FIU

FLORIDA INTERNATIONAL UNIVERSITY

Miami's public research university

School of Computing and Information Sciences

Graduate Program
2016–2017

Graduate Program in Computer Science
Florida International University

October 28, 2016

1 Overview

This document describes the requirements for students entering the graduate program with the intention of receiving the Master's Degree or Ph.D. Degree in the School of Computing and Information Sciences (SCIS). While this guide is intended to be self-contained and accurate, SCIS reserves the right to correct errors, when found, without further notice to students. It is the students' responsibility to ensure that they are in compliance with both SCIS and Graduate School requirements.

Failure to follow University guidelines (http://gradschool.fiu.edu/PoliciesProcedures.html) and deadlines (http://gradschool.fiu.edu/CalendarDeadlines.html) could result in a delay in graduation. It is your responsibility to give the affected faculty time to meet any deadlines.

2 Electronic Access to Graduate Information

Information about the graduate program is available electronically through several sources. Our URL is http://www.cis.fiu.edu/programs/grad, from which you can find a host of documents (including the latest version of this guide) relating to the computer science program at FIU. You can also send mail to the general alias grad-info@cis.fiu.edu, or contact faculty members individually.

3 Points of Contact

For further questions or clarification, the following people may be of help:

Dr. Deng Pan (Pand@cis.fiu.edu), Associate Professor and Graduate Program Director, (305) 348-6036

Mr. Carlos Cabrera, (carlos.cabrera@cs.fiu.edu) Graduate Programs Coordinator, (305) 348-7989 contact for advising and other graduate academic issues.

Ms. Olga Carbonell, (ocarbone@cs.fiu.edu) Graduate Program Secretary: (305) 348 – 2744, contact if you are not currently enrolled, or if you are enrolled and have questions relating to contracts, financial aid, etc.

Graduate assistants should see the Graduate Program Secretary immediately upon arrival to complete required paperwork.

4 General Information

4.1 Degrees Offered

The School of Computing and Information Sciences (SCIS) offers three Master of Science degrees, and a Doctor of Philosophy degree. The Master of Science degree in Computer Science provides study in state of-the-art computer applications as well as an introduction to the theoretical foundations of computer science. The Master of Science degree in Telecommunications and Networking is intended to provide study in state-of-the-art telecommunications and networking technologies and management. The Master of Science in Information Technology is intended to educate students in the area of technical aspects of Information and is ideally suited for those who wish to obtain a higher level degree in Information Technology and seek employment in the IT industry. The Doctor of Philosophy in Computer Science is designed to provide study in all major areas of computer science while leading to the frontiers of knowledge in a chosen field of concentration.

4.2 Areas of Study

There are many areas of specialization within the School, including:

- Database systems, including database design, database management systems and applications, database theory and implementation, database machines, distributed databases, information retrieval in heterogeneous databases, multimedia databases, data mining and digital libraries.

- Software Engineering, including large-scale software design, programming language environments, software development and maintenance methodologies, object-oriented techniques, software reuse, and software quality assurance.

- Parallel and distributed systems, including formal specification methodologies, distributed file systems, distributed multimedia systems and operating systems.

- Computer networks, including network protocols, multimedia networking, and wireless communications.

- Theory, including algorithms and data structures, programming languages, computer security, program
  verification, and logic.

- Intelligent systems, including artificial intelligence, machine learning, neural networks, expert systems, intelligent tutoring systems, affective computing, intelligent user interfaces, intelligent agents for health communication.

- Cognitive Science, with emphasis on the philosophical, psychological, and linguistic underpinnings of artificial intelligence.

- Bioinformatics and Computational Biology.

4.2.1 High-Performance Database Research Center

Dr. Naphtali D. Rishe, Director

The High-performance Database Research Center (HPDRC) conducts research on database management systems and various applications, leading to the development of new types of database systems and the refinement of existing database systems, as well as on the dissemination of information via the Internet.

The HPDRC, a research division of SCIS, has a strong commitment to training graduate students and preparing them for their future roles as scholars and specialists employed by industry. It has been awarded over $40 million in research grants and donations by Government and Industry, including NASA, NSF, IBM, DoI, and the USGS.

With current funding from the National Science Foundation and Industry, HPDRC is presently collaborating with a number of entities to further its mission. These groups include the College of Health and Urban Affairs, the Library's GIS lab, the International Hurricane Research Center, members of the Geology, Biology, Electrical and Computer Engineering, and Environmental Studies departments, among others. As the home of one of NASA's Regional Application Centers, HPDRC is in a prime position to perform research and development using remotely sensed data; this position has recently been further strengthened by the execution of a Cooperative Research and Development Agreement between the HPDRC and the United States Geological Survey. HPDRC is also collaborating with researchers at the University of Miami, NOAA, NASA, and space research agencies from across the state of Florida to develop better ways to store and retrieve remotely sensed data. A recently established NSF Industry/University Cooperative Research Center is enabling strong collaboration with industry as well as collaborative research with Florida Atlantic University and the University of Florida.

Research Scope:

The amount and varied types of geospatial information, such as remotely-sensed imagery, available today is vast, offering numerous applications to industries and scientists in all fields. However, an inherent problem with this is the complexity often involved with the manipulation and extraction of these data. Spatial data sets come from varied sources and in many different formats, often requiring separate specialized geographic systems to view, extract and manipulate them. The time, expense and level of difficulty introduced by such applications preclude their utilization by many potential users. In order to facilitate access to this growing collection of visual information, the HPDRC has created TerraFly, a Web based Geographic Information Viewer that allows its users to "fly" through geospatial data using nothing but a typical Internet browser.

HPDRC's public service at http://TerraFly.fiu.edu has approximately 10,000 unique users per day. The TerraFly project has been covered by worldwide press (e.g. The New York Times, USA Today, NPR), Science and Nature journals, and TV news programs. TerraFly applies the database technology developed at HPDRC for the storage and retrieval of data, allowing its users to "fly over" and manipulate the retrieved data. The database used by TerraFly currently contains textual, remotely-sensed and vector data, which can be viewed and manipulated by experts or lay users via applets using any standard browser, like Internet Explorer or Firefox, without the installation of any specialized GIS programs.

The Center also conducts research on such theoretical and applied issues as Internet-distributed heterogeneous databases, database design methodologies, database design tools, information analysis, multimedia databases, database languages, data compression, spatial databases, and data visualization.

For details, visit the URL http://hpdrc.cis.fiu.edu

4.2.2 Center for Advanced Distributed Systems Engineering

Xudong He, Director

The Center for Advanced Distributed Systems Engineering (CADSE) is a research division of SCIS at Florida International University. Its mission is to establish a streamlined research, technology exploration and advanced training program in the field of distributed and Internet-based computing. The Center's R&D cover both theoretical and practical aspects of distributed software engineering, i.e., using engineering methods and technologies to tackle development problems of complex, reliable, and/or real-time distributed systems. Our research has been supported by grants and contracts for over $5 million by National Science Foundation, Air Force Office of Scientific Research, Air Force Research Laboratory Rome Site, Army Research Office, NASA and Industry. Current projects of the Center focus on formal design methods for distributed systems, distributed system and software architecture, distributed object technology, and software testing.

Current research projects of the Center focus on the following aspects:

- Formal Methods
- Software Architecture
- Software Testing
- Software Reuse
- Object-Oriented Technology
- Distributed Multimedia Information Systems

For details, visit the URL http://cadse.cis.fiu.edu

4.2.3 Distributed Multimedia Information Systems Laboratory

Dr. Shu-Ching Chen, Director

The Distributed Multimedia Information Systems Laboratory (DMIS) has a mission to conduct leading edge research in multimedia database systems, multimedia data mining, multimedia networking, GIS and Intelligent Transportation Systems.

Other research areas of this division include:

- Multimedia Communications and Networking
- Digital Library
- 3D Animation
- Distributed Computing
- WWW

This laboratory currently receives funding from the Florida Department of Insurance, NSF, International Hurricane Research Center (IHRC)/FDCA/FEMA, Naval Research Laboratory/ITT, and NOAA.

For more details, you can visit their web page at: http://dmis.cis.fiu.edu

4.2.4 Systems Research Laboratory (SyLab)

Dr. Raju Rangaswami, Director

The mission of the Database and Systems Research Laboratory (DSRL) is to perform cutting-edge research on (i) extracting knowledge from structured and unstructured databases, and (ii) building high performance, reliable, power-efficient, and secure systems.

Current projects at DSRL include:

- Information Discovery on Clinical and Biomedical Databases
- Searching Domain Data Graphs
- Searching Text Streams
- Analyzing Disaster Management Data
- Semi structured Storage Systems
- Resource Management in Virtualized Data Centers
- Energy-efficient Mobile and RAID Storage Systems
- Reliable RAID Storage Systems
- High-performance Storage Systems
- Block-layer Storage Infrastructure for Operating Systems

DSRL sponsors include the National Science Foundation and the Department of Energy.

For more details, you can visit the DSRL web page at: http://dsrl.cs.fiu.edu.

4.2.5 Bioinformatics Research Group (BioRG)

Dr. Giri Narasimhan (Head) and Dr. Tao Li

The Bioinformatics Research Group (BioRG) conducts research on problems in the interdisciplinary fields of Bioinformatics, Biotechnology, Data Mining, and Information Retrieval. The group's research projects includes Comparative Genomics of Bacterial genomes, Genomic databases, Pattern Discovery in sequences and structures, micro-array data analysis, prediction of regulatory elements, primer design, probe design, phylogenetic analysis, medical image processing, image analysis, data integration, data mining, information retrieval, knowledge discovery in electronic medical records, and much more.

The group also collaborates with scientists from a wide variety of fields outside computer science including biology, medicine, biophysics, biochemistry, pharmacology, finance, social sciences, statistics, mathematics, environmental sciences, soil sciences, and more. This is an active group with a strong publication record. The National Institutes of Health and the National Science Foundation have funded this group's research.

For details on the members, publications, software, and recently graduated students, visit the URL http://biorg.cis.fiu.edu

4.2.6 Affective Social Computing Laboratory (ASCL)

Dr. Christine Lisetti, Director

The Affective Social Computing Laboratory (ASCL) conducts research in Affective Computing, a broad field that explores the computational nature of affective phenomena, such as emotions, moods, personality, and attitudes, and their role in human intelligence, communication and decision-making. Such insights can then be applied to allow computers to account for and adapt to human affect. This research is highly interdisciplinary in nature; it lies at the intersection of Artificial Intelligence (AI) and Human-Computer Interaction (HCI), and it involves knowledge from Psychology and Communication.

Our research goal is to create engaging, embodied socially intelligent agents that can learn to interact with humans via expressive multi-modalities in a variety of contexts involving socio-emotional content (e.g. social companions, cyber-therapy, intelligent training systems, serious games). In a specific context, these agents must:

- Sense the affect, preferences, and personality of their interlocutor (bio-sensing, pattern matching, knowledge elicitation and representation of affective phenomena);
- Make decisions (logic-based and probabilistic reasoning) that are socially acceptable based on their dynamic user-model (knowledge representation);
- Carry out their interactions (HCI design principles) within the domain-knowledge (expert systems)
- While displaying social competence (social communication theory);
- Learn to tailor and adapt (machine learning) their interactive styles to the specific socio-emotional profile (user-modeling) of their human counterpart.

Although application domains of interest are manifold, we are particularly interested in the domains of health communication and health promotion.

4.2.7 Software Testing and Research Group (STRG)

Dr. Peter J. Clarke, Director

The Software Testing Research Group in the School of Computing and Information Sciences (SCIS) at FIU was formed during the 2004-2005 academic year. The STRG is comprised of a combination of Masters and PhD students, and top undergraduate students, working under the guidance of faculty coordinator **Dr. Peter J. Clarke**, Associate Professor in the SCIS.

4.2.8 Modeling and Networking Systems Research Group (MNSRG)

Dr. Jason Liu, Director

Modeling and Networking Systems Research Group (MNSRG) conducts research in parallel and distributed simulation, high-performance modeling, simulation and emulation of computer networks and communication systems. The group mainly focuses on developing software tools and modeling techniques supporting for large-scale simulation of complex systems (such as the Internet and HPC systems) on highperformance parallel computing platforms.

4.2.9 Knowledge Discovery Research Group (KDRG)

Dr. Tao Li, Director

Our research explores two related topics on learning from data---how to efficiently discover useful patterns and how to effectively retrieve information. The interests lie broadly in data mining and machine learning studying both the algorithmic and application issues. The algorithmic aspects involve developing new scalable, efficient and interactive algorithms that can handle very large databases. The underlying techniques studied include clustering, classification, semi-supervised learning, similarity and temporal pattern discovery. The application issues focus on actual implementation and usage of the algorithms on a variety of real applications with different characteristics including bioinformatics, text mining, music information retrieval and event mining for computer system management.

4.2.10 Discovery Lab

Dr. S. S. Iyengar, Director of SCIS and Founder of the Discovery Lab
Jong-Hoon Kim, Director

Dr. Ram Iyengar leads the Discovery lab and a team of CIS researchers who are currently performing advanced research in areas of intelligent systems, advanced security systems, autonomous mobile robots, and senor networks, and smart grids. The Discovery Lab provides an infrastructure to promote collaborative

research among universitese and research organizations across the nation. In addition to adressing a comprehensive set of fundamental research topics, the Lab is pursuing commercialization, distinguishing itself from traditional reaserch labs through its focus on translating research discoveries into technology transfer outcomes. At the same time the laboratory provides students with the hands-on experiences they need to solve real-world challenges, develops student-led research opportunities, fosters students' entrepreneurial skills, and trains a new generation of IT professionals who reflect the diversity of South Florida.

4.2.11 Virtualized Infrastructure, Systems, and Applications (VISA)

Dr. Ming Zhao, Director

Virtualization is an enabling technology for creating important new system abstractions and addressing the various challenges faced by today's computing systems. The use of virtualization can span across computing systems of different sizes, from desktops to supercomputers, and across different layers of the systems, from virtual machines, virtual storage, to virtual networks.

The fundamental goal of the VISA Research Lab is to explore innovative techniques in virtualization as well as autonomics in order to effectively utilize the resources in large-scale, dynamic, and complex computing systems and to support the high-performance, robust, and secure computing of challenging applications from different domains. Currently, our team is focusing on several NSF and DHS funded project son virtual machines and virtual storage.

4.2.12 Telecommunications and Information Technology Institute (IT2)

Dr. Niki Pissinou and Dr. S. S. Iyengar, Director

Funded by the State of Florida, industry and federal government, the Telecommunications and Information Technology Institute (IT2) is a unique hub for research, technology transfer and education at the graduate and undergraduate levels. With a sustainable growth model as the basis for its development, IT2's portfolio now boasts cutting edge research, active alliances with industry and unique academic programs. It is now a leading resource for education, training, research and technology development in United States of America and abroad.
The Telecommunications and Information Technology Institute's research cross traditional disciplinary boundaries to investigate a broad range of advanced topics in communications and computers. Its researchers model, design and implement systems that include these goals:

- Pioneering new core technologies along with supportive algorithms, architectures, toolkits and prototypes.
- Exploring ways to scale networks that are pervasive, unattended, and widely embedded throughout the physical environment.
- Exploring research, development and commercialization in mobile and wireless communications, networks and software.
- Creating new technologies and solutions utilizing networking, software and hardware solutions essential to the advancement and practical proliferation of new technologies.
- Offering access to advanced multidisciplinary and collaborative research and real-world virtual applications support to the revolutionary next generation of telecommunications and information technologies.

To fulfill the Institute's vision of developing next-generation technologies, the efforts of the research groups are segmented into a few, somewhat complementary thrusts that naturally coincide with industrial needs. The fundamental science and technologies are distinctively unique; hence, different approaches are required within each group. IT2's researchers have lead research efforts and development projects targeted at solving complex problems conducive to early identification of high impact solutions in a wide range of areas including security, privacy, wireless ad-hoc and sensor networks.

4.2.11 Industry/University Cooperative Research Center for Advanced Knowledge

Enablement (I/UCRC-CAKE) (VISA)

Dr. Naphtali Rishe, Director

The National Science Foundation's (NSF) FIU-FAU-Dubna Industry/University Cooperative Research Center for Advanced Knowledge Enablement (CAKE) was established to develop long-term partnerships among industry, academe and government. The Center is supported primarily by industry center members, with NSF taking a supporting role in its development, evolution, and core funding. The Center's mission is to conduct industry-relevant studies and deployments in the representation, management, storage, analysis, search and social aspects of large and complex data sets, with particular applications in geospatial location based data, disaster mitigation, healthcare, transportation, and town planning.

4.3 Computing Resources

SCIS Computing Facilities are located on the second and third floors of the Engineering and Computer Science building. The facility consists of a large number of networked workstations with contemporary hardware/software, which are used by faculty, staff, and graduate students.

The majority of these machines is dispersed throughout the various research and open laboratories located on the second floor. These systems are connected to the campus backbone that also provides our interface to the Internet.

Computing facilities are to be used only for work directly related to duties as a graduate student. Under no circumstances should students allow their accounts to be used by third parties.

Any student who is determined to have used the computer unethically will be expelled from the graduate program. This includes accessing other user's data (files, mail, etc.) without their permission (even if the protection modes allow access).

Any student who is found to have used the computing facilities in violation of any state or Federal laws will be expelled from the University and prosecuted to the full extent of the law. This includes using the computer to distribute material in violation of copyright laws, and attempting to violate security protocols on both FIU and non-FIU machines.

General Information for prospective students

5.1 Admissions Process

5.1.1 Application

The admissions application can be completed online at http://gradschool.fiu.edu/admissions.shtml. Graduate Admissions will promptly acknowledge receipt, notify the applicant of any deficiencies (e.g. missing transcripts) and forward all relevant documents to the School of Computing and Information Sciences. Submission deadlines are indicated at http://gradschool.fiu.edu/deadlines.shtml. Please note that Graduate Admissions will only forward complete applications to SCIS; if your application is incomplete (e.g. missing a TOEFL score), SCIS will not see the application, nor will SCIS be able to act upon it.

The School recommends that applications be submitted as early as possible (six months prior to the beginning of enrolled term). Foreign students should begin the process even earlier. Terms generally begin in late August for Fall, early January for Spring, and early May for Summer.

All applicants should arrange for three letters of recommendation to be mailed to the following address:

Admissions Coordinator
College of Engineering & Computing
Florida International University
EC 2430
10555 W. Flagler Street
Miami, FL 33174

Applicants may use the recommendation form located at the following website:

http://www.cis.fiu.edu/programs/grad/docs/RECOMLTR.doc

Graduate Admissions formally notifies the applicants.

5.1.2 Records

One official copy of all transcripts and test scores must be sent to the College of Engineering & Computing at the above mentioned address.

Official transcripts of academic records from each college or university attended must be forwarded by that institution. Transcripts in possession of the applicants will not be accepted. It is the responsibility of all degree-seeking applicants to make arrangements to take the Graduate Record Examination (GRE) and request that the Educational Testing Service (ETS) mail the official test results directly to FIU. Foreign applicants whose native language is not English must take the Test of English as a Foreign Language (TOEFL) exam and have their scores submitted directly to FIU by ETS. In addition, foreign applicants are required to submit financial statements verifying adequate financial resources.

Medical History Reports are required of all students by Student Health Services. Completion and clearance of medical history and immunization reports are required to validate registration. A medical history form will be mailed shortly after the receipt of the application by the FIU Graduate Admissions Office.

5.2 Assistantships and Fellowships

Note: Applicants interested in assistantships and fellowships should mail their résumé along with their admission application materials.

There are several sources of assistantships and fellowships.

5.2.1 Assistantships from SCIS

Financial assistance is available on a highly competitive basis in the form of Graduate Assistantships for PhD students. Students admitted to the PhD program are automatically placed in the list for Graduate Assistantship consideration for the Fall semester. Those students from the list who are selected as Graduate Assistantship recipients will be formally notified through e-mail.

Awards primarily start in the Fall semester.

Only full-time students are eligible for assistantships. This means that Graduate Assistants must register for at least nine credits during the Fall and Spring and six credits during the Summer if supported during the summer and must not accept other forms of employment.

Graduate Assistants are expected to assist in teaching and research duties. The exact assignment is variable and depends on the student's progress towards degree and performance. The student's performance is evaluated once a year; based on the evaluation a student may be given an excellence award, be given a summer appointment, or, in case of unsatisfactory performance, be dismissed.

Graduate Assistants in the Ph.D. program are expected to find a faculty advisor, willing to eventually supervise their dissertation, by the end of their first year. Failure to do so may result in the non-renewal of the student's assistantship.

Students in the Ph.D. program will not be supported by SCIS for more than five years.

5.2.2 Assistantships from Research Projects

Many faculty members have sponsored research projects, from various funding agencies, that provide Research Assistantships. These research assistantships are highly competitive and require specific background and skills, and are awarded by individual faculty members having sponsored research projects. Students should contact individual faculty members directly to apply for these assistantships.

5.2.3 Fellowships

SCIS may also offer fellowships. These fellowships are highly competitive and have strict eligibility requirements. The availability of fellowships is announced at the SCIS website. Students need to follow the announcements' instructions to apply for fellowships.

5.2.4 Tuition Waivers

Most Teaching and Research Assistants receive a waiver of their tuition. This is done on a competitive basis and depends on the state budget. Information on this is generally not available until the term begins. Excluding the tuition, all assistants are required to pay several service fees, such as a health fee.

In 2015-2016, tuition for in-state graduate students is $455.67 per credit for both regular course work and dissertation or thesis credit. Tuition for out-of-state and international graduate students is $1001. per credit

hour for both regular course work and dissertation credit. Graduate students who are on a full assistantship (0.50 FTE appointment) pay only $70.93 (for continuing students) or $72.61 (for new students) per credit. Graduate students on a part-time assistantship (0.25 FTE appointment) receive an out-of-state tuition waiver, but are responsible for the in-state portion. In addition there is a $93.19 assessment each semester for the use of the campus health center and athletic fees, and students pay need to pay for parking. Graduate Assistants must also pay 25% of the health insurance premium (the university will pay for the other 75% as part of the assistantship).

5.3 Grade Requirements

Students must maintain a Grade Point Average of at least 3.0 for courses attempted in the graduate program. Undergraduate prerequisites taken after the bachelor's degree will not count toward the graduate GPA. All courses needed for graduation must be completed with a grade of C or higher. For required core courses a more stringent rule applies (see sections on MS and PhD program). A student whose GPA falls below 3.0 will be placed on warning. If the GPA remains below 3.0 for a second semester, the student will be placed on probation. If the (cumulative) GPA is still below 3.0 for third semester, and the (third) semester GPA is also below 3.0, then the student will be dismissed from the graduate program. Graduate assistants must maintain a GPA above 3.3. Failure to do so may result in the non-renewal of the student's assistantship.

5.4 Active Status

Doctoral candidates require a minimum of three credit hours per semester to retain active status. Master's candidates require a minimum of one credit hour per semester to retain active status. Lapses in enrollment for two or more consecutive semesters require that the student apply for readmission subject to the admission procedures, criteria, and policies in effect at the time the reapplication is made. A student who finds it necessary to be excused from registration for two or more consecutive semesters should formally request a leave of absence from the graduate program director. Leaves will be granted only under exceptional circumstances.

At the doctoral level all requirements, including the successful defense of a dissertation, must be completed within nine years of first enrollment in the doctoral program. At the Master's level all requirements, including the successful defense of a thesis (if thesis option is selected), must be completed within six years of first enrollment in the Master's program.

5.5 Advisement

One faculty member is designated as the Graduate Advisor. New students should see the Graduate Advisor prior to registering for their first semester. The Graduate Advisor is the person to consult concerning program requirements.

5.6 University Requirements

The student should keep informed of Graduate School requirements as outlined in the Graduate Catalog and FIU Graduate Policies and Procedures Manual (http://gradschool.fiu.edu/PoliciesProcedures.html).

6 Master's Programs

6.1 Admission to Master's Program in Computer Science

Requirements for admission to the Master's program are as follows:

A Bachelor's Degree or equivalent in Computer Science from a regionally accredited institution.

A degree in a related field is acceptable if the applicant shows evidence of computer science background suitable for entry into the master's program as judged by the Graduate Committee. Generally speaking, the minimum background is the equivalent of all prerequisites for the required graduate courses. (See Section 9)

'B' average or better in all course work attempted while registered as an upper-division student in the Bachelor's program, and a GRE general test score with a minimum quantitative score of 148.

Three letters of recommendation from persons in a position to judge the applicant's potential success in graduate study.

Approval of the Graduate Committee.

Applicants whose native language is not English must score a total of 80 on the iBT (internet Based Test) TOEFL or 6.5 overall on the IELTS. TOEFL = Test of English as a Foreign Language (www.toefl.org). IELTS = International English Language Testing System (www.ielts.org).

6.1.1 Master's Transfer Credit

A maximum of two graduate courses may be transferred into the program from outside the University, subject to the approval of the Graduate Committee.

6.1.2 Master's Degree General Requirements

1. Required course work: 15 credits

CEN 5011 Advanced Software Engineering
COP 5614 Operating Systems
COP 5725 Principles of Database Management Systems
COT 5407 Introduction to Algorithms
COT 5420 Theory of Computation I

Required courses must be completed with an average of "B" or higher, and only one course may receive a grade less than "B-".

2. Elective course work:
   a. non-thesis option: 15 credits of elective courses

b. thesis option: 9 credits of elective courses and 6 credits of master's thesis

Elective courses can be selected from Graduate Course Offerings (Section 9). A maximum of 6 credits can be chosen from sections other than 9.1.1. Of these 6 credits, a maximum of 3 credits can be chosen from Section 9.2 (i.e. either a 3-credit Independent Study or a 3-credit coop course).

Note: A student must comply with all University Graduate School requirements regarding enrollment and deadlines.

6.1.3 Master's Degree with Thesis Option

This option requires the completion of a Master's Thesis (6 credits) in addition to the eight graduate courses (24 credits). A student may commence work on the Master's thesis at any time.

6.1.3.1 Thesis Committee

The student must propose to the Chairperson of the Thesis Committee consisting of three members with graduate faculty status. The Thesis Advisor is the Chairperson of the Thesis Committee. University regulations require that the Chairperson of the Thesis Committee be a member of the School of Computing and Information Sciences. Form M-1 must be completed.

6.1.3.2 Thesis Proposal

A thesis proposal should be submitted after the Thesis Committee has been approved by the Chairperson of the Graduate Committee. The proposal will be given by the Thesis Advisor to the student's Thesis Committee for review. Based on written recommendations of its members, the Thesis Committee will make a final decision. Upon acceptance of the proposal, Form M-2 will be completed, to indicate that both a committee and a proposal have been approved. Before the submission of M-2 form, the Graduate School requires the M.S. candidate to complete an on-line "Responsible Conduct of Research Certification" training course (http://www.ori.fiu.edu/responsibleConduct.html).

The purpose of the proposal is to convince the Committee that the chosen thesis topic and the student's approach have a reasonable chance of success. We want to minimize the chance that the thesis will be turned down when almost completed. In particular it should

- explain the basic idea of the thesis topic
- argue why that topic is important
- state what kind of results are expected
- make plausible that these results are sufficient for a Master's thesis and that they are obtainable within the given time frame with the available resources
- demonstrate the student's academic qualifications for doing the proposed work

6.1.3.3 Thesis Defense

The Master's thesis must be a written account of a critical and scholarly study in an area in computer science. The Thesis Committee will review it critically for both content and form. The thesis may consist of:

1. Independent research work,

2. A critical study and analysis of known results that provide new significance and insights, or

3. A significant and constructive contribution to computer applications such as software development for important applications.

The defense is public. The Thesis Committee makes the final pass/fail decision.

6.1.4 Accelerated Master of Science in Computer Science

Admission Requirements

1. Current enrollment in the Bachelor's Degree program in Computer Science at FIU.
2. Completed at least 60 credits of coursework.
3. Current GPA must be 3.3 or higher.
4. GRE general test score with a minimum quantitative score of 148.
5. International graduate student applicants whose native language is not English are required to submit a score for the Test of English as a Foreign Language (TOEFL) or for the International English Language Testing System (IELTS). A total score of 80 on the iBT TOEFL or 6.3 overall on the IELTS is required.
6. Three letters of recommendation.
7. Approval of the Graduate Committee.

General Requirements

The FIU Bachelor's degree in Computer Science must be awarded before the Master's degree.

Coursework:

Required Courses:
Required courses must be completed with an average of "B" or higher, and only one course may receive a grade less than "B-".

CEN 5011	Advanced Software Engineering
COP 5614	Operating Systems
COP 5725	Principles of Database Management Systems
COT 5407	Introduction to Algorithms
COT 5420	Theory of Computation I

Elective:
5 courses selected from the Graduate Course Offerings subject to the same rules for regular M.S. students described in Section 6.3.

Overlap:
Up to 4 graduate courses (12 credits) may be used in satisfying both the Bachelor's and Master's degree requirements. The courses must be regular computer science graduate courses and must be approved by an undergraduate advisor to satisfy the Bachelor's degree requirements.

Additional Graduate Courses before Completing a Bachelor's Degree

A student in the accelerated M.S. program, or a "4 + 1" student, intending to take more than 4 graduate courses (12 credits) before completing a Bachelor's degree must get pre-approval from the Dean of the Graduate School; otherwise, any additional graduate course cannot be used to satisfy the Master's degree requirements.

6.2 Master **of Science in Telecommunications and Networking**

The Master of Science in Telecommunications and Networking is intended to educate individuals seeking employment with hardware and/or software companies, service providers, large user organizations, or telecommunications regulatory agencies as well as for those who are employed by these companies/organizations and wish to obtain formal, higher-level, specialized degree in Telecommunications and Networking. Telecommunication and Networking students learn how to lead in the ever changing environment of real-time global information networking, telecommunications, wireless and optical strategies and how to amplify business value through communications, technologies and systems. All courses in the program are categorized under the five following areas. SCIS offers thesis and non-thesis options for the Master's Degree. The Master is a multidisciplinary program that offers two tracks:

Admissions Requirements

1. In addition to the FIU graduate requirements, a student admitted to the program must have a bachelor's degree in a related field from an accredited institution, in the case of foreign students, from an institution recognized in its own country as preparing students to continue studies at the graduate level.

2. An applicant must have a GPA score of 3.0 or higher in upper level work.

3. International students whose native language is not English, must take the Test of English as a Foreign Language (TOEFL) or the International English Language Testing System Test (IELTS). Minimum required score is: 550 on the paper-based test (PBT TOEFL), or 80 on the iBT TOEFL, or 6.3 overall on the IELTS test.

4. The University's required GPA and TOEFL scores are to be considered minimum requirements for admissions.

Graduate Requirements

The degree will be granted when the following criteria have been met:

1. Recommendation of Advisor and faculty of the School.

2. Certification by the Dean of the School that all requirements have been met.

3. Maintain an overall GPA of at least 3.0. No grade below "C" will be accepted in any course taken to satisfy graduate program requirements.

4. Completion of 30 required semester hours of graduate level in three categories:

    - 15 credits of required courses
    - 6 credits of either thesis or courses from any one focus area
    - 9 credits of electives.

Required Courses (breadth)
All students must complete the following five courses:

TCN 5030 Computer Communications and Networking Technologies (or an alternate course if waived)
TCN 6430 Networks Management and Control Standards

TCN 6275 Mobile Computing
TCN 5080 Secure Telecommunications Transactions (or CIS 5372)
TCN 5640 Telecommunications Enterprise Planning and Strategy

One Focus Area (depth)
Students in the non-thesis option must select two courses from one focus area that aligns with their backgrounds and interests. Areas include but are not limited to software, communications, policy/legal issues, wireless and security. These areas are designed to serve a wide constituency of students.

Business Focus:
TCN 5010 Telecommunications Technology Applications
TCN 6880 Telecommunications Public Policy Development and Standards
TCN 6820 Telecommunications Industry Development

Communications Focus:
EEL 5500 Digital Communications I
EEL 5501 Digital Communications II

Software Focus:
TCN 5440 Software Development for Telecommunication Networks
COP 5725 Principles of Database Management Systems
TCN 5445 Telecommunications Networking Programming

Security Focus:
CIS 5373 Systems Security
CIS 5374 Information Security and Privacy
TCN 5455 Information Theory

Wireless and Sensor Network Focus:
TCN 6270 Mobile and Wireless Networks
TCN 6450 Wireless Information Systems
TCN 5155 Wireless Communications with Multimedia Application

Electives:
Three additional courses offered by the School of Computing and Information Sciences (to bring to 30 credits), including any above course or TCN-prefix course not otherwise used to satisfy a focus. The list of acceptable courses is maintained by the School.

6.3 Master of Science in Information Technology (MSIT)

The Master of Science in Information Technology is intended to educate students in the area of technical aspects of Information. It provides an emphasis on software technology, database technology, and security technology. The program is ideally suited for those who wish to obtain a higher level degree in Information Technology, and seek employment in the IT industry.

Admissions Requirements

The following are in addition to the University's graduate admissions requirements.

1. Bachelor's degree from regionally accredited institution with GPA of 3.0 in Information Technology, Computer Science, Computer Engineering, or a similar field or a Bachelor's degree in any field
2. Three letters of recommendation
3. Approval of the Graduate Committee
4. Foreign students whose native language is not English must score at least 550 (or 213 on computerized exam) in the Test of English as a Foreign Language (TOEFL)

A student's GPA and required test scores will be considered as minimum requirements for admission. The academic background of each student shall be analyzed to determine if there is need for remedial courses in addition to the required curriculum. Students are also required to comply with all course prerequisites.

Coursework:

Students in the Master of Science in Information Technology program will be required to take 30 credits of graduate level courses. Included in the program are 12 credits of Information Technology core courses, 12 credits that form a track, and 6 credits of Information Technology elective courses.

Core Coursework (9 credits)
Students must complete all three courses with a grade of B or better.

CEN 5087	Software and Data Modeling
CIS 5372	Information Assurance
CIS 5027	Computer Systems Fundamentals

Track courses (9 credits) Students must choose one track.

Security Track
The security track will equip students with fundamental knowledge and skills in information security and privacy, system security, and network security so they become highly qualified workforce in information technology fields.

Students must choose three courses from the following list:

CIS 5373	Systems Security
CIS 5374	Information Security and Privacy
EEL6787	Network Security
TCN5080	Secure Telecommunications Transactions

Software Track
The software concentration prepares students with fundamental methods and cutting-edge technologies for developing and maintaining software systems. Students graduating from the software engineering specialization will have a thorough knowledge of the process and major techniques for modeling, designing,

and analyzing software systems. The graduates of this track will be well-prepared to undertake major software systems development projects from major software corporations such as Motorola, Siemens, and IBM.

Students must choose three courses from the following list:

CEN 5011	Advanced Software Engineering
CEN 5064	Software Design
CEN 6075	Software Specification
CEN 6070	Software Verification
CEN 5076	Software Testing
CIS 6612	Advanced Topics in Software Engineering
COP 5725	Principles of Database Management Systems

System Administration Track

The System Administration concentration prepares the student to be able to install, support, and maintain servers or other computer systems, and planning for and responding to service outages and other problems. Other duties may include scripting and basic programming, setting up custom operating system environments, project management for systems-related projects, supervising or training computer operators, and being the consultant for computer problems beyond the knowledge of technical support staff.

Students must choose three courses from the following list:

CIS 5346	Storage Systems
CIS 5432	Advanced IT Automation
CEN 5011	Advanced Software Engineering
COP 5614	Operating Systems
COP 6611	Advanced Operating Systems
TCN 5030	Computer Communications and Networking Technology
TCN 6260	Internetworking
TCN 6270	Mobile and Wireless Networks
TCN 6430	Network Management and Control Standards

Electives (12 credits)

Students must choose any four graduate level courses offered by the School of Computing and Information Sciences, with the exception of CGS-6834 and COP-6007. Three credits can be earned in either CIS-5900 or CIS-5910, but not both. With the approval of the Graduate Program Director, one course not appearing on this list can be substituted for an elective.

7 Ph.D. Program

7.1 Admission to Ph.D. Program

The following are in addition to the University's graduate admission requirements:

1. A baccalaureate or master's degree in Computer Science, or equivalent degree in a related field as judged by the School's Graduate Committee.
2. For students without a Master's degree in a related field: A minimum of a 3.2 average on all upper division work and acceptable courses in Calculus and Statistics.

For students with a Master's degree in a related field: A minimum of a 3.0 average on all upper division work and acceptable courses in Calculus and Statistics, and a minimum of a 3.3 average in related graduate work.

3. GRE (general test with a minimum quantitative score of 155. International graduate student applicants whose native language is not English are required to submit a score for the Test of English as a Foreign Language (TOEFL) or for the International English Language Testing System (IELTS). A total score of 80 on the iBT TOEFL or 6.5 overall on the IELTS is required. GRE must have been taken within the past five years and TOEFL within the past two years. TOEFL = Test of English as a Foreign Language (www.toefl.org). IELTS = International English Language Testing System (www.ielts.org).
4. Three letters of recommendation from persons in a position to judge the applicant's potential for advanced graduate study in computer science.
5. Approval of the School of Computing and Information Sciences Graduate Committee.

7.2 Ph.D. Transfer Credit

A maximum of 6 (or 36 if part of a completed Master's degree) semester hours earned elsewhere as a graduate degree-seeking student may be transferred to FIU.

Acceptance of transfer credits is dependent upon the following provisions:

- The student received a grade of "B" or better.
- The course was taken at an accredited institution
- The course was relevant.
- The course was listed on an official transcript received by the Graduate Admissions Office.
- The course was completed within six years preceding admission.

The final decision regarding transfer credits is made by the Graduate Director in consultation (if necessary) with the Graduate Committee.

7.3 Ph.D. General Requirements

1. The student must pass five required courses and at least five elective courses. In addition, the student must earn at least 24 dissertation credits. In total, 75 credits beyond the bachelor's degree are required.
2. The student must pass the Candidacy Examination, which is a written and oral examination of the student's knowledge in a broad research area.
3. The student must pass the Proposal Defense, which is an oral examination of his or her dissertation proposal.
4. The student must write a dissertation on his or her research and successfully defend it orally in the Dissertation Defense.

Note: A student must comply with all University Graduate School requirements regarding enrollment and deadlines.

7.4 Ph.D. Credit Requirements

7.4.1 Required Courses

All students must complete the following three courses and receive a grade of 'B' or higher in each.
COP 5614 Operating Systems (3) or TCN 5445 Telecommunication Network Programming (3)
COT 5420 Theory of Computation I (3) or TCN 5421 Theory of Networked Computation (3) COT 6405 Analysis of Algorithms (3)

No grade below "C" will be accepted in any course taken to satisfy graduate program requirements. Transfer courses may be used to satisfy this requirement.

7.4.2 Elective Courses

The student must pass at least seven elective courses, for a total 30 semester credit hours of course work and maintaining a cumulative GPA of 3.0 or higher. Acceptable courses are listed in Section 9.1, but the list is subject to change, and the graduate program director has final approval. The required courses listed in Section 7.4.1 may not be used as an elective. In addition, the student must also earn at least 24 dissertation credit hours, and satisfy the School's seminar attendance requirement. In total, 75 credits beyond the bachelor's degree are required.

7.4.3 Research and Dissertation Credits

At least 24 dissertation credits must be earned. Other credits can include graduate research and independent studies.

7.4.4 Seminar Attendance Requirement

The student must attend at least 20 weekly seminars. In addition, Ph.D. students are expected to attend all the Ph.D. Proposal and Dissertation Defenses in the school to be familiar with the expectation of highquality Ph.D. research work.

7.5 Candidacy Examination

The Candidacy Examination will be offered each Fall and Spring semester, during the last four weeks of the semester. There are a total of two exams for each student. The goal of the Candidacy Examination is to test both knowledge of core class material, and the ability to synthesize knowledge learned in respective areas. Students are expected to take the Candidacy examination by the end of their second year.

7.5.1 Application

Application to take the Candidacy Exam is made in the first week of the semester in which the student wishes to take the exam. The application is in writing to the Chairperson of the Graduate Committee.

7.5.2 Eligibility for Candidacy Examination

To sit for the Candidacy Examination, a student must meet the following two criteria:

- The student must be in good academic standing and have active status,

- A Ph.D. student can take the candidacy examination as soon as he/she finishes the 30 credit course Requirements (including transfer credits) and has a Ph.D. advisor.
- A Ph.D. Student needs to get the approval from the Graduate Program Director if he/she plans to take the candidacy examination without Ph.D. advisor.
- The Graduate Program Director must certify that the student is capable of completing all required course work by the end of the semester in which the Candidacy Examination is given.

7.5.3 Candidacy Examination Administration and Content

The Candidacy Examination is designed to ensure that the student has competency in core computer science topics.

1) The format of the exam is written, and each subject test is 2 hours long. The exam is normally administered over 2 consecutive days;
2) The course instructors and area faculty members will make and grade the exams. The exam will be graded anonymously with student identities hidden;
3) The passing criterion for each subject test is 70%. A Ph.D. student needs to pass all 4 subject tests to pass the candidacy exam;
4) A Ph.D. student failing just one subject test may, upon recommendation of the subject area faculty, be allowed to satisfy the candidacy exam through remedial work such as taking a relevant course or retaking just the failed subject test. A student failing two or more subject tests needs to retake the entire candidacy exam;
5) A Ph.D. student can take the candidacy exam as early as in the semester in which he/she is completing the required 30 credit course work; but no later than 2 years into the Ph.D. program;
6) A Ph.D. student has two chances to pass the candidacy exam. A Ph.D. student failing the candidacy exam twice will be dismissed from the Ph.D. program.

The Candidacy examination will include the following three core courses and a research area specific test:

- COP 5614 Operating Systems (3) or TCN 5445 Telecommunication Network Programming (3)
- COT 5420 Theory of Computation I (3) or TCN 5421 Theory of Networked Computation (3)
- COT 6405 Analysis of Algorithms (3)

7.5.4 Research areas and the associated faculty members:

1) AI - Tao Li, Ram Iyengar, Mark A. Finlayson, Nagajan Prabakar
2) Algorithm - Ram Iyengar, Giri Narashimhan, Ning Xie, Mark Weiss, Malek Adjouadi
3) Human Centered Computing - Christine Lisetti, Radu Jianu
4) Database/Data Mining/ Information Retrieval - Shu-Ching Chen, Tao Li, Naphtali Rishe, Radu Jianu, Jai Navlakha, Fang
5) Medical Imaging - Ruogu Fang, Malek Adjouadi
6) Graphics / Image Processing - Radu Jianu, Ram Iyengar, Wei Zeng, Ruogu Fang, Malek Adjouadi
7) Network - Ram Iyengar, Niki Pissinou, Deng Pan, Shaolei Ren, Xin Sun
8) Security - Bogdan Carbunar, Geoffrey Smith, Jinpeng Wei
9) Software Engineering - Peter Clarke, Xudong He, Masoud Sadjadi, Masoud Milani
10) Systems - Jason Liu, Raju Rangaswami, Ming Zhao
11) Cognitive Modeling – Christine Lisetti, Mark A. Finlayson
12) Robotics - Nagajan Prabakar, Leonardo Bobadilla
13) Computer Graphics and Vision Research
14)

Students should ideally take the exam by the end of their second year of studies (students holding a prior Master's Degree would take the exam sooner), and after completion of required courses.

7.6 Termination of Ph.D. Candidates

Graduate students in the Doctoral program will be terminated if they have not attained candidacy status within three years, unless an extension is granted by the Graduate Program Director.

Students already advanced to Ph.D. candidacy status, and who meet the graduate school's continuous enrollment requirements, may only be terminated by a vote of the faculty. Such a decision will be based on the recommendation of the student's Dissertation Committee.

7.7 Ph.D. Dissertation

7.7.1 Dissertation Committee

At any time, but usually after successfully passing the Candidacy exam, the student will propose to the Graduate Committee Chairperson a Dissertation Committee. This committee has a minimum of 5 members, at least 4 Graduate Faculty members from the School and at least 1 from outside of the School. The Dissertation Advisor is the Chairperson of the Dissertation Committee and must be a Graduate Faculty member in the School with Dissertation Advisor Status. Form D-1 must be completed.

7.7.2 Proposal Defense

After the Dissertation Committee has been approved by the Chairperson of the Graduate Committee, the student will write a dissertation proposal. The proposal will be given by the Dissertation Advisor to the student's Dissertation Committee for review. The Dissertation Advisor will also schedule an oral presentation of the proposal in the form of a public lecture. Based on the reviews and on the oral presentation, the Dissertation Committee will make the final decision. Upon acceptance of the proposal, Form D-3 will be completed, to indicate that both a committee and a proposal have been approved. Before the submission of D-3 form, the Graduate School requires the Ph.D. candidate to complete an on-line "Responsible Conduct of Research Certification" training course:

(http://www.ori.fiu.edu/responsibleConduct.html).

The purpose of the proposal is to convince the Committee that the chosen dissertation topic and the student's approach have a reasonable chance of success. We want to minimize the chance that a dissertation will be turned down when almost completed. In particular the proposal should:

1. Explain the basic idea of the thesis topic
2. Argue why that topic is important
3. State what kind of results are expected
4. Make plausible that these results are sufficient for a Ph.D. thesis and that they are obtainable within the given time frame with the available resources
5. Demonstrate the student's academic qualifications for doing the proposed work by including a comprehensive survey of the area of specialization.

7.8 Ph.D. Dissertation Defense

The dissertation must describe a piece of original and high-quality work and must describe it well. It is on this basis that the School of Computing & Information Sciences certifies the qualification of the new Ph.D. Furthermore, it is the most important basis on which the rest of the scientific community judges the initial achievement and potential of that individual.

The *final public oral defense* is a public presentation describing the contributions of the dissertation.

The Dissertation Committee makes the final decision whether the student passes or fails based on the content and form of the dissertation, as well as the outcome of the dissertation defense.

7.9 Progress toward Ph.D. Degree

Graduate assistants in the Doctoral program are expected to finish the requirements for the Ph.D. within five years. All doctoral students are required to complete Annual Student Evaluation and Mentoring Plan each April.

7.10 Time Limit

At the doctoral level all requirements, including the successful defense of a dissertation, must be completed within nine years of first enrollment in the doctoral program.

The result of the Candidacy exam is valid for five years unless the Graduate Committee deems it appropriate to extend the time limit up to the period the student is allowed to be a graduate student by the university.

8 Faculty and Research Interests

Malek Adjouadi, Professor (dual appointment: Engineering and Computer Science), Ph.D., University of Florida, 1985. Graphic \ Image Processing, Computer Vision, Human Computer Interface, Algorithm and Medical Imaging.

Walid Akache, Instructor; M.S., University of Miami, 1984. Computer science.

Toby S. Berk, Professor Emeritus; Ph.D., Purdue University, 1972. Operating systems.

Leonardo Bobadilla, Assistant Professor, Ph.D., University of Illinois, Urbana-Champaign, 2013. Robotics, Artificial Intelligence, and Cyber-Physical Systems.

Bogdan Carbunar, Assistant Professor; Ph.D., Purdue University, 2005. Privacy, data and network security, Applied cryptography and distributed algorithms.

Shu-Ching Chen, Professor; Ph.D., Purdue University, 1998. Distributed Multimedia Database Systems, Databases, Information Retrieval, Multimedia Data Mining, Distributed Computing.

Peter Clarke, Associate Professor; Ph.D., Clemson University, 2003. Software Engineering, Software Testing, Software Maintenance, and Programming Languages .

Timothy Downey, Senior Instructor; M.S., SUNY Albany, 1986. Computer science.

Mark A. Finlayson, Assistant Professor, PhD, MIT, 2012. AI, Natural Language Processing (NLP), Cognitive Modeling.

Xudong He, Professor and Director of Center for Advanced Distributed Systems Engineering; Ph.D., Virginia Tech, 1989. Software Engineering, Formal Methods.

Sitharama S. Iyengar, Ryder Professor and Director; Ph.D., Mississippi State University, 1974. Computational sensor networks, parallel and distributed algorithms and data structures, autonomous and distributed systems.

Kip Irvine, Senior Instructor; M.S., University of Miami, 1995. Computer Science.

Radu Jianu, Assistant Professor, Ph.D., Brown University, 2012. Visualization Graphics and Neuroscience.

Bill Kraynek, Professor Emeritus; Ph.D., Carnegie Mellon University, 1968. Analysis of algorithms.

Tao Li, Professor; Ph.D., University of Rochester, 2004. Data mining and machine Learning, studying both the algorithmic and application issues.

Christine Lisetti, Associate Professor, Ph.D., FIU, 1995. Affective Computing, Cognitive Science, Intelligent User Interfaces, Serious Games, Believable Agents for Health Communication and Health Promotion.

Xiaowen Liu, Associate Professor, Ph.D., Dartmouth University, 2003. Computer networks, high-performance simulation and modeling, parallel computing.

Masoud Milani, Associate Professor; Ph.D., University of Central Florida, 1986. Computer Science Education, Theory of Computation, Software Engineering.

Giri Narasimhan, Professor and Associate Dean of Research and Graduate Studies; Ph.D., University of Wisconsin, 1989. Design and Analysis of Geometric Algorithms, Experimental Algorithmic, Computational Biology, Bioinformatics, Biotechnology and Biomedical Engineering, Computational Statistics, Neural Networks and Genetic Algorithms, Graph Theory and Combinatorics.

Jainendra Navlakha, Professor, Case Western Reserve, 1977. Analysis of algorithms, Software metrics, expert systems development and applications, neural network applications, computer education.

Deng Pan, Associate Professor; Ph.D., SUNY Stony brook, 2007. High-performance routers and switches, high-speed networking, quality of service, network processors, network security.

Alexander Pelin, Associate Professor; Ph.D., University of Pennsylvania, 1977. Automated reasoning.

Norman Pestaina, Senior Instructor; M.S., Penn State, 1979. Computer science.

Niki Pissinou, Professor; Ph.D. University of Southern California, 1991. Network centric middleware components, wireless information networks, distributed and wireless systems, and networked databases for newly emerging applications.

Nagarajan Prabakar, Associate Professor; Ph.D., University of Queensland, 1985, Database systems and computer networks.

Raju Rangaswami, Associate Professor; Ph.D., University of California at Santa Barbara, 2004. Operating systems, storage systems, virtualization, and security.

Shaolie Ren, Assistant Professor, Ph.D., UCLA, 2012. Cloud Computing, Cyber-Physical Systems.

Naphtali Rishe, Professor; Ph.D., Tel-Aviv, 1984. Database management and systems.

S. Masoud Sadjadi, Associate Professor; Ph.D., Michigan State University, 2004. Distributed computing, software engineering, adaptive middleware, and component-based design.

Greg Shaw, Senior Instructor; M.S., Barry University, 1992. Computer Science.

Geoffrey Smith, Associate Professor; Ph.D., Cornell University, 1991. Programming languages and security: type systems, language-based security, secure information flow.

Joslyn Smith, Instructor; M.S., New Brunswick, Canada, 1994. Computer Science.

Xin Sun, Assistant Professor, Ph.D., Purdue, 2012. Networks and Systems.

Jinpeng Wei, Assistant Professor; Ph.D., Georgia Tech, 2009. Computer security.

Jill Weiss, Senior Instructor; M.S., Barry University, 1992. Computer Science.

Mark A. Weiss, Professor and Associate Director; Ph.D., Princeton University, 1987. Data structures and algorithm analysis.

Ning Xie, Assistant Professor, Ph.D., MIT, 2012. Theory and Algorithms.

Ming Zhao, Assistant Professor, Ph.D., University of Florida, 2008. Distributed and grid computing.

Wei Zeng, Assistant Professor, Ph.D., Chinese Academy of Sciences (Doctor Research at SUNY Stony Brook), 2008. Computational Geometry, Graphics and Vision

SOMETIMES

9 Graduate Course Offerings

9.1 Regular Scheduled Courses

Courses marked with * are not acceptable for the M.S. in C.S. or Ph.D. program.

9.1.1 SCIS Courses

CAP-Computer Applications; CDA-Computer Design/Architecture; CEN-Computer Software Engineering; CIS-Computer Information Systems; CGS-Computer General Studies; CNT-Computer Networks; COC-Computer Concepts; COP-Computer Programming; COT-Computing Theory;

CAP 5011 Multimedia Systems and Applications (3). Course covers organization of multimedia systems, data representation, and quality of service, scheduling algorithms, synchronization and tele-communication of multimedia systems. Prerequisite: Graduate standing.

CAP 5510C Introduction to Bioinformatics (3). Introduction to bioinformatics; algorithmic, analytical and predictive tools and techniques; programming and visualization tools; machine learning; pattern discovery; analysis if sequence alignments, phylogeny data, gene expression data, and protein structure. Prerequisites: COP 3530, or equivalent and STA 3033 or equivalent.

CAP 5602 Introduction to Artificial Intelligence (3). Presents the basic concepts of AI and their applications to game playing, problem solving, automated reasoning, natural language processing and expert systems. Prerequisite: COP 3530.

CAP-5701 Advanced Computer Graphics (3) TBD Prof Wei Zeng

CAP 5610 Introduction to Machine Learning (3). Decision trees, Bayesian learning reinforcement learning as well as theoretical concepts such as inductive bias, the PAC learning, minimum description length principle. Prerequisite: Graduate standing.

CAP 5627 Affective Intelligent Agents (3). Design and implementation methods using artificial intelligence (AI) techniques, human-computer interaction (HCI) principles, emotion theories; applications, e.g. health informatics, education, games. Prerequisites: Graduate standing or permission of the instructor.

CAP 5738 Data Visualization (3). Advanced topics class covering data visualization principles, techniques, and algorithms. Students are familiarized with the scientific research workflow by proposing, implementing, and presenting a project with strong collaborative, interdisciplinary, and visual components.

CAP 5771 Principles of Data Mining (3). Introduction to data mining concepts, knowledge representation, inferring rules, statistical modeling, decision trees, association rules, classification rules, clustering, predictive models, and instance-based learning. Prerequisites: COP 4540 and STA 3033.

CAP-6736 Geometric Modeling and Shape Analysis (3): Techniques for 2D/3D geometric modeling and analysis, including representation, reconstruction, processing, modeling and shape analysis, and applications in science and engineering. Prerequisite: Graduate Standing or by Permission of Instructor

CAP 6776 Advanced Topics in Information Retrieval (3). Information Retrieval (IR) principles including indexing and searching document collections, as well as advanced IR topics such as Web search and IR-style search in databases. Prerequisite: COP 5725.

CAP 6778 Advanced Topics in Data Mining (3). Web, stream data, and relational data mining, graph mining, spatiotemporal data mining, privacy-preserving data mining, high-dimensional data clustering, social network, and linkage analysis. Prerequisite: CAP 5771 or permission of the instructor.

CDA 5655 Virtualized Systems (3). Topics include the concepts and principles of virtualization and the mechanisms and techniques of building virtualized systems, from individual virtual machines to virtualized networked infrastructure.

CDA 6939 Special Topics: Advanced Topics in Computer Architecture (3). This course deals with selected special topics in computer architecture. Prerequisite: Permission of the instructor.

CEN 5011 Advanced Software Engineering (3). This course deals with the design of large scale computer programs. Included are topics dealing with planning design, implementation, validation, metrics, and the management of such software projects. Prerequisite: CEN 4010.

CEN 5064 Software Design (3). Study of object-oriented analysis and design of software systems based on the standard design language UML; case studies. Prerequisite: CEN 5011.

CEN 5076 Software Testing (3). Tools and techniques to validate software process artifacts: model validation, software metrics, implementation-based testing, specification-based testing, integration and systems testing. Prerequisites: CEN 4010 or CEN 5011.

CEN 5082 Grid Enablement of Scientific Applications (3). Fundamental principles and applications of high-performance computing and parallel programming using OpenMP, MPI, Globus Toolkit, Web Services, and Grid Services. Prerequisites: Graduate standing or permission of the instructor.

CEN 5087 Software and Data Modeling (3).* Essential software and data modeling methods and techniques such as UML, XML, and ER. Prerequisite: Graduate standing.

CEN 5120 Expert Systems (3). Introduction to expert systems, knowledge representation techniques and construction of expert systems. A project such as the implementation of an expert system in a high level AI-language is required. Prerequisites: COP 3530 or permission of the instructor.

CEN 6070 Software Verification (3). Study of formal verification of software systems; verification methods; verification of sequential and concurrent software systems. Prerequisite: CEN 5011.

CEN 6075 Software Specification (3). Study of formal specification in the software development process; specification methods; specification of sequential and concurrent systems. Prerequisite: CEN 5011.

CGS 5166 Introduction to Bioinformatics Tools (2).* Introduction to bioinformatics; analytical and predictive tools; practical use of tools for sequence alignments, phylogeny, visualizations, pattern discovery, gene expression analysis, and protein structure. Prerequisites: PCB 6025 or equivalent.

CGS 6834 Programming for the Web (3).* Installation and maintenance of servers. Techniques for building secure multimedia interactive web pages. A hands-on project to develop an educational interactive multimedia web site is required. This course is not an elective for SCIS programs.

CIS 5027 Computer Systems Fundamentals (3)*. Fundamentals concepts of IT Systems: operating systems, networking, distributed systems, platform technologies, web services and human-computer interaction. Covers design principles, algorithms and implementation techniques. Prerequisite: Graduate standing.

CIS 5346 Storage Systems (3). Introduction to storage systems, storage system components, storage architecture, devices, trends and applications, performance, RAID, MEMS and portable storage, filesystems, OS storage management. Prerequisite: Graduate standing.

CIS 5372 Fundamentals of Computer Security (3). Information assurance algorithms and techniques. Security vulnerabilities. Symmetric and public key encryption. Authentication and Kerberos. Key infrastructure and certificate. Mathematical foundations. Prerequisite: Graduate standing.

CIS 5373 Systems Security (3). Risk, Trust, and Threat models; Types of Attacks; Safe Programming Techniques; Operating System Mechanisms, Virtual Machine Systems; Hardware Security Enforces; Application Security; Personal Security. Prerequisite: CIS 5372.

CIS 5374 Information Security and Privacy (3). Information Security Planning, Planning for Contingencies, Policy, Security Program, Security Management Models, Database Security, Privacy, Information Security Analysis, Protection Mechanism. Prerequisite: CIS 5372.

CIS 5432 Advanced IT Automation (3). Advanced topics in system/network management including monitoring, help desk, antivirus, anti-malware, backup, disaster recovery, discovery, audit, remote control, automated response, policies, and reports. Prerequisites: CIS 4431 or permission of the instructor.

CIS 5931 Special Topics (VAR). A course designed to give groups of students an opportunity to pursue special studies not otherwise offered.

CIS 6612 Special Topics: Advanced Topics in Software Engineering (3). This course deals with selected topics in software engineering. Prerequisite: Permission of the instructor.

CIS 6930 Advance Special Topics. (3) A course designed to give groups of students an opportunity to pursue special studies not otherwise offered. Prerequisite: Permission of the instructor.

CIS 6930 Advance Special Topics. Natural Language Processing (3). A course designed to give groups of students an opportunity to pursue special studies not otherwise offered. This course will introduce students to the fundamental concepts and common approaches in the computational processing of language. The course will focus on text-based approaches, but we will treat the basics of speech processing as well. Prerequisite: Permission of the instructor.

CIS 6931 Special Topics: Advanced Topics in Information Processing (3). This course deals with selected special topics in information processing. Prerequisite: Permission of the instructor.

CNT 6207 Distributed Processing (3). Study of distributed processing using networking and distributed computing techniques. Investigation of distributed algorithms and models of distributed computing. Prerequisite: Graduate Standing.

CNT 6208 Advanced Topics in Concurrent and Distributed Systems (3). Study of the major aspects of concurrent and distributed systems. Topics include foundations of concurrent computation, languages and tools for concurrent systems, distributed real-time systems, distributed multimedia systems, and concurrent object-oriented systems.

COP 5614 Operating Systems (3). Operating systems design principles, algorithms and implementation techniques: process and memory management, disk and I/O systems, communications and security.

COP 5621 Compiler Construction (3). Basic techniques of compilation; scanning; grammars and LL and LR parsing, code generation; symbol table management; optimization. Prerequisites: MAD 3512 and CEN 4010.

COP 5725 Principles of Database Management Systems (3). Overview of Database Systems, Relational Model, Relational Algebra and Relational Calculus; SQL; Database Applications; Storage and Indexing; Query Evaluation; Transaction Management. Selected database topics will also be discussed.

COP 6007 Computer Programming Concepts (3).* For non-SCIS graduate students. Concepts of object oriented programming, introduction to an object oriented programming language; internet programming; applications of programming to learning technologies. Prerequisite: Permission of the instructor.

COP 6556 Semantics of Programming Languages (3). This course provides an overview of systematic and effective approaches to programming. Abstraction; formal specification techniques; program verification and; semantics of programming languages. Prerequisite: COT 5420.

COP 6611 Advanced Operating Systems (3). Advanced topics in operating system design; microkernel; memory architecture; multi-processor issues; multimedia operating systems; case studies. Prerequisite: Graduate standing.

COP 6727 Advanced Database Systems (3). Design, architecture and implementation aspects of DBMS, distributed databases, and advanced aspects of databases selected by the instructor. Prerequisite: Graduate standing.

COP 6795 Special Topics on Databases (3). Study of selected advanced topics in databases and related areas. Prerequisite: Permission of the instructor.

COT 5407 Introduction to Algorithms (3). Design of efficient data structures and algorithms; analysis of algorithms and asymptotic time complexity; graph, string, and geometric algorithms; NP-completeness.

COT 5420 Theory of Computation I (3). Abstract models of computation; including finite automata, regular expressions, context-free grammars, pushdown automata, Turing machines. Decidability and undesirability of computational problems. Prerequisite: MAD 3512.

COT-5520 Computational Geometry (3) Design and analysis of efficient algorithms to solve geometric problems: geometric searching, convex hull, proximity problem, Voronoi diagram, spanning tree, triangulation, graph drawing applications. Prerequisite: COP 3530

COT 6405 Analysis of Algorithms (3). Design of advanced data structures and algorithms; advanced analysis techniques; lower bound proofs; advanced algorithms for graph, string, geometric, and numerical problems; approximation algorithms; randomized and on-line algorithms. Prerequisite: Graduate standing.

COT 6421 Theory of Computation II (3). Verification of program correctness; program schemes; fixed point theory of programs; resolution and theorem proving. Prerequisite: COT 5420.

COT 6930 Special Topics: Advanced Topics in Theory (3). This course deals with selected special topics in computing theory. Prerequisite: Permission of the instructor.

COT 6931 Topics in Cognitive Science (3). A "top-down" view of Computer Science, in particular artificial intelligence, by studying the computational aspects of human cognition. Prerequisite: Permission of the instructor.

COT 6936 Topics in Algorithms (3). Advanced data structures, pattern matching algorithms, file compression, cryptography, computational geometry, numerical algorithms, combinational optimization algorithms and additional topics. Prerequisite: COP 3530.

TCN 5010 Telecommunications Technology and Applications (3). An in-depth introduction to voice and data networks, signaling and modulation, multiplexing, frequency band and propagation characteristics, special analysis of signals, and traffic analysis. Prerequisite: Permission of the instructor.

TCN 5030 Computer Communications and Networking Technologies (3). Teaches the dynamics related to computer communications, how computers are grouped together to form networks, various networking implementation strategies, and current technologies. Prerequisite: Permission of the instructor.

TCN 5060 Telecommunications Software and Methodologies (3). A high-level look into network architectures and distributed applications, client-server models, network software platforms and advanced techniques for programs specifications through implementation. Prerequisites: TCN 5030 or permission of the instructor.

TCN 5080 Secure Telecommunications Transactions (3). Telecom and information security issues such as: digital signatures, cryptography as applied to telecom transactions, network policing, nested authentication, and improving system trust. Prerequisites: TCN 5030 or permission of the instructor.

TCN 5150 Multimedia Computer Communications (3). Covers multimedia computer communications technologies including, multimedia over networks, videoconferencing, telephone, compression algorithms and techniques for transmitting data efficiently. Prerequisites: TCN 6210 or permission of the instructor.

TCN 5421 Theory of Networked Computation (3). Fundamental mathematical models of general and networked computation: finite state automata, regular languages, decidability; stochastic processes, Markov chains, queueing theory.

TCN 5440 Software Development for Telecommunication Networks (3). Focuses on the aspects, tools, and techniques of developing software applications for telecommunications networks. Prerequisites: TCN 5030 or equivalent.

TCN 5445 Telecommunications Networking Programming (3). Advanced telecommunications network programming skills including Router and Bridge Software, socket programming and protocol handler. Prerequisite: Permission from instructor.

TCN 5455 Information Theory (3). Entropy and measure of information. Proof and interpretation of Shannon's fundamental theorem for various channels, including noiseless, discrete, time-discrete and time continuous channels. Prerequisite: Permission of the instructor.

TCN 5640 Telecommunications Enterprise Planning and Strategy (3) Methodologies for reengineering, project management, strategic planning, change management, RFPs, and life-cycle management within the telecommunications and IT arena. Prerequisite: Permission of the instructor.

TCN 6210 Telecommunications Network Analysis and Design (3). A systematic, analytic and descriptive approach to the evaluation of telecommunications networks, networking principles, and control and quality of service. Prerequisite: Permission of the instructor.

TCN 6215 Advanced Network Algorithms (3). This course will cover algorithms that are used in network research and implementation. Prerequisites: TCN 6210 or consent of the instructor.

TCN 6230 Optical Networks (3). Enabling technologies, multiplexing techniques, WDM, broadcast networks, wavelength-routed networks, network architectures, protocols, network algorithms, and device network interfaces. Prerequisites: TCN 5030 or equivalent.

TCN 6260 Internetworking (3). The course will discuss advanced topics, current trends and control of internetworking. An analytical and descriptive approach will be used to cover the subject of internetworking.

TCN 6270 Mobile and Wireless Networks (3). Techniques in the design and operation of wireless networks; LANs, MANs, and WANs; analytical models; application of traffic and mobility models; mobility control, and wireless ATM. Prerequisites: TCN 5030 or equivalent.

TCN 6275 Mobile Computing (3). Enabling technologies and impediments of mobile computing. It includes mobile architectural design, mobile-aware and transparent adaptation, mobile data access and file systems, and ad-hoc networks. Prerequisite: Permission of the instructor.

TCN 6420 Modeling and Performance Evaluation of Telecommunications Networks (3). Covers methods and research issues in the models and performance evaluation of high-speed and cellular networks. Focuses on the tools from Markov queues, queuing networks theory and applications. Prerequisites: TCN 5030 or equivalent.

TCN 6430 Networks Management and Control Standards (3). Protocols for management of telecom networks, including Simple Network Management Protocol and Common Management Information Protocol. Extension of protocols to optimize network performance. Prerequisites: TCN 5030 or equivalent.

TCN 6450 Wireless Information Systems (3). Enabling technologies and impediments of wireless information systems. Focuses on software architectures, and information and location management in the wireless environment. Prerequisite: Permission of the instructor.

TCN 6820 Industrial Development of Telecommunications (3). This course, from a management perspective, addresses the evolution of the telecom industry, the impact it has on reshaping our world, and the importance of management decisions in telecom.

TCN 6880 Telecommunications Public Policy Development and Standards (3). A concept-oriented examination of the domestic and international telecommunications policy processes and standards setting environment. Prerequisite: Permission of the instructor.

Note: Undergraduate prerequisites can be found in the Undergraduate Catalog.

9.1.2 Non-SCIS Courses

EEL 6167 VLSI Design
EEL 5348 Digital Electronics
EEL 5500 Digital Communication Systems I
EEL 5718 Computer-Communication Network Engineering
EEL 5810 Neural Networks
EEL 5820 Image Processing
EEL 6787 Network Security
ESI 6546 Network Flow Analysis
STA 5236 Regression Analysis
STA 6807 Queuing & Stat Models

No more than one course from the above list can be applied towards a graduate degree. Other non-CS graduate courses not in this list may be requested by a student with good justifications and must be preapproved by the graduate director for it to be counted towards the student's degree requirements.

9.2 Independent Study, Dissertation and Thesis

CIS 5900 M.S. Independent Study (1-10). Individual conferences, assigned readings, and reports on independent investigations. At most 3 credits with a letter grade can be counted towards the MS graduation requirement and pre-approval from the Graduate Advisor is needed.

CIS 5910 Project Research (1-10). Advanced undergraduate or Master's-level research for particular projects. Repeatable. Prerequisite: Permission of department.

CIS-5915 Research Experience for Graduate Students (0-9). Participation in ongoing research in the research centers of the school.

CIS 6900 Ph.D. Independent Study (1-10). Individual conferences, assigned readings, and reports on independent investigations.

CIS 6933 Computer Science Seminar (1). Regularly scheduled seminar series featuring speakers on computer science related topics. Prerequisite: Graduate standing.

CIS 6970 Thesis (1-10). Prerequisite: Completion of all other requirements for the M.S. Degree in Computer Science.

CIS 7910 Graduate Research (1-25). Doctoral Research prior to candidacy. Repeatable. Prerequisite: Permission of Department.

CIS 7980 Ph.D. Dissertation (1-12). Prerequisite: Admission to doctoral candidacy. Permission of instructor.

COP 5949 Cooperative Education in Computer Science (1-3). One semester of full-time work, or equivalent, in an outside organization, limited to students admitted to the CO-OP program. A written report and supervisor evaluation is required of each student. Prerequisites: Graduate Standing. At most 3 credits with a letter grade can be counted towards the MS graduation requirement and pre-approval from the Graduate Director is needed.

Graduate Syllabi

CAP 5510 Introduction to Bioinformatics

Catalog Description
Introduction to bioinformatics; algorithmic, analytical and predictive tools and techniques; programming and visualization tools; machine learning; pattern discovery; analysis of sequence alignments, phylogeny data, gene expression data, and protein structure. (3 credits)

Prerequisites
COP 3530, or equivalent and STA 3033 or equivalent.

Type
Elective for MSCS, MSIT, MSTN, and Ph.D. students

Course Objectives
This is an introductory graduate course in Bioinformatics. Students will learn standard tools and techniques used to analyze and interpret biomedical data. There is considerable overlap with areas such as data mining, machine learning, pattern recognition, and algorithms. No prerequisite knowledge in molecular and cell biology, genetics, or biochemistry will be assumed.

Topics
Fundamentals of Biology, Statistics, the Internet, and Bioinformatics •
Databases and Software Packages, BioPerl.
• Sequence Alignment, Multiple Sequence Alignment
• Sequencing; Next Generation Sequencing & Applications
• Predictive Methods: Nucleotide Sequences and Protein Sequences
• Pattern Discovery Techniques and applications • Machine Learning: NN, HMM, SOM, SVM, etc.
• Gene Regulation; Predicting Regulatory Elements
• Analysis of Gene Expression Data
• Gene Ontology and Pathways; Protein-protein interactions
• Genomics, Proteomics, Comparative Genomics
• Phylogenetic Analysis
• Molecular Structural Analysis: RNA and Proteins
• Genetics and Genome-Wide Association Schemes
• Single Nucleotide Polymorphisms
• Advanced Topics: RNAi, Alternative Splicing, Epigenetics
The course will contain a lab component to learn Bioinformatics analysis tools.

Textbook
Bioinformatics and Functional Genomics, J. Pevsner, Wiley-Blackwell, 2nd Edition, **ISBN**: 978-0-470-08585-1

Last Update
Giri Narasimhan 9/13/2012

CAP-5602 Introduction to Artificial Intelligence

Catalog Description
Presents the basic concepts of AI and their applications to game playing, problem solving, automated reasoning, natural language processing and ex- pert systems. (3 credits)

Prerequisites
COP 3530 - Data Structures

Type
Elective for MSCS, Ph.D. in CS, MS in CS for current CS undergraduate students (4+1 Program).

Course Objectives
At the end of the course the students will be able to
1. Write reasonably complex programs in sn AI language like LISP or prolog, 2. be familiar with the basic concepts and methods of AI,
3. Use these concepts to solve basic AI problems.

Topics learn an AI language (LISP, prolog, or another AI Language) intelligent agent's problem solving games Constraint satisfaction classical planning natural language processing other topics like automated reasoning, neural nets, expert systems, image processing, or robotics, at the discretion of the instructor

Textbook

Stuart Russell and Peter Norvig Artificial Intelligence: A Modern Approach, Third Edition (Prentice Hall, 2010)

Last Update

Alex Pelin 5/20/2013

CAP-5610 Introduction to Machine Learning

Catalog Description
Decision trees, Bayesian learning reinforcement learning as well as theoretical concepts such as inductive bias, the PAC learning, minimum description length principle. (3 credits)

Prerequisites
Graduate Standing

Type
Elective graduate courses

Course Objectives
A student completing this course should:

1. have knowledge and understanding of the principle algorithms used in machine learning
2. have sufficient knowledge of information theory and probability theory to provide a theoretical framework for machine learning
3. be able to apply machine learning algorithms, evaluate their performance and appreciate the practical issues involved in the study of real datasets
4. be able to provide a clear and concise description of testing and benchmarking experiments

Topics

- Concept Learning and the General-to-Specific Ordering
- Decision Tree Learning
- Artificial Neural Networks
- Evaluating Hypotheses
- Bayesian Learning
- Computational Learning Theory
- Instance-Based Learning
- Genetic Algorithms
- Learning Sets of Rules
- Analytical Learning
- Combining Inductive and Analytical Learning
- Reinforcement Learning

Textbook

- Tom Mitchell. Machine Learning. McGraw Hill, 1997. **References**
- Christopher M. Bishop. Pattern Recognition and Machine Learning, Springer, 2006

- Ethem Alpaydin. Introduction to Machine Learning, MIT press, 2004.

Last Update
Tao Li 10/30/2012

CAP-5627 Affective Intelligent Agents (3 credits)

Catalog Description
This course is about building computers that can adapt to their user's emotions and enhance the user's experience when interacting with computers. It covers: design and implementation methods using artificial intelligence (AI) techniques, human-computer interaction (HCI) principles, emotion theories, applications, e.g. health informatics, education, computer games.

Prerequisite: Graduate Standing.

Type
Elective for CS Master and PhD students
Particularly relevant to the Intelligent Systems and Cognitive Science PhD tracks

Course Objectives
Students learn about what are affective intelligent agents, why they are having such an impact on novel technologies, and how to design and build such affective intelligent agents from a variety of perspectives. This course is highly beneficial to students whose research interests are in intelligent systems, affective computing, emotion automatic recognition and simulation, virtual characters, artificial intelligence, HCI involving socio-emotional content (education, personal health informatics, games).

Sample Topics Covered
- Emotion and human-computer interaction
- Physiology and neuroscience findings on emotion
- Affect recognition by machines
- Psychological aspects and theories of emotions
- Expression of emotion by machines/agents/synthetic characters
- Engagement measurement
- Responding adaptively to user's emotions
- Emotion-based affective-cognitive architectures
- Computer agents "with" empathy for emotional support
- Applications of affective intelligent agents
- Philosophical, social, and ethical implications of affective computing

Text
- R. Picard. *Affective Computing*, MIT Press, 1997.
- K. Scherer, T. Banziger , and E. Roesch. *Blueprint for Affective Computing*. Cambridge University Press, 2010.
- D. Gokcay and G. Yildirim. *Affective Computing and Interaction. Psychological, Cognitive and Neuroscientific Perspectives*. IGI Global, 2011.
- A Collection of articles available online which may vary each year.

Last Update
Christine Lisetti 9/17/2012

CAP-5738 Data Visualization

Catalog Description
Advanced topics class covering data visualization principles, techniques, and algorithms. Students are familiarized with the scientific research workflow by proposing, implementing, and presenting a project with strong collaborative, interdisciplinary, and visual components.

Prerequisites
SCIS Graduate Standing

Type
Elective for MSCS, MSIT, and Ph.D. students.

Objectives
In this class students will be familiarized with Information Visualization principles, techniques, and algorithms. They will implement a few fundamental visualization techniques. They will read and discuss seminal and state of the art research papers on the subject. Finally, students will experience the research pipeline in its entirety by participating in a simulated funding process and implementing a collaborative visualization project. Specifically, students will meet potential collaborators, decide on projects that are likely to yield valuable research contributions, write short project proposals, review each other's proposals and decide collectively which proposals are worth "funding", implement the project, write a short paper documenting the results, and present that paper.

Topics
Principles of visual encoding
Multidimensional data visualization
Tree and Graph visualization
Visualizing text and document collections
Geospatial and temporal visualization
Interactivity in visual analysis systems
3D or scientific visualization
Evaluating visualization efficiency
Principles of visual reasoning
An introduction to research funding mechanisms and interdisciplinary projects

Textbook
1. The Visual Display of Quantitative Information (2nd Edition). E. Tufte. Graphics Press, 2001. ISBN 9780961392147
2. Visualization Analysis and Design: Abstractions, Principles, and Methods. T. Munzner. (pre-publication draft available online: http://www.cs.ubc.ca/~tmm/courses/533-11/book/)

Last Update
Radu Jianu 7/5/2013

CAP-5771 Principles of Data Mining

Catalog Description
Principles of data mining concepts, knowledge representation, inferring rules, statistical modeling, decision trees, association rules, classification rules, clustering, predictive models, and instance-based learning. (3 credits)

Prerequisites: Graduate Standing

Type: Elective graduate courses

Course Objectives

After completing this module, students will be able to

- Demonstrate an understanding of principles and theoretical foundations behind major data mining approaches
- Demonstrate an understanding of current research issues in data mining
- Undertake the systematic and comparative evaluation of data mining procedures
- Select and apply data mining techniques to the solutions of real world problems

Topics

- Data Mining Introduction
- Data Exploration and Visualization
- Data Preprocessing
- Classification
- Association Analysis
- Sequential pattern mining
- Advanced pattern mining
- Cluster Analysis
- Anomaly Detection

Textbook

- Pang-Ning Tan, Michael Steinbach and Vipin Kumar. Introduction to Data Mining. Addison Wesley, 2005.

References

- Jiawei Han and Micheline Kamber. Data Mining: Concepts and Techniques. Morgan Kaufmann Publishers, 2006, Second Edition.
- Tom Mitchell. Machine Learning. McGraw Hill, 1997.
- Hastie, Tibshirani and Friedman. The Elements of Statistical Learning. SpringerVerlag, 2001.

Last Update
Tao Li 10/30/2012

CAP-6778 Advanced Topics in Data Mining

Catalog Description
Topics such as web data mining, stream data mining, relational data mining, tree/graph mining, spatiotemporal data indexing and mining, privacy-preserving data mining, highdimensional data clustering, basics of natural language processing, social network and linkage analysis. (3 credits)

Prerequisites
COP 5577 or Permission of Instructor

Type
Elective graduate courses

Course Objectives
This is a seminar course that will focus on recent developments of advanced data mining techniques and their applications to various problems.

Topics

- Overview of Basic Data Mining Techniques
- Large-scale Data Mining
- Similarity Search (including minwise hashing and locality sensitive hashing)
- Mining Data Streams
- Mining Social Networks
- Dimensionality Reduction
- Spectral Clustering
- Matrix Factorization
- High-Dimensional Data Clustering
- Ensemble Methods in Data Mining
- Web Applications (including advertising, recommendation, and summarization)

Textbook

Handouts will be provided

Last Update
Tao Li 10/30/2012

CDA-5655 Virtualized Systems

Catalog Description
Topics include the concepts and principles of virtualization and the mechanisms and techniques of building virtualized systems, from individual virtual machines to virtualized networked infrastructure. (3 credits)

Prerequisites
Permission of the instructor.

Type
Elective for M.S. and Ph.D. students

Course Objectives
Students will learn the concepts and principles of virtualization, the mechanisms and techniques of building virtualized systems, as well as the various virtualization-enabled computing paradigms.

Topics
Virtual machines (Classic virtual machines, Paravirtualization, Hardware-assisted virtualization), Virtual networking (Tunneling, Overlay networks), Virtual storage (File system level virtualization, Block level virtualization), Virtualized computing (Virtual machine based distributed computing, Cloud computing)

Textbook
N/A

Last Update
Ming Zhao 9/15/2012

CDA-6939 Advanced Topics in Computer Architecture

Catalog Description
This course deals with selected special topics in computer architecture. (3 credits)

Prerequisites
Permission of the instructor

Type
Elective for M.S. and Ph.D. students

Course Objectives
Students will review the fundamental computer architecture topics, including Instructionlevel parallelism, Data-level parallelism, and Thread-level parallelism, and learn the advanced topics, including Multi-processor, Multi-core, Multi-threading, and Warehousescale computers.

Topics
Instruction-level parallelism, Data-level parallelism, Thread-level parallelism Multi-processor, Multi-core, Multi-threading, Warehouse-scale computers

Textbook
N/A

Last Update
Ming Zhao 9/15/2012

CEN 5011 – Advanced Software Engineering

Catalog Description
This course deals with the design of large scale computer programs. Included are topics dealing with planning, design, implementation, validation, metrics, and the management of such software projects. (3 credits)

Prerequisite
Knowledge of a data structure course (e.g., COP 3530), Familiarity with at least two high-level programming languages (e.g., C++ and Java) and the foundations of computing, Familiarity with the basic concepts of software engineering, including software process, requirements analysis, design, coding, and testing.

Type: Required for MSCS
Can be an Elective for MSIT, MSTN, and Ph.D. students

Course Objectives
This course provides a comprehensive coverage of software development processes and wellknown methods for system requirements analysis, design, implementation, and testing. Essential software management methods will also be introduced. Students will be involved in a semester long team project, which requires the application of various management and development methods covered in the class. Students will gain real experience in developing large software systems, which are extremely useful and helpful for future employment in software industry.

Topics
Essential concepts of software engineering
Software process models
Software management techniques
Software Analysis methods
Software design methods
Software testing techniques
Advanced topics in software engineering

Textbook
Bernd Bruegge and Allen Dutoit, *Object-Oriented Software Engineering: Using UML, Patterns, and Java*, Third Edition, (Prentice-Hall, 2010).

Other References
Grady Booch, Ivar Jacobson, James Rumbaugh, *The Unified Modeling Language User Guide*, 1st Edition, (Addison-Wesley Professional, 1998).
Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides, *Design Patterns: Elements of Reusable Object-Oriented Software*, 1st Edition, (Addison-Wesley Professional, 1995)

Last Update
Xudong He 8/30/2012

CEN 5064 - Software Design

Catalog Description:
Study of object-oriented analysis and design of software systems based on the standard design language UML; case studies. (3 credits)

Prerequisite:
CEN 4010 – Software Engineering I or CEN 5011 – Advanced Software Engineering.

Type
Can be an Elective for MSCS, MSIT, MSTN, and Ph.D. students

Course Objective:
The purpose of this course is to conduct in-depth study of object-oriented analysis and design of software systems based on the standard design language UML. Primary topics of study include the use-case driven approach for software analysis, system design and detailed design. In particular, emphasis will be made on how to strengthen major design qualities such as robustness, changeability, interoperability, and reliability via UML based concepts, processes, methods and techniques. If time allows, a complete case study will be discussed.

Topics
Review the phases of the software process (1 week)
Review of UML diagrams used in the phases of the development life cycle (1 week):
Static modeling (2 weeks) Class
diagrams
Object diagrams
Dynamic modeling (2 weeks)
Sequence diagrams
State machines
Activity diagrams
Software Architectural Design (2weeks)
N-Tier (peer-peer, client-server, 3-tier, 4-tier)
Pipe and Filter
Repository
Service-oriented
Event driven
Detailed Design and Design Patterns (2weeks)
Creational
Structural
Behavioral
Concurrency
Model-Driven Software Development (3 weeks)
Metamodeling

Domain Architectures
Model transformation
Code generation
Current research (1 week)

Required Text: Carlos E. Otero. "Software Engineering Design: Theory and Practice (Applied Software Engineering Series)", Auerbach Publications; 1 edition (June 11, 2012). ISBN-10: 1439851689, ISBN-13: 978-1439851685

Recommended Text: Markus Völter and Thomas Stahl, "Model-Driven Software Development: Technology, Engineering, Management", Wiley 2005, ISBN: 978-0-47002570-3.

Other reading material: Relevant papers from conference proceeding and journals.

Last Update
Peter J. Clarke 10/29/2012

CEN 5076 - Software Testing

Catalog Description:
Introduce tools and techniques used to validate artifacts developed during the software development process. Included topics are: model validation, software metrics, implementation-based testing, specification-based testing, integration testing and systems testing. (3 credits)

Prerequisite:
CEN 4010 – Software Engineering I or CEN 5011 – Advanced Software Engineering.

Type
Can be an Elective for MSCS, MSIT, MSTN, and Ph.D. students

Course Objectives:
Graduate students in Computer Science and Information Technology will learn how to validate software artifacts using both specification-based and implementation-based testing techniques, as well as, use testing tool to automate the testing process.

Topics
Review the phases of the software process (1 week)
Techniques and tools to validate the following models (3 weeks):
- Requirements (Use Case)
- Analysis
- Design
- Deployment

Planning and documenting the testing process (1 week):
- Test plans
- Test cases

Validation of the software implementation (Sequential, Concurrent and Distributed systems) (5 weeks):
- Software metrics
- Implementation-based testing
- Specification-based testing
- Integration testing
- Systems testing
- Regression testing

Current research (4 weeks)
- Testing theory
- Testing concurrent systems
- Testing distributed systems

Required Text: Aditya P. Mathur. "Foundations of Software Testing" 2008 Edition, Pearson, ISBN 9788131716601.

Recommended Text: Robert V. Binder, "Testing Object-Oriented Systems: Models, Patterns and Tools", Addison-Wesley 2000, ISBN 0201809389.

Other reading material: Relevant papers from conference proceeding and journals.

Last Update
Peter J. Clarke 10/29/2012

CEN-5087 Software and Data Modeling

Catalog Description
Essential software and data modeling methods and techniques such as UML, XML, and ER. This course covers basic and advanced modeling concepts: how to model, how to manage complexity with patterns and tools.

Prerequisites
SCIS Graduate Standing

Type
Required for MSIT
Cannot be an Elective for MSCS, MSTN, and Ph.D. students

Course Objectives
Students will learn the core set of skills required during software development life cycle including project initiation and management, requirement gathering, analysis and design.

Topics

- Introduction
- Project Initiation
- Project Management
- Requirements gathering
- Analysis ○ Functional Modeling ○ Object Modeling ○ Dynamic Modeling
- Design ○ Class design ○ Data Design ○ Interface Design ○ Architecture Design

Textbook
Alan Dennis, Barbara Haley Wixom and David Tegarden, *System Analysis and Design with UML version 2.0: An Object-Oriented Approach. 3rd Edition,* (Wiley, 2009).

Last Update
Masoud Milani 12/17/2012

CEN-5120 Expert Systems

Catalog Description
Introduction to expert systems, knowledge representation techniques and construction of expert systems. A project such as the implementation of an expert system in a high level AI-language is required. (3 credits)

Prerequisites
COP 3530 or permission of Instructor

Type
Elective for MSCS, Ph.D. in CS, MS in CS for current CS undergraduate students (4+1 Program).

Course Objectives
A thorough presentation of the steps needed to develop an expert system: the components of an expert system, knowledge representation, knowledge accquisition, reasoning, methods for dealing with uncertainty, and validation. The students will use an expert system language like prolog or a shell like CLIPS.

Topics
what is an expert systems, types of expert systems, its components knowledge representation methods of inference reasoning with uncertainty the design of an expert system
learning the expert system language or the expert system shell writing an expert system

Textbook
Joseph Giarratano and Gary Riley Expert Systems : Principles and Program- ming, Fourth Edition (Thompson, Course Technology, 2005)

Last Update
Alex Pelin 5/20/2013

CEN 6070 – Software Verification

Catalog Description
Study of formal verification of software systems; verification methods; verification of sequential and concurrent software systems. (3 credits)

Prerequisites
Undergraduate level mathematics: discrete mathematics (set theory, logic, algebra) and advanced software engineering (CEN 5011).

Type
Can be an elective for MSCS, MSIT, and Ph.D.

Course Objectives
Students, after taking this course, are expected to know the benefits of formal verification in the software development process, and to understand a variety of formal verification methods and their applicability. Furthermore, students are expected to learn several well developed formal verification methods for both sequential and concurrent software systems and be able to apply them to verify small benchmark systems. In particular, this course will cover the new verification paradigm of model checking, which has become the focal research area in the past decade and has become very successful in industrial applications. Several well-established model checking techniques will be studied. Further research issues with regard to overcoming the limitations and improving the efficiency of model checking will be discussed.

Topics
The Fundamentals of Software Verification
The Basic Concepts of Model Checking Paradigm
Temporal Logics CTL*
Binary Decision Diagram
Symbolic Model Checking
Model Checking for the □-Calculus
Model Checking in Practice
Model Checking and Automata Theory
Partial Order Reduction
Equivalence and Preorders between Structures
Compositional Reasoning
Abstraction
Symmetry
Infinite Families of Finite State Systems

Textbook
Edmund M. Clarke, Orna Grumberg, and Doron A. Peled**,** *Model Checking*, Third Printing (The MIT Press 2001)

Last Update
Xudong He 8/31/2012

CEN 6075 – Software Specification

Catalog Descriptions
Study of formal specification in the software development process; specification methods; specification of sequential and concurrent systems. (3 credits).

Type
Can be used as an elective for MSCS, MSIT, and Ph.D.

Prerequisites
Undergraduate level mathematics: discrete mathematics (set theory, logic, algebra) and graduate level software engineering (CEN5011).

Course Objectives
Students, after taking this course, are expected to know the benefits of formal specification in the software development process, and to understand a variety of formal specification methods and their applicability. Furthermore, students are expected to learn several well developed formal methods for both sequential and concurrent software systems and be able to apply them to specify small benchmark systems.

Topics

Fundamental Concepts of Software Correctness and Formal Specification Methods
Specification Method for Sequential Systems – Z
Model-oriented Formal Specification Method for Concurrent Systems – Petri Nets
Property-oriented Formal Specification method for Concurrent Systems – Temporal Logic

Textbook
Leslie Lamport, *Specifying Systems*, (Pearson Education Inc., 2003).

References
Mike Spivy, *Z Reference Manual*, (Springer-Verlag, 1992)
Wolfgan Reisig, *Petri Nets – An Introduction* (Springer-Verlag, 1985).
Amir Pmueli and Zohar Manna, *The Temporal Logic of Reactive and Concurrent Systems* (Springer-Verlag, 1992).

Last Update
Xudong He 8/31/2012

CGS 5166 Introduction to Bioinformatics Tools

Catalog Description
Introduction to bioinformatics; analytical and predictive tools; practical use of tools for sequence alignments, phylogeny, visualizations, pattern discovery, gene expression analysis, and protein structure. (2 credits)

Prerequisites: PCB 6025 or equivalent.

Type: Elective for non-CS and non-IT majors

Course Objectives
This course will introduce computational tools and techniques for analyzing biomolecular (DNA, RNA, protein) sequences, structures, and quantitative data arising from biological experiments. Students will also learn about the major databases and repositories of bioinformatics information. No background in Computer Science will be expected. However, knowledge of basic molecular biology and genetics will be useful.

Topics
Fundamentals of Biology, Statistics, the Internet, and Bioinformatics •
Databases and Software Packages: GenBank, SwissProt, BioPerl.
• Sequence Alignment, Multiple Sequence Alignment: BLAST, CLUSTAL
• Sequencing, Assembly & Applications: VELVET
• Pattern Discovery: PROSITE, Pfam,
• Predictive Machine Learning Tools: HMMPro, GeneCluster, SVMLite.
• Gene Regulation; Predicting Regulatory Elements: RegulonDB
• Analysis of Gene Expression Data: MAS, GeneSpring
• Ontology and Pathways – Databases and Analysis: GO, KEGG
• Genomics, Proteomics, Comparative Genomics: GreenGenes
• Phylogenetic Analysis: PHYLIP, PAUP
• Molecular Structural Analysis – RNA & Proteins: RASMOL, DALI
• Genetics and Genome-Wide Association Schemes
• Single Nucleotide Polymorphisms and SNP Databases
• Advanced Topics: RNAi, Alternative Splicing, Epigenetics
The course will contain a lab component to learn Bioinformatics analysis tools.

Textbook
Bioinformatics and Functional Genomics, J. Pevsner, Wiley-Blackwell, 2nd Edition,
ISBN: 978-0-470-08585-1

Last Update
Giri Narasimhan 9/13/2012

CIS-5027 Computer Systems Fundamentals

Catalog Description
Fundamentals concepts of IT Systems: operating systems, networking, distributed systems, platform technologies, web services and human-computer interaction. Covers design principles, algorithms and implementation techniques. (3 credits)

Prerequisites
SCIS Graduate Standing

Type
Required for MSIT

Course Objectives
This course provides a thorough understanding of fundamentals of computer-based information systems and how they are used in modern enterprise systems. It introduces the fundamentals of operating systems, networking systems, distributed systems, and web services. It explores the hardware, software, and network components of typical information systems and provides some in depth description of their design principles, algorithms and implementation techniques.

Topics
Introduction of Computer Systems
System Models
Operating system support
Optimizing Program Performance
The Memory Hierarchy
Linking
Exceptional Control Flow
Virtual Memory
Mobile and Ubiquitous Computing
Web Services

Textbook
George Coulouris, Jean Dollimore, and Time Kindberg, *Distributed Systems: Concepts and Design, Fourth Edition,* (Pearson Addision Wesley, 2005).

Randal E. Bryant and David R. O'Hallaron, *Computer Systems: A Programmer's Perspective, 2nd Edition*, (Pearson Addision Wesley, 2010).

Last Update
Shu-Ching Chen 8/30/2012

CIS 5346 Storage Systems

Catalog Description
Introduction to file and storage systems, storage system components, storage architecture, devices, trends and applications, performance, RAID storage, Flash-based storage (SSDs), file-systems, I/O scheduling, distributed storage, and storage management.

Prerequisites
COP 4610 (Operating Systems Principles) or equivalent.
CDA 4101 - Computer Organization or equivalent

Type
Elective for CS Master and PhD students

Course Objectives
In this class, we examine storage systems in detail, starting from its individual components to how large-scale storage systems are built. We will learn how to manage storage systems, how they relate to the rest of the computer system, and how to design storage solutions for both general and specific applications. To learn about storage systems, we will use the Linux operating system as a concrete evaluation case-study throughout the course.

This class will be part instruction and part seminar-style learning based on reading, understanding, evaluating, and presenting both classic and current research in storage systems. Each student will need to extensively prepare for and lead the discussion for 1 research paper to the entire class during the semester. In addition, each student will also submit 4 paper summaries and participate significantly in the other paper readings. Paper readings will be assigned for most of the weeks ahead of time and requires each student to have read the paper prior to class.

Each student will also work on a individual warm-up project and a semester project (as part of a group). Projects will be of a research orientation having the potential to eventually lead to a research publication. Deliverables related to the semester project are a formal Project Proposal, Mid-term Project Report, and a Final Project Presentation and Document.

Topics

* Introduction to Storage Systems
* Storage Devices
* Storage System Architecture
* Storage Interconnects and Interfaces
* Disk Drive Architecture
* Disk Profiling
* RAID Systems
* Flash-based Storage (Solid-state Drives)
* Storage System Quality of Service

* File-systems
* Operating Systems Storage Management
* Storage Area Networks and Network-Attached Storage
* Large-scale Storage Systems
* Emerging Storage Technologies and Future Trends

Textbooks

Basic material will be provided by the instructor. Advanced material will be mostly from recent research papers in the area of Storage Systems. The following reference books will also be used:

1. Linux Kernel Development, Third Edition, Robert Love, Addison Wesley
2. Operating System Concepts, Seventh Edition, Avi Silberschatz, Peter Baer Galvin, Greg Gagne, John Wiley & Sons, Inc.
3. Computer Architecture: A Quantitative Approach, Hennessy and Patterson Morgan Kaufmann; 3rd edition (May 15, 2002)

Last Update

Raju Rangaswami 10/24/2012

CIS-5372 Fundamentals of Computer Security

Catalog Description
Information assurance algorithms and techniques. Security vulnerabilities. Symmetric and public key encryption. Authentication and Kerberos. Key infrastructure and certificate. Mathematical foundations. (3 credits)

Prerequisites: SCIS Graduate Standing

Type: Required for MSIT

Course Objectives
This course provides an in-depth understanding into the fundamental concepts of computer security. It covers basic cryptography, including symmetric and public key cryptosystems as well as key management and distribution and user authentication. It provides an introduction to digital signatures, hash functions, message authentication codes and their application to message and user authentication. The course further focuses on software vulnerabilities and the malware exploiting them. It introduces the basic concepts of access control as well as network security and privacy.

Topics
Basic computer security concepts, threat models, common security goals
Key management and distribution, certificates, x509
Authentication protocols including Needham-Schroeder, Kerberos, Denning-Sacco, Woo-Lam
Cryptography and cryptographic protocols
Symmetric cryptography
Public key cryptography
Digital signatures
Hash functions
Message authentication codes
Vulnerabilities, including buffer overflows and incomplete mediation.
Malware, including viruses, worms, trapdoors, rootkits, trojan horses and covert channels
Access control
Network security
Concepts of privacy and anonymity

Textbook
William Stallings. *Cryptography and Network Security, 5th Edition* (Prentice Hall)

Charles P. Pfleeger and Shari Lawrence Pfleeger. *Security in Computing, 4th Edition* (Prentice Hall)

Last Update
Bogdan Carbunar, 8/30/2012

CIS-5373 Systems Security

Catalog Description
Risk, Trust, and Threat models; Types of Attacks; Safe Programming Techniques; Operating System Mechanisms; Virtual Machine Systems; Hardware Security Enforcers; Application Security; Personal Security. (3 credits)

Prerequisites
SCIS Graduate Standing
CIS-5372 Information Assurance

Type
Elective for MSIT and MSTN

Course Objectives
The basic computer infrastructure, ranging from consumer desktops to business servers are under continual attack from a variety of miscreants (or "hackers") for both fun and monetary gain. The design of computer systems have allowed many vulnerabilities to exist and the attacks exploit these vulnerabilities for stealing private information, perform unauthorized operations, destroy data and such. Computer Systems Security covers the art of countermeasures to attacks to general purpose systems, operating systems, applications and the end-user. The topics provide the student a keen insight into the methods employed by the miscreants, the loopholes that exist and how they come about and the methodology to prevent and defend against such attacks.

Topics
Security basics
Host security
Malware
High-level network security
Web security
Security models and practice
Distributed applications security

Textbook
Michael T. Goodrich and Roberto Tamassia. *Introduction to Computer Security*. (Pearson Addison Wesley, 2010)

Last Update
Jinpeng Wei 9/12/2012

CIS-5027 Information Security and Privacy

Catalog Description
Information Security Planning, Planning for Contingencies, Policy, Security Program, Security Management Models, Database Security, Privacy, Information Security Analysis, Protection Mechanism. (3 credits)

Prerequisites: CIS-5372

Type: Can be an elective for MSCS, MSIT, and Ph.D. students.

Course Objectives
This course provides an in-depth understanding of the concepts of privacy and security in distributed environments. It introduces the fundamental building blocks, including secret sharing, bit commitment, fair coin flips and zero knowledge protocols as well as the basic concepts of symmetric and public key cryptography. It the applies these building blocks to explore more complex privacy and security constructs, including oblivious transfer and private information retrieval, digital payment technologies, anonymizers, network and web security and privacy.

Topics
Secret sharing
Time stamping
Bit commitment
Fair coin flips
One-way accumulators
Zero knowledge proofs
Cryptography and cryptographic protocols
Symmetric cryptography
Public key cryptography, including RSA, ElGamal.
Oblivious transfer
Oblivious signatures
Private information retrieval. Blind
signatures
Digital payments.
Anonymizers, mixnets. Case studies: Tor, Crowds, etc.
Network security and privacy
Web security and privacy

Textbook
Bruce Schneier. *Applied Cryptography 2nd Edition* (John Wiley and Sons)
Charles P. Pfleeger and Shari Lawrence Pfleeger. *Security in Computing, 4th Edition* (Prentice Hall)

Last Update
Bogdan Carbunar, 8/30/2012

CIS-6930 Informatics for Smart Health and Well-being (3 credits)

Catalog Description
The class explores recent research advances in the field of health informatics, smart health and well-being, with a special emphasis on personal health informatics.

Prerequisite Graduate Standing.

Type
Elective for CS Master and PhD students
Particularly relevant for the Intelligent systems and Cognitive Science tracks

Course Objectives
Western health care and medicine aim at curing established diseases, and recently they have become interested in promoting proactive and preventive care as well. Health informatics can help provide preventive care in a variety of ways. This course discusses latest progress on research in smart health and well-being technologies, personalized health and medical informatics from a patient-centered and consumer perspective, health dialog systems, as well as the development of virtual patients for training healthcare personnel.

Sample Topics Covered
- Scope, societal needs, promises and challenges of smart health and well-being
- Consumer and clinician health information needs and use
- Patient education, learning and involvement
- Computational support for patient-centered and evidence-based care
- Disease profiling and personalized treatment
- Lifestyle profiling and personalized/tailored behavior change interventions
- Motivational and mobile approaches to increasing healthy lifestyles and better self-care
- Health dialog systems and embodied conversational agent
- Computer-based therapy for mental health
- Virtual and augmented reality for healthcare
- Virtual patient modeling for learning, practicing and demonstrating care practices
- Computer Systems for telemedicine
- Assistive devices and tools for individual with special needs
- Health informatics for cultural diversity

Text
- A collection of articles available online which may vary each year.

Last Update
Christine Lisetti 9/17/2012

CIS-6931 Special Topics - Advanced Topics in Information Processing

Catalog Description
Selected special topics in information processing. (3 credits.)

Prerequisites
Permission of the instructor.

Type
Advanced graduate course

Course Objectives
Awareness of frontiers of the current science of Information Processing.
Learn how to read, present and analyze conference style paper.
Identify and define a problem related to a predefined research topic. Write a conference style paper.

Topics

Topic change annually. A recent offering of this course included the following topics.

- ALM (Application Life-circle Management) in Modern Practical Software Engineering
  Case Study: Team System for TerraFly development.
- Rich Internet Application #1: Flash + Internet-based API Case Study: Terrafly API.
- Rich Internet Application #2: AJAX Application Case Study: TerraFly Realtor + Water
- Mobile Application development
  Case Study: TerraFly Android, Window Mobile, iPhone Map application.
- Social Network Application
  Case Study: TerraFly Social network application for Realtors.
- Large volume/High performance Spatial Map Engine Case Study: TerraFly Map Engine. Storage, index, Query,
- Large volume/High performance Spatial Raster Engine Case Study: TerraFly Imagery Engine. Storage, index, Query
- High Availability system
  Case Study: TerraFly Network load balance, Auto-Fail over, Monitoring, backup, Hyper-V tech.
- Spatial Data Processing
  Case Study: STREE, Property Analysis project, data merging
- Spatial Data Processing
  Case Study: Spatial Keyword Search Engine (SKS)
- Building a High quality application Case Study: TerraFly Qualtiy Assurance
- Build N-Ties Architecture and Design pattern Case Study: TerraFly architecture.

- Software configuration management: Source code version, promotion strategy and release management
  Case Study: Terrafly Team development
- High quality coding
  Case Study: coding in Terrafly Projects
- Building Fast Web application: N-tie Architecture, MVC & design pattern, ASP.Net, PHP, JSP
  Case Study: TerraFly Social Realtor, budget Survey Projects etc.

Textbook
Research papers to be distributed

Last Update
Naphtali Rishe 9/19/2012

Catalog Description: This course introduces graduate students to key concepts and techniques underlying the design and engineering of distributed computing systems. Topics covered in this course include interprocess communication, remote invocation, distributed naming, distributed file systems, security, distributed clocks, process coordination, concurrency control, consistency and replication, and fault-tolerance. Also included is an introduction to grid/cloud computing and autonomic computing.

Credits: 3

Prerequisites: Undergraduate courses on operating systems and networking

Goals: To prepare students for graduate work or software development directed at grid/cloud computing and distributed information processing

Outcomes: Students who successfully complete the course will understand the fundamental issues involved in the design of distributed computing systems

Textbook: Andrew S. Tanenbaum, Maarten van Steen, Distributed Systems: Principles and Paradigms, 2nd edition, Prentice Hall, ISBN-10: 0132392275 ISBN-13: 9780132392273

Grading: Based on exams and a project. Failing grade given in case of academic dishonesty. FIU student honor code applies.

Topics:

	Lectures
Architectures (layers, tiers, peers, middleware, management,…)	2
Communication (Layered Protocols. Remote Procedure Call …)	3
Processes (Threads. Clients. Servers. Code Migration. Agents)	3
Naming (Naming Entities. Mobile Entities. Removing Entities…)	3
Synchronization (Logical Clocks. Global State. Distributed Transactions…)	4
Consistency and Replication (Models, Protocols, Examples…)	4
Fault Tolerance (Process Resilience. Reliable Communication. Recovery…)	3
Security (Secure Channels. Access Control. Security Management…)	3
Distributed File and Web-based Systems (Sun NFS. WWW, …)	3
Introduction to grid/cloud computing and autonomic computing	2
Exam and project presentations	3

CEN-6502 Concurrent & Distributed Systems

Catalog Description

Study of the major aspects of concurrent and distributed systems. Topics include foundations of concurrent computation, languaages and tools for concurrent systems, distributed real-time systems, distributed multimedia systems, and concurrent objectoriented systems. (3 credits)

Prerequisites

COP 5611

Type

Elective graduate courses

Course Objectives

This is an advanced research seminar course, which will be taught differently from basic courses. The objective is to provide students with both basic and advanced knowledge in the areas of concurrent & distributed systems and broad research skills to start their research career, which include, for example, basic research methodologies, how to search research publications, how to read/critique papers, how to develop and formulate research ideas, how to carry the ideas through toward publishable results, how to write research papers, how to conduct effective technical presentations, and so on.

Topics

- Distributed algorithms
- Inter-process communication
- Models of distributed computing
- Distributed middleware and component technologies
- Internet-based computing
- Web services
- Security for distributed systems
- Wireless communication and computing
- Distributed multimedia communication and systems

Textbook

Handouts will be provided

Last Update

Shu-Ching Chen 10/30/2012

COP-5614 Operating Systems

Catalog Description
This course discusses Operating Systems design principles, algorithms and implementation techniques, which include process and memory management, file systems, disk and I/O systems, communications and security. It can serve as the foundation for more advanced computer systems courses. (3 credits)

Prerequisites
SCIS Graduate Standing

Type
Required for MSCS and Ph.D. students
Elective for MSIT and MSTN

Course Objectives
This graduate level OS course serves as an introduction to modern systems understanding. Essential topics of operating and distributed systems are covered in breadth to lay the foundation for advanced courses, such as advanced operating systems and distributed systems.

Topics
OS structures
Processes and threads
CPU scheduling
Synchronization and deadlock
Memory management
Virtual memory
File systems interface and implementation
Mass-storage structure
I/O systems
Protection and Security

Textbook
Abraham Silberschatz, Peter B. Galvin, Greg Gagne. *Operating System Concepts, 8th Edition*, (John Wiley and Sons, 2009).

Last Update
Jinpeng Wei 9/12/2012

COP-5621 Compiler Construction

Catalog Description
Basic techniques of compilation; scanning; grammars and LL and LR parsing, code generation; symbol table management; optimization. (3 credits)

Prerequisites
MAD 3512 and CEN 4010.

Type
Elective for MSCS, MSIT, and MSTN.
Ph.D. students must take either this course or CEN 5011.

Course Objectives
Students will learn about the technology underlying modern compilers by developing a compiler for a subset of Java, called MiniJava. MiniJava is a small, but expressive, object-oriented language designed especially for a student compiler project. The compilers will be written in Java, using tools similar to the well-known Unix tools lex and yacc for lexical analysis and parsing, respectively. The compilers will have a sophisticated "back end" to generate good SPARC assembly language code.

Topics
Lexical Analysis
LR Parsing
Abstract Syntax Trees
Type Checking
Activation Records
Translation to Intermediate Code
Instruction Selection

Textbook
Andrew W. Appel with Jens Palsberg, *Modern Compiler Implementation in Java, Second Edition* (Cambridge University Press, 2002).

Last Update
Geoffrey Smith 10/3/2012

COP-5725 Principles of Database Management Systems

Catalog Description
Overview of Database Systems, Relational Model, Relational Algebra and Relational Calculus; SQL; Database Applications; Storage and Indexing; Query Evaluation; Transaction Management; Selected database topics will also be discussed. (3 credits)

Prerequisites
COP4540

Type
Required for MSCS

Course Objectives
This is a graduate level course that introduces the principles of database management systems. After the students successfully finish this course, they should have a better understanding on different aspects of a database management system. They should also be familiar with relational model, SQL, storage and indexing, query evaluation, transaction management, and some selected topics.

Topics

- Database Design
- Relational Model
- Relational Algebra and Calculus
- Schema Refinement and Normal Forms
- SQL
- Indexing and Storage
- Query Evaluation and Optimization
- Transaction Management
- Concurrency Control
- Crash Recovery

Textbook

Raghu Ramakrishnan and Johannes Gehrke. Database Management Systems. Third Edition, McGraw Hill, 2003. ISBN: 0-07-246563-8.

Last Update Tao Li 10/30/2012

COP 6556 – Semantics of Programming Languages

Catalog Description
This course provides an overview of systematic and effective approaches to programming abstraction; formal specification techniques; program verification and; semantics of programming languages. (3 credits)

Prerequisites
Students need to know discrete mathematics such as set, functions, and logic. Knowledge of abstract computational models (covered in COT 5420) will be very helpful. Knowledge of some high-level programming languages is also useful.

Type
Can be an elective for MSCS, and Ph.D.

Course Objectives
COP 6556 is a graduate-level course on formal semantics of programming languages. Students will learn the fundamental concepts and approaches in defining the formal semantics of programming languages. These formal approaches lay the foundation for understanding, designing, and implementing new programming languages, and for ensuring program correctness.

Topics
Basic Mathematical Concepts: Logic, Sets, Functions, Relations, Partially Ordered Sets
Semantics of Sequential Programs – Operational Semantics
Principles of Induction and Inductive Definitions
Semantics of Sequential Programs – Denotational Semantics
Semantics of Sequential Programs – Axiomatic Semantics
Completeness of the Hoare Rules
Introduction to Domain Theory
Recursion Equations
Techniques for Recursion
Languages with Higher Types
Recursive Types
Nondeterminism and Parallelism

Textbook
Glynn Winskel, *The Formal Semantics of Programming Languages – An Introduction*, The MIT Press 1993.

References
Eike Best, *Semantics of Sequential and Parallel Programs*, Prentice-Hall International, 1996.

Last Update
Xudong He 9/8/2012

COP-6611 Advanced Operating Systems

Catalog Description
Advanced topics in operating system design; microkernel; memory architecture; multiprocessor issues; multimedia operating systems; case studies. (3 credits)

Prerequisites
Graduate standing

Type
Elective for M.S. and Ph.D. students

Course Objectives
Students will learn selected advanced operating systems topics and accomplish a termlong research project.

Topics
Virtual Machines, Distributed Systems, Cloud computing

Textbook
N/A

Last Update
Ming Zhao 9/15/2012

COP-6727 Advanced Database Systems

Catalog Description
Design, architecture and implementation aspects of DBMS, distributed databases, and advanced aspects of databases selected by the instructor. (3 credits.)

Prerequisites
SCIS Graduate Standing; an undergraduate database course.

Type
Advanced graduate course

Course Objectives
Become familiar with advanced modeling, architectural, implementation, and theoretical aspects of database management and information retrieval.

Learn how to read, present and analyze conference style paper

Identify and define a problem related to a predefined research topic

Write a conference style paper

Topics
Database design
Spatial Databases
Cloud Databases
Distributed Databases
Database Virtualization
Advanced semantic aspects of databases Streaming
data query and analysis
Medical, Health and Personal Databases
Integration and data analysis of heterogeneous databases
Web Search and Information Retrieval
XML
Semantic Web and Mashups
Web page analysis and summarization

Textbook
Research papers to be distributed

Last Update
Naphtali Rishe 9/18/2012

COT-5420 Theory of Computation I

Catalog Description
Mathematical models of computation; regular, context-free, recursive, and recursively enumerable languages; equivalence of models; techniques for proving non-membership of a language in a class: pumping lemmas, diagonalization, reductions. (3 credits)

Prerequisites
MAD 3512 - Theory of Algorithms

Type
Required for MSCS, Ph. D. in CS, MS in CS for current CS undergraduate students (4+1 Program).

Course Objectives
The course provides a thorough description of the mathematical models of computation starting with the regular languages and ending with the un- decidable languages. The student will learn to construct a grammar that generates a given language, design a machine that accepts it, and prove that the answers are correct.

Topics
determininistic and non-deterministic finite automata regular expressions regular languages the equivalence of the finite automata, regular expressions, and regular languages the pumping lemma for regular languages context free languages the Chomsky normal form for a context free language pushdown automata the equivalence of the context free languages and the pushdown automata the pumping lemma for context free languages Turing machines variants of Turing machines decidable languages diagonalization and the halting problem undecidable languages reducibility primitive recursive functions recursive and recursively enumerable functions

Textbook
Michael Sipser Introduction to the Theory of Computation, Third Edition (Cengage Learning, 2013)

Last Update
Alex Pelin 5/20/2013

COT-5407 Introduction to Algorithms

Catalog Description
Design of efficient data structures and algorithms; analysis of algorithms and asymptotic time complexity; graph, string, and geometric algorithms; NP-completeness. (3 credits)

Prerequisites
SCIS Graduate Standing

Type
Required for MSCS
Elective for MSIT and MSTN
Ph.D. students should take COT-6405

Course Objectives
Students will learn techniques for designing efficient algorithms, for elementary analysis of algorithms, for proving lower bounds, and for proving intractability.

Topics
Recurrence Relations and Analysis of Algorithms
Incremental and Divide-and-Conquer Algorithms
Sorting and Order Statistics
Lower Bound Arguments
Basic data structures: trees, hash tables, priority queues, union/find
Graphs & Graph Algorithms
Dynamic Programming & Greedy Algorithms
NP-Completeness

Textbook
Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, *Introduction to Algorithms, Third Edition*, (MIT Press, 2009).

Last Update
Mark Weiss 8/30/2012

COT-6405 Analysis of Algorithms

Catalog Description
Design of advanced data structures and algorithms; advanced analysis techniques; lower bound proofs; advanced algorithms for graph, string, geometric, and numerical problems; approximation algorithms; randomized and on-line algorithms. (3 credits)

Prerequisites
SCIS Graduate Standing, esp., Data Structure, Computer Programming, Algebra, Probability Analysis

Type
Required for MSCS
Elective for MSIT, MSTN, and Ph.D. students

Course Objectives
Students will learn both the elementary and advanced techniques for efficient algorithm design along with asymptotic analysis of running time or cost and intractability proof for real problems.

Topics
Introduction: Asymptotic Analysis
Divide-and-Conquer Paradigm & Randomized Algorithms
Sorting Algorithms
Advanced Data Structures
Dynamic Programming, Greedy Algorithms, & Amortized Analysis
Graph Algorithms
String Matching
Geometric Algorithms
NP Completeness
Approximation Algorithms

Textbook
Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, *Introduction to Algorithms, Third Edition*, (MIT Press, 2009).

Last Update
Wei Zeng 8/30/2012

COT 6421 – Theory of Computation II

Catalog Description
Advanced computability theory; diagonalization and reductions; applications of computability theory to logic; computational complexity; the classes P, NP, and PSPACE; polynomial-time reductions and completeness. (3 credits)

Prerequisites
Students need to know discrete mathematics such as set, functions, and logic; and abstract computational models such as finite automata and Turing machines. (COT 5420)

Type
Can be an elective for MSCS, MSIT, and Ph.D.

Course Objectives
Students will learn the fundamental concepts in computability and complexity. Students will learn the major techniques to show (un)decidability and complexity.

Topics
Abstract Computation Models Revisited
The Church-Turing Thesis
Decidability & Reducibility
Advanced Topics in Computability
Time Complexity
Space Complexity
Intractability
Advanced Topics in Complexity

Textbook
Michael Sipser, *Introduction to the Theory of Computation*, 2nd edition, The MIT Press, 2006.

Last Update
Xudong He 9/8/2012

COT-6931 Topics in Cognitive Science (3 credits)

Catalog Description
A "top-down" view of Computer Science, in particular artificial intelligence, by studying the computational aspects of human cognition.

Prerequisites
Permission of the instructor.

Type
Elective for CS Master and Ph.D. students
Particularly relevant for the Intelligent Systems and Cognitive Science PhD tracks

Course Objectives
The course objectives are to understand and discuss answers to questions such as, "What is artificial intelligence and is it possible?" and "How does the human mind work and what can computers teach us about it?" Students learn about the limitations of existing computer programs and compare them to human memory, learning, and language capabilities.

Sample Topics Covered
- Foundations of cognitive science
- Human memory
- Meaning and mental representations
- Representation and computation
- Language, linguistics and semantics
- Computational linguistics
- Innateness and connectionist perspective on development
- Physiology of behavior
- Embodied cognition
- Emotions and consciousness
- Situated cognition

Textbook
- Paul Thagard. *Mind: Introduction to Cognitive Science*. MIT Press, Second Edition, 2005, ISBN 0-262-70109-X
- William Clancey. *Situated Cognition, On Human Knowledge and Computer Representations*. Cambridge University Press, 1997.
- A collection of articles available online which may vary each year.

Last Update
Christine Lisetti 9/17/2012

TCN-5030 Computer Communications and Networking Technologies

Catalog Description
Teaches the dynamics related to computer communications, how computers are grouped together to form networks, various networking implementation strategies, and current technologies. (3 credits)

Prerequisites
SCIS Graduate Standing

Type
Required for MSTN

Course Objectives
This course provides an introduction to the concepts and principles of computer communications and networks. Students will understand the architectures, protocols, and techniques in different layers of the Internet protocol stack. In addition, students will learn fundamental network programming and analyzing skills.

Topics
Introduction
Application Layer
Transport Layer
Network Layer
Link Layer and Local Area Networks
Multimedia Networking
Network Management

Textbook
James Kurose and Keith Ross, Computer Networking: A Top Down Approach (6th Edition), Addison-Wesley, 2012.

Larry Peterson and Bruce Davie, Computer Networks: A Systems Approach (5th Edition), Morgan Kaufmann, 2011.

Andrew Tanenbaum, Computer Networks (5th Edition), Prentice Hall, 2011.

Last Update
Deng Pan 8/30/2012

TCN-5080 Secure Telecommunications Transactions

Catalog Description
Telecom and information security issues such as: digital signatures, cryptography as applied to telecom transactions, network policing, nested authentication, and improving system trust. (3 credits)

Prerequisites
TCN-5030 or permission of the instructor.

Type
Required for MSTN

Course Objectives
This course provides an in-depth understanding of the threats, principles, and mechanisms in network security. Students will study cryptographic algorithms and their applications in security protocols in different layers of the Internet protocol stack. Students will also learn to determine appropriate security mechanisms for specific network applications.

Topics
Symmetric Key Encryption
Public Key Encryption
Hash Functions
Message Authentication Code
Digital Signatures
Authentication Protocols
IP Security
Email Security
Web Security
Firewalls

Textbook
Charlie Kaufman, Radia Perlman, and Mike Speciner, Network Security: Private Communication in a Public World (2nd Edition), Prentice Hall, 2002.

William Stallings, Cryptography and Network Security (5th Edition), Prentice Hall, 2010.

Matt Bishop, Introduction to Computer Security, Addison-Wesley, 2004.

Last Update
Deng Pan 8/30/2012

TCN-5421 Theory of Networked Computation

Catalog Description
Fundamental mathematical models of general and networked computation: finite state automata, regular languages, decidability; stochastic processes, Markov chains, queueing theory. (3 credits)

Prerequisites
SCIS Graduate Standing

Type
Elective for MSTN, Core option for PhD

Course Objectives
This course provides an in-depth understanding of the theoretical foundations for networked computation. In addition to various models of general computation, such as finite state automata and decidability theory, students will also learn mathematical background for stochastic processes and queueing models.

Topics
Introduction
Finite State Automata
Regular Languages
Decidability
Random Variables
Stochastic Processes
Markov Chains
Queueing Analysis of Computer Systems

Textbook
Michael Sipser, Introduction to the Theory of Computation (3rd Edition), Course Technology, 2012.

D. Gross, J. Shortle, J. Thompson, and C. Harris, Fundamentals of Queueing Theory (4th Edition), Wiley, 2009.

Last Update
Deng Pan and Shaolei Ren 11/6/2012

TCN-5445 Telecommunication Network Programming

Catalog Description
Advanced telecommunications network programming skills including Router and Bridge Software, socket programming and protocol handler. (3 credits)

Prerequisites
SCIS Graduate Standing

Type
Elective for MSTN, Core option for PhD

Course Objectives
This course teaches network programming from a system perspective and uses UNIX/Linux as an example. It provides students with essential network and system programming skill training. In addition to socket programming, students will also learn in depth the system fundamentals, including I/O, multi-threading, IPC, synchronization, and shared memory.

Topics
Introduction
TCP and UDP Socket Programming
I/O Multiplexing
Name and Address Conversions
Daemon Processes and the inetd Superserver
Nonblocking I/O
Routing Sockets
Broadcasting and Multicasting
Multi-threading
Interprocess communication
Synchronization: Mutexes and Semaphores
Shared Memory
Remote Procedure Calls

Textbook
W. Richard Stevens, Bill Fenner, and Andrew M. Rudoff, UNIX Network Programming, Volume 1: The Sockets Networking API (3rd Edition), Addison-Wesley Professional, 2003

W. Richard Stevens, UNIX Network Programming, Volume 2: Interprocess Communications (2nd Edition), Prentice Hall, 1999.

Last Update
Deng Pan 10/8/2012

TCN-5640 Telecommunications Enterprise Planning and Strategy

Catalog Description
Methodologies for re-engineering, project management, strategic planning, change management, RFPs, and life-cycle management within the telecommunications and IT arena.

Prerequisites
Graduate Standing / permission of the instructor.

Type
Required for MSTN

Course Objectives
This course examines theory and practice of telecommunications enterprise planning and strategy processes. Learning outcomes include familiarity with the essential requirements for the successful planning of a new telecommunications and networking venture and essential requirements for the development of a successful telecommunications and networking new venture plan.

Topics
1. Overview of Telecommunications Industry: changes and actors in the telecom industry
2. Strategy in Telecom entrepreneurial companies
3. Telecom product development
4. Developing a Telecom business plan
5. Telecom Market Analysis segmentation & planning
6. Telecom product cycle
7. Assessing Telecom technology ventures
8. Evaluating a telecom business plans
9. Legal issues, corporate governance and fundamentals of intellectual property
10. Case studies

Textbook
All of the assigned required and recommended reading material assigned will be on the class website. Students are responsible for using the Uniform Resource Location (URL) addresses provided on the website to locate the assigned material. The course syllabus itself will be on the Web, with links to all the assigned reading material.

Last Update
Dr. Niki Pissinou 9/1/2012

TCN-6215 Advanced Network Algorithms

Catalog Description
This course will cover algorithms that are used in network research and implementation. (3 credits)

Prerequisites
SCIS Graduate Standing

Type
Elective for MSTN

Course Objectives
Students will study advanced network algorithms to solve research problems or implementation challenges. Students will learn to design efficient and practical algorithms for specific problems in wired and wireless networks.

Topics
Graph Theory
Computational Geometry
Maximum Flow
Combinatorial Optimization
NP Completeness
Queuing Theory
Fair Queuing Algorithms
Switch Scheduling Algorithms

Textbook
Thomas Cormen, Charles Leiserson, Ronald Rivest, and Clifford Stein, Introduction to Algorithms (3rd Edition), MIT Press, 2009.

Steve Skiena, The Algorithm Design Manual (2nd Edition), Springer, 2010.

Last Update
Deng Pan 8/30/2012

TCN-6260 Internetworking

Catalog Description
The course will discuss advanced topics, current trends and control of internetworking. An analytical and descriptive approach will be used to cover the subject of internetworking. (3 credits)

Prerequisites
SCIS Graduate Standing

Type
Elective for MSTN

Course Objectives
This course provides an in-depth understanding of the internetworking techniques of the current Internet. Students will study various routing and switching algorithms and protocols, including intra-/inter-AS routing, router/switch architecture, switch scheduling, and traffic engineering. Students will also learn hands-on operation with typical routers/switches.

Topics
Introduction
Routing Algorithms
Network Flow Optimization
Routing Protocols
IP Address Lookup
Packet Classification
Switch Architecture
Packet Queuing and Scheduling
Traffic Conditioning

Textbook
Deepankar Medhi and Karthikeyan Ramasamy, Network Routing: Algorithms, Protocols, and Architectures, Morgan Kaufmann, 2007.

H. Jonathan Chao and Bin Liu, High Performance Switches and Routers, Wiley-IEEE Press, 2007.

Last Update
Deng Pan 8/31/2012

TCN-6270 Mobile and Wireless Networks

Catalog Description
Techniques in the design and operation of wireless networks; LANs, MANs, and WANs; analytical models; application of traffic and mobility models; mobility control, and wireless ATM. (3 credits)

Prerequisites
TCN-5030 or equivalent

Type
Elective for MSTN, MSCS, MSIT, and Ph.D. students.

Course Objectives
This course provides students with fundamental knowledge and key techniques in the design and operation of mobile and wireless networks. Focusing on the upper layers for various wireless networks, this course covers analytical models, routing algorithms, scheduling algorithms and MAC protocols, congestion control algorithms, cross-layer design, QoS provisioning as well as selected topics in cutting-edge wireless networking research.

Topics
Transmission fundamentals
Communication networks
Satellite communications
Cellular networks
Mobile IP and WAP WLANs
Introduction to PHY
Cross-layer design
Introduction to optimization and its application in communication networks Selected topics in wireless networking research

Textbook
William Stallings, *Wireless Communication and Networks, 2nd Edition*, (Prentice Hall 2005).

Last Update
Shaolei Ren 8/30/2012

TCN-6275 Mobile Computing

Catalog Description
Enabling technologies and impediments of mobile computing. (3 credits)

Prerequisites
Graduate Standing / permission of the instructor.

Type
Required for MSTN

Course Objectives
The course explores enabling technologies and impediments of mobile computing Cellular systems are described in multiple generations (2G, 3G, 4G) including emerging fifth-generation, providing a range of mobility management solutions. Impediments of the mobile environment will be covered. The course also explores research issues in pervasive computing and its close relative, ubiquitous computing. It examines a young but rich body of exciting ideas, solutions, and paradigm shifts. Many traditional areas of telecommunications, networking, computer science and engineering, information technology and others are impacted by the constraints and demands of mobile and pervasive computing including but not limited to energy management. Hence problems and limitations due to such impediments will be explained. We will review recent literature in each of these categories and will identify problems that we will attempt to solve. The course will be to understand the literature, define new problems, provide solutions, and finally provide evaluation of the solutions. The objective of the course is threefold: (1) expose you to important prior results in the field. (2) illustrate current trends, advancements and future direction (3) give you practical experience in the area through the design and execution of a modest research project.

Topics include mobile networking, personal communication systems, smart devices, and mobile applications

Topics
1. Introduction
2. Research Road Map
3. Constraints and Demands of Mobile Computing
4. Emerging mobile computing paradigms
5. Personal Communication Systems
6. 2.5 Generation Cellular Systems (GSM)
7. Mobility Management
8. Location Tracking Systems
9. Evolution to 3G, 4G systems (UMTS, LTE)
10. 5G Cellular Systems
11. Wireless networks and location management
12. Ad-hoc networks

13. Security issues in mobile ad-hoc networks
14. Pervasive/Ubiquitous Computing
15. Case Studies
16. Emerging Standards

Textbook

This course has no textbook; instead, we will cover a number of original research papers. It is very important that you read and digest each paper. The class website contains links to references and other material that will help the student digest the material presented in class.

Last Update

Dr. Niki Pissinou 9/1/2012

TCN-6420 Modeling and Performance Evaluation of Telecommunication Networks

Catalog Description
This course covers methods and research issues in the models and performance evaluation of high-speed and cellular networks. Focuses on the tools from Markov queues, queuing networks theory and applications. (3 credits)

Prerequisites
TCN 5030 (Computer Communications and Networking Technologies) or equivalent.

Type
Elective for MSIT, MSTN and MSCS

Course Objectives
Students will learn techniques for reasoning and analyzing the performance of computer communication and network systems, including mathematical models (e.g., probability and statistics, queuing theory) and simulation.

Topics
- Introduction to performance evaluation
- Measurement techniques and tools
- Probability and statistics
- Simulation
- Queuing models
- Experimental design and analysis
- Other topics of practical/subject matters

Textbook
Discrete Event System Simulation, by Jerry Banks, John Carson, II, Barry Nelson, and David Nicol. Prentice Hall, June 2009. ISBN: 9780136062127.

Last Update
Jason Liu 9/4/2012

TCN-6430 Networks Management and Control Standards

Catalog Description
Protocols for management of telecom networks, including Simple Network Management Protocol and Common Management Information Protocol. Extension of protocols to optimize network performance. (3 credits)

Prerequisites
TCN-5030 or equivalent.

Type
Required for MSTN
System Administration Track Course for MSIT

Course Objectives
This course provides students with a comprehensive view of the network management problem, including its concepts, challenges, dimensions, models and techniques. It covers the network management technologies (e.g., SNMP) widely used today, and also introduces students to the emerging technologies (e.g., OpenFlow) and research in the field.

Topics
Review of important network elements
Scope and challenges of network management
ISO Telecommunications Management Network model and framework for network management (FCAPS)
Simple Network Management Protocol (SNMP)
Software Defined Networking, OpenFlow

Textbook Required:
None

Recommended:
Douglas Comer, *Automated Network Management Systems*, (Prentice Hall, 2006)
Alexander Clemm, *Network Management Fundamentals*, (Cisco Press, 2006)

Last Update
Xin Sun 9/05/2012

TCN 6450 Wireless Information Systems

Catalog Description
Enabling technologies and impediments of wireless information systems. Focuses on software architectures, and information and location management in the wireless environment. (3 credits)

Prerequisites
Graduate Standing / permission of the instructor.

Type
Elective for MSTN

Course Objectives
Enabling technologies and impediments of wireless, pervasive, ubiquitous and wearable information systems. Impediments of the WIS environment will be covered. Then we will be set to explore a young but rich body of exciting ideas, solutions, and paradigm shifts. Problems and limitations due to such impediments will be explained. Students will review recent literature in each of these categories and will identify problems that we will attempt to solve. Our approach will be to understand the area and associated literature, define new problems, provide solutions, and finally provide evaluation of the solutions.

Topics
1. Introduction
2. WIS Models
3. WIS Architectural Design
4. Service Oriented, Context Oriented and Safety Oriented WIS Models
5. Service Discovery models
6. Broadcasting and over the air indexing
7. Mobile Databases
8. Wireless data caching
9. Moving objects
10. Trajectory privacy
11. Trajectory sensor objects
12. Wearable, wireless sensing systems
13. WIS security and privacy
14. Adaptive Mobile Applications
15. Mobile Software Development
16. Models Peer-to-Peer Systems
13. Case Studies
14. Emerging Standards

Textbook

This course has no textbook; instead, we will cover a number of original research papers. It is very important that students read and digest each paper. The class website contains links to references and other material that will help the student digest the material presented in class.

Last Update

Dr. Niki Pissinou 9/1/2012

TCN-6880 Telecommunications Public Policy Development and Standards

Catalog Description
A concept-oriented examination of the domestic and international telecommunications policy processes and standards setting environment. (3 credits)

Prerequisites
Graduate Standing / permission of the instructor.

Type
Elective for MSTN

Course Objectives
This course covers public policy issues related to the telecommunications, networking and Information Technology industries (including the internet) from historical, present and future perspective. It addresses the evolution of the telecom industry public policy, the impact it has on reshaping our world, and the importance of government regulations, management and technical decisions in these industries. Examples include privacy, electronic signatures, digital divide, bandwidth auctions, IP telephone, internet taxation and wireless communication. Students will learn the legal and regulatory history of the industry to better understand the current issues confronting the marketplace. Through lectures, discussions, and project analyses, students gain a basic understanding of how the telecommunications public policy is being developed as well current issues.

Topics
- History & Development of Telecommunications Industry (Why are firms regulated? Natural monopoly and market power, Economies of scale and scope, Public interest concepts and regulatory capture, Regulation vs. antitrust, Network externalities, Overview of services and players (access services, toll, local, other) and how they are regulated (who regulates what?). Traditional rate-of-return regulation and revenue requirement. Value of service pricing. Traditional patterns of cross-subsidy. The early history of telecommunications; the Communications Act of 1934; Partial history after 1934, the 1956 AT&T consent decree.)
- The Slow Development of Competition Before Divestiture
- Divestiture and Access Changes
- Alternative Regulatory Frameworks
- The Telecom Act of 1996 and FCC Orders
- The Economics of Networks and Regulations (Economics of Scale and Scope, Sunk Costs, Barriers to Entry, Unbundled Network Elements)
- Regulation and Deregulation (The Telecom Act of 1996, The effect of government regulation on the framework of competition)
- Competition in Local Services (Facilities Based Competition and regulation-based competition, From Wireline to Wireless)
- Competition for Residential Local and Long Distance (Bundling for Residential Local and Long Distance

- Competition in Mobile and Wireless Communications, Competition in Wireless – Winning Strategies, Mobile Handset Market Value Chain)

- Internet Commerce in a Wireless World
- Competition where the Service Look to be increasingly like a Commodity with Little Differentiation
- Auction Theory (Is spectrum truly scarce? Does auctioning spectrum benefit the consumers?)
- Global Competition and International Regulations (The Act of 2000)
- The Effect of Convergence (Telecom companies, computer hardware & Software companies,
  cable operators to compete for voice and data traffic and integration of networks)
- Emerging Issues – privacy, security, privacy etc.

Textbook

1. Jame Harry Green, The Irwin Handbook of Telecommunications (5^{th} edition), McGraw Hill Professional,
2. International Telecommunication Regulations by ITU
3. Instructor will post readings on the website. When readings are posted, instructor will notify student
4. Most of the supplementary material assigned for each class -- nearly all of it -- will be on the World-Wide Web and class website. Students are responsible for using the Uniform Resource Location (URL) addresses provided on the website to locate the assigned material. The course syllabus itself will be on the Web, with links to all the assigned reading material.

Last Update

Dr. Niki Pissinou 9/1/2012