School of Computing and Information Sciences

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The School of Computing and Information Sciences offers both undergraduate and graduate degree programs. The major program and a minor program, are described below. The School offers three undergraduate major programs and a minor program.

Bachelor of Science in Computer Science

Degree Program Hours: 120

The Bachelor of Science program in Computer Science is accredited by the Computing Accreditation Commission (ABET), 111 Market Place, Suite 1050, Baltimore, MD 21202-4012 – Telephone (410) 347-7700.

Two tracks are available in the upper division program. The **Computer Science track** should be followed by the student who intends to continue to graduate study in computer science. The **Software Design and Development track** may be followed by the student who intends to pursue a software engineering career.

All required and elective courses must be completed with a grade of "C" or better. All students must participate in SCIS assessment activities and successfully complete an exit interview prior to graduation.

Lower Division Preparation

To qualify for admission to the program, FIU undergraduates must have met all the lower division requirements, completed 60 semester hours, completed COP 2210 with a grade of "C" or higher, and must be otherwise acceptable into the program.

As part of the 60 semester hours of lower division course work necessary to enter this upper division major, note the following recommendations or course requirements, or both.

Common Prerequisite Courses and Equivalencies

FIU Course(s)	Equivalent Course(s)
COP 2210	COPXXXX[1]
MAC 2311	MACX311
MAC 2312	MACX312
PHY 2048, PHY 2048L	PHYX048/X048L or PHYX048C
PHY 2049, PHY 2049L	PHYX049/X049L or PHYX049C
XXXXXXX[3]	XXXXXXX[2]

[1]Intro Programming in C, C++, JAVA, or equivalent language. Choose programming language required by the university to which the student wishes to transfer.
[2]Science course for science majors.

Courses which form part of the statewide articulation between the State University System and the Community College System will fulfill the Lower Division Common Prerequisites.

For generic course substitutions/equivalencies for Common Program Prerequisites offered at community colleges, state colleges, or state universities, visit: **http://www.flvc.org**, See Common Prerequisite Manual.

Required Courses

Common Prerequisites

COP 2210	Computer Programming I
MAC 2311	Calculus I
MAC 2312	Calculus II
PHY 2048	Physics with Calculus I
PHY 2048L	General Physics Lab I
PHY 2049	Physics with Calculus II
PHY 2049L	General Physics Lab II

[3]Two additional one-semester courses in natural science; each of these should be a course designed for science or engineering majors. A list of additional approved courses is available through the School of Computing and Information Sciences.

Upper Division Requirements

At least 50% of the upper division credits required for the BS in Computer Science must be taken at FIU.

Courses Required for the Degree: (both tracks)

Third and Fourth Years

CGS 1920	Introduction to Computing	1
MAD 2104	Discrete Mathematics	3
ENC 3249	Professional and Technical Writing for Computing	3
COT 3420	Logic for Computer Science	3
MAD 3512	Introduction to Theory of Algorithms	3

STA 3033	Introduction to Probability and Statistics for CS	3
CGS 3095	Technology in the Global Arena	3
COP 3337	Computer Programming II	3
COP 4338	Computer Programming III	3
CDA 3103	Fundamentals of Computer Systems	3
COP 3530	Data Structures	3
COP 4555	Survey of Programming Languages	3
COP 4710	Database Management	3
CDA 4101	Structured Computer Organization	3
CEN 4010	Software Engineering I	3
CNT 4713	Net-centric Computing	3
COP 4610	Operating Systems Principles	3
*CIS 4911	Senior Project	3

Additional required courses for SDD track

CEN 4021	Software Engineering II	3
**CEN 4072	Fundamentals of Software Testing	3

*CIS4911 for SDD-track students must be a software engineering-focused project.
**With the permission of an SCIS UG advisor students can register for CEN 5064 Software Design and then substitute CEN 5064 for CEN 4072.

Computer Science Electives

CS-track students must complete three courses from the following list.
SDD-track students must complete one course from the following list in addition to CEN 4021 and CEN 4072.

CAP 4710	Principles of Computer Graphics	3
CAP 4770	Introduction to Data Mining	3
CEN 4021	Software Engineering II	3
CEN 4072	Fundamentals of Software Testing	3
COP 4226	Advanced Windows Programming	3
COP 4604	Advanced Unix Programming	3
COP 4520	Introduction to Parallel Computing	3
COP 4722	Survey of Database Systems	3
MAD 3305	Graph Theory	3
MAD 3401	Numerical Analysis	3
MAD 4203	Introduction to Combinatorics	3
MHF 4302	Mathematical Logic	3

NOTE: Graduate courses can also be used to satisfy elective requirements. Please see adviser for approval. Graduate courses are subject to graduate fees.

Remarks: The following courses are not acceptable for credit toward graduation, unless a student has passed the course before declaring a Computer Science major: CGS 2060, CGS 3300, CGS 2100, COP 3175, MAC 2233, STA 1013, STA 2023, STA 2122, STA 3123, QMB 3200, ESI 3161.

Combined BS/MS in Computer Science

To be considered for admission to the combined bachelor's/master's degree program, students must have completed at least 75-90 credits in the bachelor's degree program at FIU and meet the admissions criteria for the graduate degree program to which they are applying. Students need only apply once to the combined degree program, but the application must be submitted to Graduate Admissions before the student starts the last 30 credits of the bachelor's degree program. A student admitted to the combined degree program will be considered to have undergraduate status until the student applies for graduation from their bachelor's degree program. Upon conferral of the bachelor's degree, the student will be granted graduate status and be eligible for graduate assistantships. Only 5000-level or higher courses, and no more than the number of credits specified by the program catalog, may be applied toward both degrees.

Admission Requirements

1. Current enrollment in the Bachelor's Degree program in Computer Science at FIU.
2. Completed at least 90 credits of coursework.
3. Current GPA must be 3.3 or higher.
4. GRE (general test) 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	3
COP 5725	Principles of Database Management Systems	3
COP 5614	Operating Systems	3
COT 5420	Theory of Computation I	3
COT 5407	Introduction to Algorithms	3

Electives

5 courses selected from the SCIS Graduate Course Offerings. No grade below "C" will be accepted in any course taken to satisfy graduate program requirements.

Overlap

Up to 4 courses (12 credits) may be used in satisfying both the Bachelor's and Master's degree requirements. All overlapping courses must be approved by both graduate and undergraduate program directors before students are enrolled in such courses.

The courses must be regular 5000-level computer science graduate courses intended for graduate majors.

Combined BS in Computer Engineering/MS in Engineering Management

Students who pursue a BS degree and are in their first semester of the senior year in Computer Science and have earned at least a 3.2 overall GPA may, upon recommendation from three faculty members, apply to the department to enroll in the combined BSCS/MSEM program. Students must also submit an online application

to the University Graduate School for admission to the MSEM program. In addition to the admission requirements of the MSEM program, students must meet all the admission requirements of the University Graduate School.

Students need only apply once to the combined degree program, but the application must be submitted to Graduate Admissions before the student starts the last 30 credits of the bachelor's degree program. A student admitted to the combined degree program will be considered to have undergraduate status until the student applies for graduation from their bachelor's degree program. Upon conferral of the bachelor's degree, the student will be granted graduate status and be eligible for graduate assistantships.

Students enrolled in the combined degree program could count up to three Computer Science graduate courses toward satisfying both the BSCS and the MSEM requirements, for a total saving of 9 credit hours. Students are required to take four courses from the following list. Additional courses may be selected with approval of the program director.

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

The combined BSCS/MSEM program has been designed to be a continuous program. During this combined BSCS/MSEM program, upon completion of all the requirements of the BSCS program, students will receive their BSCS degree. Students may elect to permanently leave the combined program and earn only the BSCS degree. Students who elect to leave the combined program and earn only the BS degree will have the same access requirements to regular graduate programs as any other student, but will not be able to use the 9 credit hours in both the BSCS and MSEM degrees.

For each of the graduate courses counted as credits for both BSCS and MSEM degrees, a minimum grade of "B" is required. Only graduate courses with formal lecture can be counted for both degrees. The students are responsible for confirming the eligibility of each course with their undergraduate advisors.

Students interested in the combined program should consult with their undergraduate advisor on their eligibility to the program, preferably during their junior year, since appropriate planning of coursework is required in order to achieve the full nine-credit benefit. The student should also meet the MSEM Program Director to learn about the graduate program and available tracks/courses before completing the application form and submitting it to their undergraduate advisor. Final decision for admission to the MSEM program will be made by the University Graduate School upon recommendation by the Engineering Management program director. Applicants will be notified by the Engineering Management Program and the University Graduate School of the decision on their applications.

Bachelor of Science in Information Technology

The School of Computing and Information Sciences offers a Bachelor of Science degree in Information Technology. There are two majors in the program. **1) Information Technology (IT) Major:** The information technology major is for students who want broad coverage of information technology concepts. **2) Software Major:** The software major is for students who want to add a strong theoretical foundation of Computer Science that can be integrated within a vast array of career options.

The B.S. in Information Technology degree as a first major requires completion of prerequisite courses and 60 credit hours of required and elective courses as outlined below. All courses must be completed with a grade of "C" or better. All students must participate in SCIS assessment activities and successfully complete an exit interview prior to graduation.

Lower Division Preparation

To qualify for admission to the program, FIU undergraduates must have met all the University Core Curriculum requirements, completed 60 semester hours and must be otherwise acceptable into the program.

As part of the 60 semester hours of lower division course work necessary to enter this upper division major, note the following recommendations or course requirements, or both.

Degree Program Hours: 120

Common Prerequisite Courses and Equivalencies

FIU Course(s)	Equivalent Course(s)
CGS 2060 or CGS 2100	CGSXXXX
COP 2250	COPXXXX
PSY 2012	PSYXXXX
MAC 1147	MACXXXX

Note #2: FIU – Consult FIU Catalog for double majors coupled with IT Programs. Students would need to take the prerequisites for the other major they select, in addition to the IT prerequisites.

Courses which form part of the statewide articulation between the State University System and the Community College System will fulfill the Lower Division Common Prerequisites.

For generic course substitutions/equivalencies for Common Program Prerequisites offered at community colleges, state colleges, or state universities, visit: **http://www.flvc.org**, See Common Prerequisite Manual.

Required Courses

Common Prerequisites for Both Majors

All students must have completed the following courses (or equivalent) prior to starting the Information Technology program.

CGS 1920	Introduction to Computing	1
CGS 2060	Introduction to Microcomputers	3
	or	
CGS 2100	Introduction to Microcomputer Applications for Business	3
MAC 1147	Pre-Calculus Algebra and Trigonometry	3
PSY 2012	Introductory Psychology or equivalent	3

IT Major-specific Prerequisites

COP 2250	Programming in Java	3
MAD 1100	Mathematics Concepts for Information Technology	3

Software Major-specific Prerequisites

COP 2210	Computer Programming I	3
MAD 2104	Discrete Mathematics	3

Upper Division Requirements

At least 50% of the upper division credits required for the BS in Information Technology must be taken at FIU.

Interdisciplinary Courses for Both Majors

Nine additional credits must be taken outside the School of Computing and Information Sciences. These credits must normally be selected from the courses for a minor or certificate in another discipline. When there is no minor or certificate in the area of the student's interest, a set of courses can be created with the approval of advisers from SCIS and the other area of interest.

Common Required Courses for Both Majors

All students must complete the following courses.

CEN 3721	Introduction to Human-Computer Interaction	3
CGS 3767	Computer Operating Systems	3
CGS 4285	Applied Computer Networking	3
CGS 4854	Web Site Construction and Management	3
CNT 4403	Computing and Network Security	3
COP 4703	Information Storage and Retrieval	3
COP 4814	Component-Based Software Development	3
ENC 3249	Professional and Technical Writing for Computing	3
CGS 3095	Technology in the Global Arena	3

Information Technology Electives

Students in both majors must take information technology electives. The electives are arranged in the following areas of concentration:

- System Administration
- Applied Network Administration
- Application Development
- Databases

Information Technology (IT) Major

IT Major-specific Required Course

COP 3804	Intermediate Java	3

IT Major-specific Electives

Students must complete five electives courses, as follows. Select two areas of concentration and take two courses in each of the chosen concentration areas (four courses). Select the fifth course from any area of concentration. With approval of an adviser, the fifth elective may be met with a coop or internship.

Software Major

Software Major-specific Required Courses

CDA 3103	Fundamentals of Computer Systems	3
COP 3337	Computer Programming II	3
COP 3530	Data Structures	3
COP 4338	Computer Programming III	3

Software Major-specific Electives

Students must select one area of concentration and complete two elective courses in that area.

Free Electives for Both Majors

All students must complete nine additional credits of general electives.

Combined BS in Information Technology/MS in Engineering Management

Students who pursue a BS degree and are in their first semester of the senior year in Information Technology and have earned at least a 3.2 overall GPA may, upon recommendation from three faculty members, apply to the department to enroll in the combined BSIT/MSEM program. Students must also submit an online application to the University Graduate School for admission to the MSEM program. In addition to the admission requirements of the MSEM program, students must meet all the admission requirements of the University Graduate School.

Students need only apply once to the combined degree program, but the application must be submitted to Graduate Admissions before the student starts the last 30 credits of the bachelor's degree program. A student admitted to the combined degree program will be considered to have undergraduate status until the student applies for graduation from their bachelor's degree program. Upon conferral of the bachelor's degree, the student will be granted graduate status and be eligible for graduate assistantships.

Students enrolled in the combined degree program could count up to three Management Electives toward their nine "interdisciplinary credits" in the BSIT degree program, for a total saving of 9 credit hours.

ACG 6026	Accounting for Managers
EIN 5359	Industrial Financial Decisions
FIN 6406	Corporate Finance
MAN 6167	Leadership in a Global Environment
MAN 6209	Organization Design and Behavior
MAN 6501	Operations Management
MAN 6830	Organization Information Systems
MAR 6805	Marketing Management

The combined BSIT/MSEM program has been designed to be a continuous program. During this combined BSIT/MSEM program, upon completion of all the requirements of the BSIT program, students will receive their BSIT degree. Students may elect to permanently leave the combined program and earn only the BSIT degree. Students who elect to leave the combined program and earn only the BS degree will have the same access requirements to regular graduate programs as any other student, but will not be able to use the 9 credit hours in both the BSIT and MSEM degrees.

For each of the graduate courses counted as credits for both BSIT and MSEM degrees, a minimum grade of "B" is required. Only graduate courses with formal lecture can be counted for both degrees. The students are responsible for confirming the eligibility of each course with their undergraduate advisors.

Students interested in the combined program should consult with their undergraduate advisor on their eligibility

to the program, preferably during their junior year, since appropriate planning of coursework is required in order to achieve the full nine-credit benefit. The student should also meet the MSEM Program Director to learn about the graduate program and available tracks/courses before completing the application form and submitting it to their undergraduate advisor. Final decision for admission to the MSEM program will be made by the University Graduate School upon recommendation by the Engineering Management program director. Applicants will be notified by the Engineering Management Program and the University Graduate School of the decision on their applications.

Bachelor of Arts in Information Technology

Degree Program Hours: 120

The School of Computing and Information Sciences offers a Bachelor of Arts degree in Information Technology as a second major or as a second Bachelor Degree. This program is open to those students who are enrolled in and will be completing another bachelor degree program or those who already have a bachelor degree from an accredited institution. Computer Science and Computer Engineering are not accepted as the primary major at this time.

The B.A. in Information Technology degree as a second major requires completion of prerequisite courses and 30 credit hours (10 courses) of required and elective courses as outlined below. All courses must be completed with a grade of "C" or better.

Lower Division Preparation

To qualify for admission to the program, FIU undergraduates must have met all the University Core Curriculum requirements, completed 60 semester hours, must have a different primary major or a previous Bachelor degree, and must be otherwise acceptable into the program.

As part of the 60 semester hours of lower division course work necessary to enter this upper division major, note the following recommendations or course requirements, or both.

Common Prerequisite Courses and Equivalencies

Courses which form part of the statewide articulation between the State University System and the Community College System will fulfill the Lower Division Common Prerequisites.

For generic course substitutions/equivalencies for Common Program Prerequisites offered at community colleges, state colleges, or state universities, visit: **http://www.flvc.org**, See Common Prerequisite Manual. The Common Prerequisite Manual does not include a sheet for this program.

Required Courses
Common Prerequisites

All students must have completed the following courses (or equivalent) prior to starting the Information Technology program.

CGS 2060	Introduction to Microcomputers	3
	or	
CGS 2100	Introduction to Microcomputer Applications for Business	3
	or	
CGS 2518	Computer Data Analysis	3
COP 2250	Programming in Java	3
MAD 1100	Mathematics Concepts for Information Technology	3

Upper Division Requirements

At least 50% of the upper division credits required for the BA in Information Technology must be taken at FIU.

Required Courses

All students must complete the following courses (18 credits).

CEN 3721	Introduction to Human-Computer Interaction	3
CGS 3767	Computer Operating Systems	3
CGS 4285	Applied Computer Networking	3
CGS 4854	Web Site Construction and Management	3
COP 3804	Intermediate Java	3
COP 4703	Information Storage and Retrieval	3

Information Technology Electives

All students must complete 2 courses (6 credits) from the following.

CIS 4431	IT Automation	3
CNT 4403	Computing and Network Security	3
CNT 4504	Advanced Network Management	3
CNT 4513	Data Communications	3
COP 4005	Windows Programming for IT Majors	3
COP 4655	Mobile Application Development	3
COP 4722	Survey of Database Systems	3
COP 4813	Web Application Programming	3
COP 4814	Component-Based Software Development	3
CTS 4348	Unix System Administration	3
CTS 4408	Database Administration	3

Cognate Electives

All students must complete 2 additional elective courses (6 credits). Students who are completing their major concurrent with their IT degree must choose their cognate elective courses from a list of designated courses from the department of their primary major. Students who have received their first Bachelor Degree prior to enrolling in the IT program must instead choose an additional two courses from the list of IT elective courses.

Minor in Computer Science

A minor program is an arrangement of courses enabling a student to develop a degree of expertise and knowledge in an area of study in addition to his or her major academic program of study. A student with a major that has a significant overlap with Computer Science must first obtain permission from a CS advisor.

Required Courses

CDA 3103	Fundamental of Computer Systems	3
COP 2210	Computer Programming I	4
COP 3337	Computer Programming II	3

Plus two from the following list:

CAP 4770	Introduction to Data Mining	3
CDA 4101	Structured Computer Organization	3

CEN 4010	Software Engineering I	3
CNT 4713	Net-centric Computing	3
COP 3530	Data Structures	3
COP 4226	Advanced Windows Programming	3
COP 4338	Programming III	3
COP 4520	Introduction to Parallel Computing	3
COP 4555	Principles of Programming Languages	3
COP 4604	Advanced Unix Programming	3
COP 4710	Database Management	3
COT 3420	Logic for Computer Science	3

Students should ensure that he or she has the necessary prerequisites for the chosen courses. At least nine of the credits for the minor must be taken from SCIS. Four of the minor courses cannot be courses that may be applied to the major program of the student.

Course Descriptions

Definition of Prefixes

CAP-Computer Applications; CDA-Computer Design/Architecture; CEN-Computer Software Engineering; CGS-Computer General Studies; CIS-Computer Information Systems; CNT-Computer Networks; COP-Computer Programming; COT-Computing Theory; CTS-Computer Technology and Skills.
Courses that meet the University's Global Learning requirement are identified as GL.

CAP 4710 Principles of Computer Graphics (3). A first course in algorithms/techniques for image generation devices, geometric transformations/matrics, algorithms for hidden surfaces, ray tracing, advanced rendering. Programming with standard graphics interface. Prerequisites: COP 3337 and MAC 2312. This course will have additional fees.

CAP 4770 Introduction to Data Mining (3). Data mining applications, data preparation, data reduction and various data mining techniques such as association, clustering, classification, anomaly detection. Prerequisite: COP 3530. Corequisite: COP 4710.

CAP 5011 Multimedia Systems and Applications (3). Course covers organization of multimedia systems, data representation, quality of service, scheduling algorithms, synchronization and tele-communication of multimedia streams. Prerequisite: COP 4610.

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 of 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. This course will have additional fees.

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 5701 Advanced Computer Graphics (3). Advanced topics in computer graphics: system architecture, interactive techniques, image synthesis, current research areas. Prerequisites: COP 3530 and CAP 3710 or equivalent, or by permission. This course will have additional fees.

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 4710 and STA 3033.

CDA 3003 Microcomputer Organization (3). A study of the hardware components of modern microcomputers and their organization. Evaluation and comparison of the various microcomputer systems. Not acceptable for credit for Computer Science Majors. Prerequisite: COP 2250. This course will have additional fees.

CDA 3103 Fundamentals of Computer Systems (3). Overview of computer systems organization. Data representation. Machine and assembly language programming. Prerequisites: COP 2210 or equivalent. This course will have additional fees.

CDA 4101 Structured Computer Organization (3). Covers the levels of organization in a computer: Design of memory, buses, ALU, CPU; design of microprogram. Covers virtual memory, I/O, multiple processes, CISC, RISC and parallel architectures. Prerequisites: MAD 2104, CDA 3103 and COP 3337. This course will have additional fees.

CDA 4400 Computer Hardware Analysis (3). The study of hardware functions of a basic computer. Topics include logic elements, arithmetic logic units, control units, memory devices, organization and I/O devices. Prerequisite: CDA 4101.

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. Prerequisites: COP 4610 or permission of the instructor.

CEN 3721 Introduction to Human-Computer Interaction (3). Fundamental concepts of human-computer interaction, cognitive models, user-centered design principles and evaluation, emerging technologies. Prerequisites: COP 2210 or COP 2250 or equivalent.

CEN 4010 Software Engineering I (3). Software Process Model, software analysis and specification, software design, testing. Prerequisites: CGS 3095, COP 3530, and COP 4710. Corequisite: CNT 4713. This course will have additional fees.

CEN 4012 Software Design and Development Project (3). Students design, implement, document, and test software systems working in faculty supervised project teams and utilizing knowledge obtained in previous courses. Required for Software Design and Development track. Prerequisite: CEN 4010. This course will have additional fees.

CEN 4021 Software Engineering II (3). Issues underlying the successful development of large scale software projects: Software Architectures; Software Planning and Management; Team Structures; Cost Estimation. Prerequisite: CEN 4010. This course will have additional fees.

CEN 4072 Fundamentals of Software Testing (3). Fundamentals of software testing. Topics include: test plan creation, test case generation, program inspections, specification-based and implementation-based testing, GUI testing, and testing tools. Prerequisite: COP 3530.

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. This course will have additional fees.

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. Prerequisite: COP 3530 or permission of the instructor. This course will have additional fees.

CGS 1920 Introduction to Computing (1). Overview of the computing field to students, research programs and career options.

CGS 2060 Introduction to Microcomputers (3). A hands-on study of microcomputer software packages for applications such as operating system, word processing, spreadsheets, and database management. For students without a technical background. Not acceptable for credit for Computer Science majors.

CGS 2100 Intro to Microcomputer Applications for Business (3). A hands-on study of spreadsheet and database management packages for business students without a technical background. Not acceptable for credit for Computer Science majors.

CGS 2518 Computer Data Analysis (3). A hands-on study of how to use a modern spreadsheet program to analyze data, including how to perform queries, summarize data, and solve equations. For non-technical students. Not acceptable for CS students.

CGS 3092 Professional Ethics and Social Issues in Computing (1). Ethical, legal, social issues and the responsibility of computer professionals. Codes of conduct, risks and reliability, responsibility, liability, privacy, security, free speech issues. Prerequisites: ENC 3213 and (COP 2210 or COP 2250).

CGS 3095 Technology in the Global Arena – *GL* (3). Legal, ethical, social impacts of computer technology on society, governance, quality of life: intellectual property, privacy, anonymity, professionalism, social identity in the U.S. and globally. Prerequisites: For CS/IT majors: COP 2250 or COP 2210, ENC 3213; for others: upper division standing.

CGS 3416 Web-based Programming (3). A programming course in Java with emphasis on web-based applications: Applets; Components; Servlets; Java Beans. Not acceptable for credit for Computer Science majors. Prerequisites: COP 2250 and MAD 1100. This course will have additional fees.

CGS 3559 Using the Internet (1). Internet history and importance. What is available on the Net. Tools such as email, listserves, telnet, ftp, Archie, Veronica, Gopher, netfind, the World Wide Web, Wais, and Mosaic. Nontechnical. Prerequisite: CGS 2060 or equivalent.

CGS 3767 Computer Operating Systems (3). Introduction to fundamental concepts of operating systems and their implementation in UNIX and Windows. Prerequisites: COP 2250 or COP 2210. This course will have additional fees.

CGS 4285 Applied Computer Network (3). Principles of computer network design, operation and management. Network protocols. Network configuration. Network security. Not acceptable for credit for Computer Science majors. Prerequisite: CGS 3767. This course will have additional fees.

CGS 4365 Knowledge-Based Management Systems (3). Introduction to knowledge-based and expert systems. Knowledge acquisition, knowledge representation, and creation of expert system. Not acceptable for credit for Computer Science majors. Prerequisite: COP 4703. This course will have additional fees.

CGS 4854 Website Construction and Management (3). The fundamentals of creating and maintaining a website. Installation and maintenance of a web-server. Techniques for building multimedia interactive web-pages. Not acceptable for credit for Computer Science majors. Prerequisites: CGS 3767 and (COP 3804 or COP 3337). This course will have additional fees.

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

CIS 3900 Independent Study (1-5). Individual conferences, assigned readings, and reports on independent investigations.

CIS 3930 Special Topics (1-5). A course designed to give groups of students an opportunity to pursue special studies not otherwise offered.

CIS 4431 IT Automation (3). IT automation: mgmt models, auditing, assets, change mgmt, network monitoring, OS imaging, patch mgmt, help desk, remote control, user state mgmt, end-point security, backup, disaster recovery. Prerequisite: CGS 3767. Corequisite: CGS 4285 or permission of the instructor.

CIS 4905 Independent Study (1-20). Individual conferences, assigned readings, and reports on independent investigations.

CIS 4911 Senior Project (3). Students work on faculty supervised projects in teams of up to 5 members to design and implement solutions to problems utilizing knowledge obtained across the spectrum of Computer Science courses. Prerequisites: CEN 4010 and permission of the instructor.

CIS 4912 Research Experience for Undergraduate Students (0-9). Participation in ongoing research in the research centers of the school.

CIS 4930 Special Topics (1-3). A course designed to give groups of students an opportunity to pursue special studies not otherwise offered.

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 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 5900 Independent Study (1-10). Individual conferences, assigned readings, and reports on independent investigations.

CIS 5910 Project Research (1-6). 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 5931 Special Topics (1-3). A course designed to give groups of students an opportunity to pursue special studies not otherwise offered.

CNT 4403 Computing and Network Security (3). Fundamental concepts and principles of computing and network security, symmetric and asymmetric cryptography, hash functions, authentication, firewalls and intrusion detection, and operational issues. Prerequisites: CGS 4285 and COP 3804.

CNT 4504 Advanced Network Management (3). Advanced principles of modern internetworking network design and implementation. Hands on experience with routers and switches and core Internet support protocols. Prerequisite: CNT 4513.

CNT 4513 Data Communications (3). Study Computer network models and protocol layers. Topics include: error handling, frames, broadcast networks, channel allocation; network routing algorithms, internetworking, TCP/IP, ATM protocols. Prerequisites: CDA 4101 or (COP 3804 and CGS 4285).

CNT 4713 Net-centric Computing (3). This course covers networking fundamentals, network security, network applications, mobile and wireless computing. The course focuses on network programming, including sockets and web programming concepts. Prerequisite: COP 4338.

COP 1000 Introduction to Computer Programming (3). Uses graphics and animation in a media programming environment to engage students with no programming experience. Students develop problem solving skills and learn fundamental programming concepts.

COP 2210 Computer Programming I (4). A first course in computer science that uses a structured programming language to study programming and problem solving on the computer. Includes the design, construction and analysis of programs. Student participation in a closed instructional lab is required. This course will have additional fees.

COP 2250 Programming in Java (3). A first course in programming for IT majors. Syntax and semantics of Java. Classes and Objects. Object oriented program development. Not acceptable for credit for Computer Science majors. This course will have additional fees.

COP 2270 C for Engineers (3). A first course in programming geared for engineering and natural science students that describes the syntax and semantics of ANSI C programming language. Includes developing algorithms and writing for problems in engineering and science.

COP 3175 Programming in Visual Basic (3). An introduction to Visual Basic programming with emphasis on Business Applications. Not acceptable for credit for Computer Science majors. Prerequisites: CGS 2100 or CGS 2060. This course will have additional fees.

COP 3337 Computer Programming II (3). An intermediate level course in Object Oriented programming. Topics include primitive types, control structures, strings arrays, objects and classes, data abstraction inheritance polymorphism and an introduction to data structures. Prerequisites: COP 2210 or EEL 2880. This course will have additional fees.

COP 3353 Introduction to Using Unix/Linux Systems (3). Techniques of Unix/Linux systems. Basic use, file system structure, process system structure, unix tools (regular expressions, grep, find), simple and complex shell scripts, Xwindows. Not acceptable for credit for Computer Science majors. Prerequisites: COP 2210 or COP 2250 or equivalent. This course will have additional fees.

COP 3465 Data Structures for IT (3). Basic concepts of running time of a program, data structures including lists, stacks, queues, binary search trees, and hash tables, and internal sorting. Not acceptable for credit for CS majors. Prerequisite: Programming II (IT). This course will have additional fees.

COP 3530 Data Structures (3). Basic concepts of data organization, running time of a program, abstract types, data structures including linked lists, nary trees, sets and graphs, internal sorting. Prerequisites: MAD 2104 and COP 3337. This course will have additional fees.

COP 3804 Intermediate Java Programming (3). A second course in Java programming. Continues Programming in Java by discussing object-oriented programming in a more detail, with larger programming projects and emphasis on inheritance. Not acceptable for credit for CS majors. Prerequisite: COP 2250. Corequisite: CEN 3721. This course will have additional fees.

COP 3832 Advanced Web Server Communication (3). Maintain a web server on the Internet. Learn HTML, PERL, Javascript. Configure the Apache web server. Write interactive server scripts. Discuss Web security & ASP. Use Java applets and ActiveX controls. Prerequisites: CGS 3559, COP 2210 or equivalents. This course will have additional fees.

COP 3835 Designing Web Pages (3). Designing basic pages for display on the World Wide Web. Fundamental design elements and contemporary design tools are discussed. Computer literacy is expected.

COP 3949 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: MAC 2312 and COP 3337.

COP 4005 Windows Programming for IT Majors (3). Application development techniques in Windows: Classes, Objects, Controls, Forms and Dialogs, Database, and Multitier Application Architecture. Students cannot receive credit for both COP 4005 and COP 4226. Prerequisite: COP 3804 or COP 3337. Corequisite: COP 4703. This course will have additional fees.

COP 4009 Windows Components Technology (3). Component-Based and Distributed Programming Techniques: C#, Common Type System, Windows and Web Forms, Multithreading, Distributed Objects. Prerequisites: COP 4226 or COP 4005. This course will have additional fees.

COP 4226 Advanced Windows Programming (3). Document and Dialog Based App, Message Passing, Printing, Drawing, GUI Design, Common Controls, Multithreaded Programming, Serialization, Database Connectivity, Runtime Libraries, Memory Management. Prerequisite: COP 3530. This course will have additional fees.

COP 4338 Computer Programming III (3). Topics include Object-Oriented programming Concepts and Modern Programming Techniques. Prerequisite: COP 3530. This course will have additional fees.

COP 4516 Competitive Programming and Problem Solving (3). Problem solving for programming competitions. Algorithms, analysis, programming, debugging, group collaboration. Participation in team practices and rigorous individual preparation. Prerequisite: COP 3530.

COP 4520 Introduction to Parallel Computing (3). This course introduces the field of parallel computing. The students will be taught how to design efficient parallel programs and how to use parallel computing techniques to solve scientific problems. Prerequisites: COP 3530 and CDA 4101 or EEL 4709C.

COP 4534 Algorithm Techniques (3). Basic algorithm design, including greedy algorithms, divide-and-conquer, dynamic programming, randomization, and backtracking. Graph, string, numerical, geometric, and optimization algorithms. Prerequisite: COP 3530.

COP 4555 Principles of Programming Languages (3). A comparative study of several programming languages and paradigms. Emphasis is given to design, evaluation and implementation. Programs are written in a few of the languages. Prerequisite: COP 3530. This course will have additional fees.

COP 4604 Advanced Unix Programming (3). Unix overview: files and directories, shell scripting and systems programming. Unix tools; Internals: file systems, process structure. Using the system call interface. Interprocess communication. Prerequisite: COP 4338. Corequisite: COP 4610. This course will have additional fees.

COP 4610 Operating Systems Principles (3). Operating systems design principles and implementation techniques. Address spaces, system call interface, process/threads, interprocess communication, deadlock, scheduling, memory, virtual memory, I/O, file systems. Prerequisites: CDA 4101 and COP 4338. This course will have additional fees.

COP 4655 Mobile Application Development (3). Design and development of mobile applications. Introduction to the mobile application frameworks, including user interface, sensors, event handling, data management and network interface. Prerequisite: COP 4814.

COP 4703 Information Storage and Retrieval Concepts (3). Introduction to information management and retrieval concepts. The design and implementation of a relational database using a commercial DBMS. Online information retrieval and manipulation. Not acceptable for credit for Computer Science majors. Prerequisite: COP 3804. This course will have additional fees.

COP 4710 Database Management (3). Logical aspects of databases including Relational, Entity-Relationship, and Object-Oriented data models, database design, SQL, relational algebra, tuple calculus, domain calculus, and physical database organization. Prerequisite: COP 3337. Corequisite: COP 3530. This course will have additional fees.

COP 4722 Survey of Database Systems (3). Design and management of enterprise systems; concurrency techniques; distributed, object-oriented, spatial, and multimedia databases; databases integration; datawarehousing and datamining; OLAP; XML interchange. Prerequisites: COP 4710 or COP 4703.

COP 4813 Web Application Programming (3). Creating Web applications with user interfaces, databases, state management, user authentication, error handling, and web services. Prerequisites: CGS 4854 and COP 4005.

COP 4814 Component-Based Software Development (3). Integrating, exchanging, and transforming XML data, building software from components, understanding security concepts, basic Web services. Prerequisites: COP 4703 and CGS 4854.

COP 4906 Research Experiences in Computer Science (1-3). Participation in ongoing research in the research centers of the school. Prerequisite: Permission of the instructor.

COP 4949 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: MAC 2312, STA 3033 and COP 3337.

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. This course will have additional fees.

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 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 supervision evaluation is required of each student. Prerequisite: Graduate Standing.

COT 3420 Logic for Computer Science (3). An introduction to the logical concepts and computational aspects of propositional and predicate logic, as well as to concepts and techniques underlying logic programming, in particular, the computer language Prolog. Prerequisites: COP 3337 and MAD 2104. This course will have additional fees.

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 indecidability of computational problems. Prerequisite: MAD 3512.

CTS 2327 Microsoft Windows NT Administration (3). A two-part course covering introduction to Networking and the Windows NT Operating System. This course will cover material that is covered on the Microsoft Certified systems Engineer (MCSE) exam. Prerequisites: CGS 2060, or CGS 2100, or equivalent. This course will have additional fees.

CTS 4348 Unix System Administration (3). Techniques of Unix system administration: system configuration and management; user setup, management and accounting; software installation and configuration; network setup, configuration and management. Prerequisite: CGS 3767.

CTS 4408 Database Administration (3). Client-server architecture; planning, installation, server configuration; user management; performance optimization; backup, restoration; security configuration; replication management; administrative tasks. Prerequisites: COP 4703 or COP 4710.