FIU

FLORIDA INTERNATIONAL UNIVERSITY

Miami's public research university

School of Computing and Information Sciences

Graduate Program

2009-2010

Graduate Program in Computer Science
Florida International University

August 2009

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/policies.html) and deadlines (http://gradschool.fiu.edu/calendars.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/info/, 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:

Ms. Olga Carbonell (ocarbone@cis.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.

Dr. Mark Weiss (weiss@cis.fiu.edu), Graduate Program Director and Graduate Advisor, (305) 348-2036: contact for advising and other graduate academic issues.

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 two 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 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.
- Artificial intelligence, including neural networks, expert systems, automated reasoning, term rewriting systems, and intelligent tutoring systems.
- 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

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 Database and Systems Research Laboratory

Vagelis Hristidis and Raju Rangaswami, Directors

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
- Semistructured 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)

Giri Narasimhan (Head), Tao Li, Vagelis Hristidis

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

4.3 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.

5. 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.html. 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/admissions_deadlines.htm.

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 2460
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 2009-2010, tuition for in-state graduate students is $326.62 (for continuing students) or $340.68 (for new students) per credit for both regular course work and dissertation or thesis credit. In addition there is a $87.20 assessment each semester for the use of the campus health center and athletic fees. Tuition for out-of-state and international graduate students is $830.70 (for continuing students) or $844.76 (for new students) per credit hour for both regular course work and dissertation credit.

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.

5.3.1 Forgiveness Policy

Graduate students may repeat no more than two courses with no course being repeated more than once. The course shall be repeated on a letter grade basis. Only the grade and credit received on the second attempt shall be used in computing the graduate GPA. The original grade will remain posted on the student's permanent record.

5.3.2 Incomplete Grades

An incomplete grade is a temporary symbol given at the discretion of the instructor for work not completed because of a serious interruption not caused by the student's own negligence. An incomplete grade is not to be assigned to dissertation or thesis credits to indicate that the work is in progress. An incomplete grade must be made up within two semesters or it will automatically default to the grade that the student earned in the course. There is no extension of the two semester deadline.

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/policies.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 of 1000 (verbal and quantitative combined), with a minimum quantitative score of 600.

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 6.3 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 with a letter grade or a 3-credit coop course with a letter grade).

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 of 1000 (verbal and quantitative combined), with as minimum quantitative score of 600.
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. IT2 offers thesis and non-thesis options for the Master's Degree. The Master is a multidisciplinary program that offers two tracks:

- **Systems and Networks**: Focuses on technical aspects of the design of data networks, software, and hardware. A student must have a bachelor's in computer science, electrical, computer, or telecommunications engineering, mathematics, physics or related field.

- **Management and Policy**: It provides the necessary education for individuals involved with service providers, large user organizations and government regulators. A student must have a bachelor's degree in engineering, information systems, technology or sciences.

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 213 on the computer-based test (CBT 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. A GPA of a least 3.0 has been earned for certain courses required in the program. 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 all graduate required semester hours of graduate level (not more than 6 with a grade of "B" or better can be transferred from other institution).

Telecommunications and Networking Courses

Network Area:

TCN 6210	Telecommunications Network Analysis and Design
TCN 6230	Optical Networks
TCN 6270	Mobile and Wireless Networks
TCN 6275	Mobile Computing
TCN 6260	Internetworking

Engineering Area:

TCN 5150	Multimedia Computer Communications
TCN 5455	Information Theory

Software Area:

TCN 5440	Software Development for Telecommunications Networks
TCN 5445	Telecommunication Network Programming
TCN 6420	Modeling and Performance Evaluation of Telecommunications Networks
TCN 6430	Networks Management and Control Standards
TCN 6450	Wireless Information Systems

Technology Area:

TCN 5010	Telecommunications Technology Applications
TCN 5030	Computer Communications and Networking Technologies
TCN 5060	Telecommunications Software and Methodologies
TCN 5080	Secure Telecommunications Transactions

Management Area:

TCN 5640	Telecommunications Enterprise Planning and Strategy
TCN 6630	Economics of Telecommunications Systems

Policy Area:

TCN 6820	Telecommunications Industry Development
TCN 6880	Telecommunications Public Policy Development and Standards

7 Ph.D. Program

7.1 Admission to Ph.D. Program

The requirements for admission to the doctoral program in Computer Science are:

A baccalaureate or Master's degree in Computer Science, or equivalent degree in a related field as judged by the School's Graduate Committee.

A minimum of a "B" average on all upper division work and acceptable courses in Calculus and Statistics.

GRE general test score of 1120 (verbal and quantitative combined), with a minimum quantitative score of 650.

Three letters of recommendation from persons in a position to judge the applicant's potential for advanced graduate study in computer science.

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 6.3 overall on the IELTS. TOEFL = Test of English as a Foreign Language (www.toefl.org). IELTS = International English Language Testing System (www.ielts.org).

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 six required courses and at least six elective courses. In addition, the student must earn at least 24 dissertation credits, and 2 credit hours of a seminar course. 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

The following six courses are required and must be completed with a grade of "B" or higher:

CEN 5011	Advanced Software Engineering*
COP 5614	Operating Systems*
COP 5621	Compiler Construction
COP 5725	Principles of Database Management Systems*
COT 5407	Introduction to Algorithms*
COT 5420	Theory of Computation I*

*may be substituted with corresponding 6000-level advanced course with approval of the graduate director.

7.4.2 Elective Courses

In addition, at least six elective courses must be completed with a grade of "C" or higher, maintaining a cumulative GPA of 3.0 or higher. Acceptable courses are listed in Section 9.1. Other courses are acceptable if approved by the graduate program director. The required courses listed in Section 7.4.1 may not be used as an elective.

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 Course Credit

The student must complete at least 2 seminar courses of one credit each.

7.5 Candidacy Examination

The Candidacy Examination is designed to ensure that the student has competency in a chosen broad research area, along with the critical thinking skills necessary to undertake Ph.D.-level research. The research areas that may be chosen depend on the research interests and expertise of the current faculty of the School of Computing and Information Sciences; some recent examples include software engineering and formal methods, software engineering and testing, databases and data mining, algorithms and bioinformatics, distributed systems, computer security foundations, and cognitive science.

The Candidacy Examination is based on a reading list of 8 research papers; it consists of both a written exam and an oral exam.

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,
- 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

Each Candidacy Examination is administered by an Examining Committee consisting of 3 graduate faculty members of the School of Computing and Information Sciences. The Examining Committee is constituted as follows: the student declares a broad area of research interest and suggests 2 committee members (one of whom should be the student's advisor); the Graduate Committee then chooses a third committee member.

The Examining Committee selects the reading list for the examination. The list will consist of 8 papers that broadly sample research in the chosen area; it includes 5 fixed papers, used in every exam within that area, and 3 other papers chosen based on the student's particular research interests. The reading list will be made public no later than the second week of the semester in which the exam is to be held.

The Candidacy Examination will be held no earlier than 10 weeks after the reading list is published. The written exam is held first; it consists of 3 questions and is 2 hours long. The oral exam is held on a subsequent day within one week of the written exam; it ordinarily takes less than 2 hours. In both exams, the student will be expected to answer detailed questions addressing any aspects of the papers in the reading list, including underlying concepts and techniques, as well as relationships among the papers. During the exams, the student may consult the papers (which may be annotated) but no other resources.

7.5.4 Candidacy Examination Results

Passing the Candidacy Examination requires a unanimous vote by the Examining Committee. The Candidacy Examination may not be passed conditionally, or contingent upon other factors, such as the completion of additional coursework or the preparation of extra research projects.

The student will be informed in writing of the result of the Candidacy Examination within 14 days. Upon passing the Candidacy Examination, the student must file Form D-2 with the University Graduate School. Note that a student may enroll for dissertation credits only after being advanced to candidacy.

If the student fails the Candidacy Examination, the student can retake it within one year. Passing the Candidacy Examination is requisite to continuing in the graduate program; students who fail the examination twice will be dismissed from the graduate program.

After passing the candidacy exam, the student's support will be raised if the student is on an assistantship.

7.6 Termination of Ph.D. Candidates

Graduate assistants in the Doctoral program will be terminated if they have not passed the Candidacy Examination within three years, unless an extension is granted by the Graduate Program Director.

Students already advanced to Ph.D. candidacy status 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

After passing the Candidacy Exam, the student will propose to the Graduate Committee Chairperson a Dissertation Committee. This committee has a minimum of 4 members, at least 3 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.

After the proposal is accepted, the student's support will be raised if the student is on an assistantship.

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.

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

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

David Barton, Professor; Ph.D., Cambridge, 1966. Distributed systems and data communications.

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

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, Instructor; M.S., SUNY Albany, 1986. Computer science.

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

Vagelis Hristidis, Assistant Professor; Ph.D., University of California at San Diego, 2004. Information discovery, keyword search in relational and semi-structured databases, performance and semantics of ranked queries, and query caching and containment.

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

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

Tao Li, Associate 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. AI and Cognitive science.

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

Masoud Milani, Associate Professor; Ph.D., Central Florida, 1986. Programming language environments.

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

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

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

Ana Pasztor, Professor; Dr. rer.nat., Darmstadt, 1979. Cognitive science.

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

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

Niki Pissinou, Professor; Ph.D. USC, 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., 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.

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

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

Greg Shaw, 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.

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

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

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

Zhenyu Yang, Assistant Professor; Ph.D., University of Illinois at Urbana-Champaign, 2007. Networking and distributed multimedia systems.

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

Hao Zhu, Assistant Professor; Ph.D., Penn State, 2004. Wireless networks and mobile computing.

9 Graduate Course Offerings

9.1 Regular Scheduled Courses

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 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 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 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: COP 5577 or permission of the instructor.

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 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 Computer Science 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, file-systems, OS storage management. Prerequisite: Graduate standing.

CIS 5372 Information Assurance (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 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 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 5577 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.

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 5716 Software and Data Modeling (3). Essential software and data modeling methods and techniques such as UML, XML, and ER. Prerequisite: Graduate standing.

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-computer science 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 undecidability of computational problems. Prerequisite: MAD 3512.

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 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 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 6935 Graduate Seminar (0). Investigation and report by graduate students on topics of current

interest in telecommunication and networking. Prerequisites: Ph.D. classification and approval of 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 5990 Principles of Network Management
EEL 5991 Internetworking
EEL 6787 Network Security
ISM 6205 Database Management Systems and Design
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 pre-approved 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 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.