, Nurses, staff)

5.3 Evaluation of Healthcare Information Systems

5.4 Clinical Decision Support

5.5 Standards in Health Informatics

5.6 Human Computer Interaction

5.7 Data Mining and Data Warehousing

5.8 Mobile Computing, Telemedicine, Emerging Technologies

5.9 Applications Integration

6.0 Possible Resources

6.1 Textbook: 5.1 Designing Biomedical Informatics Computer Applications in Health Care and Biomedicine Edward H. Shortliffe, James J. Cimino Publisher: Springer (2006) ISBN: 0387289860

6.2 Research Papers: TBD

MEDI-704 Practice of Healthcare

5.0 Topics

5.1. Clinical Practice Introduction
5.2. Selected Specialties, such as
- 5.2.1 Surgery (General / Trauma)
- 5.2.2 Internal Medicine
- 5.2.3 Emergency Medicine
- 5.2.4 Cardiology
- 5.2.5 Pediatrics
- 5.2.6 Neurology

Topics within each specialty rotation will vary by semester and will be crafted to be preparation for the selected clinical rotation.

6.0 Possible Resources

6.1 Portions from multiple texts will be used

MEDI-705 Medical Knowledge Sturctures

5.0 Topics

5.1 Knowledge Structures -- The Past

- 5.1.1. General Overview and Historical Perspective
- 5.1.2. Characteristics of Medical Knowledge structures
- 5.1.3. Classification schemes
- 5.1.4. Taxonomies, controlled vocabularies
- 5.1.5. Standards
- 5.1.6. Indexes
- 5.1.7. Bibliographies and Finding Aids

5.2 Knowledge Structures – The Present

- 5.2.1 Characteristics
- 5.2.2 Indexing & controlled vocabulary
- 5.2.3 Thesauri
- 5.2.4 Medical thesauri, controlled vocabularies, nomenclatures
- 5.2.5 UMLS – a solution
- 5.2.6 Information retrieval: PubMed
- 5.2.7 Evidence Based Medicine and information retrieval
- 5.2.8 Full text searching
- 5.2.9 Metadata

5.3 Knowledge Structures – The Future

- 5.3.1 Characteristics
- 5.3.2 Ontologies
- 5.3.3 Linking to knowledge resources at the point of care
- 5.3.4 Knowledge discovery

6.0 Possible Resources

6.1 The Organization of Information (2003). Taylor, Arlene. Libraries Unlimited
   i. ISBN: 1563089696.

6.2 Biomedical Informatics: Computer Applications in Health Care and Biomedicine (2007). Shortliffe, Edward H. and Cimino, James J., eds. Springer ISBN: 0387289861

HCIN-610 Foundations of HCI

5.0 Topics

5.1. Historical Roots and Multidisciplinary Nature of HCI
5.2. Motivating need for User Centered Design
5.3. Human Factors and Design Elements
5.4. Cognitive Psychology for Interaction Design I
  5.4.1 Capabilities and Limitations of Human Information Processing
  5.4.2 Design as Applied Perception
5.5. Cognitive Psychology for Interaction Design II
  5.5.1 Attention and Memory
  5.5.2 Mental Models
  5.5.3 Problem Solving and Decision Making
5.6. Understanding Users
  5.6.1 Cultural/Individual Differences
  5.6.2 Accessibility Issues
  5.6.3 Inquiry Methods for Defining User Requirements
5.7. Modeling for Interaction Design
  5.7.1 Creating User Profiles and Personas
  5.7.2 Task Analysis, User Scenarios
  5.7.3 Descriptive and Predictive Models
5.8. Early Design Specification
  5.8.1 Prototyping: Conceptual Design
  5.8.2 Prototyping: Screen flow and navigation
5.9. Usability Evaluation
  5.9.1 Formative and Summative Evaluation
  5.9.2 Heuristic Evaluation and Relationship to Design Principles
  5.9.3 Web Accessibility
  5.9.4 Usability testing and Variations

6.0 Possible Resources

6.1 *"The Design of Everyday Things"*, Donald Norman, Basic Books, 2002/1990. ISBN 0-465-06710-7 (September 17, 2002)
6.2 *"Fundamentals of Cognition"*, Michael Eysenck, 2007 ISBN-13: 978-1841693743
6.3 *"HCI Models, Theories, and Frameworks: Toward a Multidisciplinary Science",* John Carroll (ed). , 2003, ISBN-13: 978-1558608085
6.4 Web Browsers
6.5 Programmer's Text Editor (BBEdit)
6.6 Adobe Web Development Suite
6.7 UNIX account with database access and Web server capabilities

ISTE-764 Project Management

5.0 Topics

5.1. Objectives of Project Management
5.2. The Business Case
5.3. The Project Charter
5.4. Human Resources
5.5. Managing Project Scope
5.6. Work Breakdown Structure
5.7. Managing the Project Schedule
5.8. Managing Risk
5.9. Managing Communications
5.10. Ethics
5.10 anaging Quality

6.0 Possible Resources

6.1 Information Technology Project Management, Jack Marchewka,
6.2 A Guide To The Project Management Body Of Knowledge, 4th Edition, PMI Institute
6.3 Peopleware, Lister & Demarco
6.4 The Mythical Man-Month, Brooks
6.5 Microsoft Project

MEDI-788 Capstone in Health Informatics

5.0 Topics

5.1. Organizing a team project
- 5.1.1. Identifying team members strengths
- 5.1.2. Assigning roles
- 5.1.3. Developing a project plan
- 5.1.4. Setting individual and team expectations

5.2. Requirements activities
- 5.2.1. Eliciting requirements
- 5.2.2. Identifying project boundaries
- 5.2.3. Identifying customer quality requirements
- 5.2.4. Understanding usability requirements

5.3. Design activities
- 5.3.1 Platform and tool selection
- 5.3.2 Describing the design
- 5.3.3 Evaluating the design

5.4. Project Development
- 5.4.1. Building an initial solution using the design specifications in Capstone
- 5.4.2. Iterating with the project sponsor to refine the solution.
- 5.4.3. Validating the solution.
- 5.4.4. Documenting the proposed solution.

5.5. Project Deployment
- 5.5.1. Defining processes for deployment, post-implementation maintenance, and system oversight.
- 5.5.2. Documenting training and support requirements.
- 5.5.3. Deploying the solution in an appropriate environment.

5.6. Project Solution Evaluation
- 5.6.1. Assessing the solution's effectiveness in the deployed environment.
- 5.6.2. Assessing the project team's strengths and weaknesses.

6.0Possible Resources

6.1 Books, journal articles, reference materials as appropriate.

ISTE-608 Database Design and Implementation

5.0 Topics

5.1. Data vs. Database Management System
5.2. Data Modeling
5.3. Schema Mapping
5.4. Normalization
5.5. Relational Algebra
5.6. Structured Query Language
5.7. Transactions
5.8. Current trends/issues in data management

6.0Possible Resources

6.1 Hoffer, J.A., Prescott, M., & Heikki, T. (2009). Modern *Database Management* (9^{th} ed). Prentice Hall.
6.2 Journal articles; conference proceedings; white papers; etc. as selected by the course instructor(s).
6.3 Use of a database management system such as MySQL or Oracle.

ISTE-782 Visual Analytics

5.0 Topics

5.1. The Science of Analytical Reasoning
- 5.1.1 Hypothesis generation and testing
- 5.1.2 Sense making
- 5.1.3 Situation Awareness
- 5.1.4 Intelligence Analysis

5.2. Visual Representation and Interaction
- 5.2.1 Visual Metaphors
- 5.2.2 Survey of existing visualization and interaction paradigms
- 5.2.3 Cognitive and perceptual principals
- 5.2.4 Survey of existing visualization technologies

5.3. Data representation and transformation
- 5.3.1 Large-scale data set analysis
- 5.3.2 Unified representations of heterogeneous data
- 5.3.3 Data quality, uncertainty, and accuracy

5.4. Production, presentation, and dissemination
- 5.4.1 Summarizing analytical efforts
- 5.4.2 Visual story telling

5.5. Visual Analytic case studies and applications
- 5.5.1 Visual Analytics and US Homeland Security
- 5.5.2 The Visual Analytics Industry

5.6. Visual Analytics and Ethics
- 5.6.1 Privacy

5.7. Research trends and developments
- 5.7.1 Space, Time, and Multivariate Analytics
- 5.7.2 Extreme Scale Visual Analytics
- 5.7.3 Grand challenges for Visual Analytics

6.0Possible Resources

6.1 Thomas, J. J. & Cook, K. A. 2005. *Illuminating the Path: The Research and Development Agenda for Visual Analytics*, Los Alametos, CA, IEEE.

6.2 Allendoerfer, K., Aluker, S., Panjwani, G., Proctor, J., Sturtz, D., Vukovic, M. & Chen, C. 2005. Adapting the Cognitive Walkthrough Method to Assess the Usability of a Knowledge Domain Visualization. *Proceedings, IEEE Symposium on Information Visualization.* Minneapolis, MN.

6.3 Amar, R., Eagan, J. & Stasko, J. 2005. Low-Level Components of Analytic Activity in Information Visualization. *Proceedings, IEEE Symposium on Information Visualization.* Minneapolis, MN.

MEDI-735 Clinical Information Systems

5.0 Topics

5.1. History and Evolution of Clinical Information Systems
5.2. Clinical Information Systems Concepts
- 5.2.1 Architectural Design Overview
- 5.2.2 Application Domain Overview

5.3. Computerized Physician Order Entry (CPOE) Overview
- 5.3.1 Patient Component
- 5.3.2 Activity Component

5.4. The Electronic Health Record Component
- 5.4.1 Strategies in Evolving towards Electronic Health Records
- 5.4.2 Conceptual Specifications / Types of EHRs
- 5.4.3 The User Interfaces Component

5.5. The Knowledge Component
- 5.5.1 Conceptual Specifications / Types of Knowledge
- 5.5.2 Ontologies and Terminology Servers
- 5.5.3 Clinical Decision Support Systems
- 5.5.4 Knowledge Based System Integration

5.6. The Security Component
- 5.6.1 Conceptual Specifications
- 5.6.2 Establishment of a Healthcare Security Policy
- 5.6.3 Security Issues when Accessing Health Data
- 5.6.4 Security Issues when Exchanging Health Data

5.7. Imaging Management and Integration
5.8. The Future of Clinical Information Systems
- 5.8.1 Potential Impact of Advanced Clinical Information Systems

6.0Possible Resources

6.1 Van de Velde, R. ; Degoulet, P.; *Clinical Information Systems*; Springer-Verlag: New York, NY

MEDI-731 System Integration Concepts

5.0 Topics

5.1. Overview of Medical Application Integration
- 5.1.1 Review of Integration Concepts
  - 5.1.1.1. Business Drivers supporting application integration
  - 5.1.1.2. Application Landscape: Best of Breed vs. All in One
  - 5.1.1.3. Basic Building Blocks of messaging systems
  - 5.1.1.4. Integration Models: Presentation, Programmatic (Functional) and Data
  - 5.1.1.5. Synchronous vs. Asynchronous Communication Concepts

5.2. Healthcare Business Process Analysis
- 5.2.1 Review of Workflow in Healthcare Information Systems
  - 5.2.1.1. Registration / ADT / Scheduling
  - 5.2.1.2. Enterprise Master Patient Index
  - 5.2.1.3. CPOE / CDS
  - 5.2.1.4. LIS: Order Entry / Results Reporting
  - 5.2.1.5. RIS: Order Entry / Results Reporting / PACS Integration
  - 5.2.1.6. Clinical Documentation
  - 5.2.1.7. Pharmacy / Med Reconciliation / ADS
  - 5.2.1.8. Biomedical Device Integration / Nursing Documentation
- 5.2.2 Design documentation (such as UML) for representation workflow / data flow

5.3. Health IT Systems Integration Messaging Design
- 5.3.1 HL7 v2 Messaging Design
  - 5.3.1.1. Role of standards for messaging and integration technologies
  - 5.3.1.2. HL7 v2 Message Profile Specification Design
  - 5.3.1.3. HL7 v2 Message Segment and Field Level Specification Design
  - 5.3.1.4. HL7 v2 Message Validation and Test Plan Design

5.4. Message Oriented Middleware Design Patterns
- 5.4.1 Overview and Benefit of Design Patterns
  - 5.4.1.1. Ex. Context-Based Router, Composite Message, Pipes and Filters, Aggregator, Splitter, Smart Proxy, Wire Tap, Test Message
- 5.4.2 Demonstration of Design Patterns using Message Oriented Middleware

5.5. Message Oriented Middleware Implementation
- 5.5.1 Review of Message Oriented Middleware tools and applications.

5.6. Health Information Exchange
- 5.6.1 Review of Health Information Exchange Architecture Design.
- 5.6.2 Health Information Exchange System Components
  - Enterprise Master Patient Index
  - Clinical Data Repository
  - Message Oriented Middleware for Exchange
  - HL7 v3 Clinical Document Architecture
  - XML Schema Definitions

5.7. System Integration Project Management
- 5.7.1 Project Management Overview and Factors
- 5.7.2 Case Study of Health IT System Integration Projects.
  - Electronic Health Record
  - Health Information Exchange (across Health Organizations)
  - Imaging Science and PACS
  - Medical Device Integration with EHR
  - Message Oriented Middleware Migration in a Complex Health System
  - Clinical Research Informatics Systems Integration
  - Pharmacy Automated Dispensing Integration

Clinical Document and Transcription Integration
Patient Access and Revenue Cycle Integration
Clinical Laboratory and Reference Laboratory Integration

6.0Possible Resources

6.1 Enterprise Application Integration – A Wiley Tech Brief
William Brown, Francis Maginis, William Ruh
Publisher: John Wiley & Sons, Inc (2000)
ISBN 13: 9780471376415

6.2 Enterprise Integration Patterns: Designing Building and Deploying Messaging Solutions. Gregor Hohpe, Bobby Woolf
Publisher: Addison-Wesley Professional (2003)
ISBN-13: 078-5342200683

MEDI-730 Medical Application Integration

5.0 Topics

5.1. Enterprise Application Integration Overview
- 5.1.1 The Need for Integration Standards – (i.e. Health Level 7)
- 5.1.2 Benefits of Integration
- 5.1.3 Emerging Integration Solutions

5.2. Integration Building Blocks
- 5.2.1 Synchronous Communication
- 5.2.2 Asynchronous Communication

5.3. Business Process analysis in Heath Care Information Systems

5.4. Methods of Integration
- 5.4.1 File transfer
- 5.4.2 Shared Databases
- 5.4.3 Remote Procedure Invocation
- 5.4.4 Messaging
- 5.4.5 Distributed Object Technology
- 5.4.6 Web Services

5.5. Interface Definition
- 5.5.1 Developing Specifications using HL7 Message Standards
- 5.5.2 Defining Business Process Trigger Events

5.6. Messaging Architecture and Solutions
- 5.6.1 Request / Reply
- 5.6.2 Publish / Subscribe
- 5.6.3 Message Translation
- 5.6.4 Multiple Queuing and Routing

5.7. Messaging Systems Components
- 5.7.1 Message Channel
- 5.7.2 Message
- 5.7.3 Pipes and Filters
- 5.7.4 Message Router
- 5.7.5 Message Translator
- 5.7.6 Message Endpoint

5.8. XML and Web Services
- 5.8.1 XML Schema definition
- 5.8.2 WSDL file specification
- 5.8.3 UDDI directory publication
- 5.8.4 SOAP message structure
- 5.8.5 Programmatically publishing/consuming XML

6.0Possible Resources

6.1 Kirsten, W.; Ihringer, M.; Rohrig, B.; Schulte, P. *Object Oriented Application Development using the Cache Postrelational Database*; Springer-Verlag: New York, NY

6.2 Brown, W.; Maginis, F.; Ruh, W.; *Enterprise Application Integration – A Wiley Tech Brief* John Wiley & Sons, Inc; New York, NY

6.3 Hohpe, G.; Woolf, B.; *Enterprise Integration Patterns : Designing, Building, and Deploying Messaging Solutions* Addison-Wesley Professional; Boston MA

6.4 Crawford, W.; Kaplan, J.; *J2EE Design Patterns* O'Reilly & Associates, Inc.; Sebastopol, CA

6.5 HL7 Standards referenced from http://www.hl7.org

6.6 Web Services articles referenced via the Internet.

MEDI-766 Building the Electronic Health Record

5.0 Topics

5.1. Electronic Health Records (EHR)- Overview and History

5.1.1 Healthcare Information Technology in the Twenty-First Century

5.1.2 Applications in Healthcare

5.1.3 Introduction to the Electronic Health Record (EHR)

5.2. What's in an EHR?

5.2.1 Components of the Health Record

5.2.2 Business and Clinical Processes in the EHR

5.2.3 Computerized Provider Order Entry

5.2.4 Point of Care Data Entry

5.3. Electronic Coding of Medical Records

5.3.1 Coding Standards

5.3.1 Disease Codes (SNOMED CT)

5.3.2 Clinical Findings (MEDCIN)

5.3.3 Laboratory Test Codes (LOINC)

5.3.4 Unified Medical Language System - Metathesaurus (UMLS)

5.3.5 Nursing Codes (NANDA, NIC and NOC)

5.3.6 Psychological Diagnosis Codes (DSM-IV)

5.3.7 Codes on Dental Procedures and Nomenclature

5.3.8 Dental Disease Codes (SNODENT)

5.3.9 Billing Codes

- 5.3.9.1 CPT-4 (Medical Procedures)
- 5.3.9.2 BC (Hospital Billing Codes)
- 5.3.9.3 ICD-9CM (Medical Diagnoses)
- 5.3.9.4 ICD-10 (Medical Diagnoses)
- 5.3.9.5 ICD-10PCS (Medical Diagnoses)

5.3.10 Drug Codes

- 5.3.10.1 National Drug Code (NDC)
- 5.3.10.2 National Library of Medicine Drug Vocabulary (RxNorm)
- 5.3.10.3 Department of Veterans Affairs Drug Codes (NDF-RT)

5.4. Health Insurance Portability and Accountability Act

5.4.1 HIPAA Privacy Rule

5.4.2 HIPAA Security Rule

5.4.3 Electronic Signatures

5.5. Web-based EHR Applications

5.5.1 Object Oriented Design of EHR Components

6.0Possible Resources

6.1 Electronic Health Records, 2007 edition, Richard Gartee, ISBN 0-13-196079-2

Object-Oriented Application Development Using the Cache Postrelational Database, Second Edition, W. Kirsten, M. Ihringer, M. Kuhn, and B.Rohrig,

NYSED Table 1b.

Table 1b: MS Health Informatics Graduate Program Schedule

- Indicate academic calendar type: _X__Semester
- Label each term in sequence, consistent with the institution's academic calendar (e.g., Fall 1, Spring 1, Fall 2)
- Note: The notation (A) courses are offered in the first 8 weeks of a semester and (B) courses are offered in the second 8 weeks of a semester

Term: Fall 1			
Course Number & Title	Credit	New	Prerequisite
(A) MEDI-701 Introduction to Medical Informatics	3		
(B) HCIN - 610 Foundations of Human-Computer Interaction	3		
Term credit total:	6		

Term: Spring 1			
Course Number & Title	Credit	New	Prerequisite
(A) MEDI-735 Clinical Information Systems	3		MEDI-701
(B) Concentration Elective	3		
Term credit total:	6		

Term: Summer 1			
Course Number & Title	Credit	New	Prerequisite
MEDI-704 Practice of Health Care	3		MEDI-701
Term credit total:	3		

Term: Fall 2			
Course Number & Title	Credit	New	Prerequisite
(A) MEDI-707 Clinical Decision Support	3		MEDI-704
(B) MEDI-705 Medical Knowledge Structures	3		MEDI-701
Term credit total:	6		

Term: Spring 2			
Course Number & Title	Credit	New	Prerequisite
(A) Concentration Elective	3		
(B) Concentration Elective	3		
Term credit total:	6		

Term: Summer 2			
Course Number & Title	Credit	New	Prerequisite
MEDI-788 Capstone in Health Informatics	3		Completed Coursework
Term credit total:	3		

Program Totals:	**Total Credit :30**	**For Master's programs, identify the required comprehensive, culminating element(s) (e.g., thesis), including course number if applicable:** **Capstone options:** Capstone in Health Informatics MEDI-788