

COMPUTER SCIENCE and INFORMATION TECHNOLOGY

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Mission Statement

In accordance with the mission of Carroll University, the Computing and IT Programs provide an excellent and state-of-the-art educational opportunity for students based on their individual skill sets, interests and career goals in the areas of modern software development, business problem solving, and IT problem solving and support. Both programs enable students to combine their theoretical and technical understanding with their broad-based liberal-arts education to think analytically and critically when designing and implementing software or IT solutions.

Learning Outcomes for Computer Science Major

Graduates of the Computer Science Program are able to:

1. Problem-solve (for business, scientific, Web, and recreational problems) through programming using multiple programming paradigms, enterprise resources, different software development frameworks, sound software design techniques and software engineering practices.
2. Successfully work in or be adapted to an organization in any business setting to meet technology challenges.
3. Further their academic pursuits and meet challenges in graduate schools by having the necessary body of theory that underpins the discipline of computer science.
4. Demonstrate an understanding of ethics as it applies to the discipline of computer science.
5. Work effectively as part of a team.

Learning Outcomes for Information Technology Major

Graduates of the Information Technology Program are able to:

1. Think creatively and analytically in technological problem-solving.
 2. Problem-solve using productivity software and through computer programming.
 3. Demonstrate an understanding of information system and technology evaluation and management.
 4. Demonstrate an understanding of the application of new and developing technologies with sensitivity for security and ethical issues at global, societal, organizational, and personal levels.
 5. Work effectively as part of a team.
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In addition, graduates of the IT major with Computer-Game Development emphasis are able to:

1. Design game stories, implement them in code, and test working games against various game-playing platforms,
2. Apply knowledge of data structures, software analysis and design to implement efficient game programs,
3. Apply knowledge of artificial intelligence and computer graphics to develop interactive and aesthetic games of good quality and reasonable size.

The Computer Science and IT programs are grounded in the liberal arts tradition, balance theory and practice, and focus on the problem-solving skills necessary for life-long learning in a field characterized by rapid change in technology. We succeed in our mission by preparing our students through classroom work and appropriate external internships to secure fulfilling careers in the field of their choosing.

The world has been in an era of rapid technological advancement. The Internet and World Wide Web have increasingly become critically important in corporate strategies, people's social lives and personal development. We recognize this by integrating the latest technologies into the curricula. The curricula are designed to emphasize problem solving, multiple programming paradigms, and higher order thought processes that will always be needed by corporate America under any business models.

Several emphases and minors are available within the computer science or information technology program. Each allows students to begin taking required major courses during the fall semester of the freshman year.

Computer Science majors may select the:

- Software Engineering emphasis if interested in developing the skills necessary to design and build large and reliable software systems.
- Information Systems emphasis if they desire to work as system analysts in business.
- ABET-suggested curriculum emphasis if they wish to have a broader background in mathematics and natural sciences, in particular if they desire to further their study of computer science in graduate schools. This emphasis is designed based upon the computer science curriculum standards set by the Accreditation Board for Engineering and Technology. (ABET)

Information Technology majors may select the:

- Web Application Development emphasis if they wish to work as developers of Web applications, as network or database administrators.
- Business and Social Applications emphasis if they wish to work technologically as analysts in a business or social environment.
- Computer Networking emphasis if they wish to work as a computer network specialist to design computer networks, manage network security, and improve business data communications.

- Computer-Game Development emphasis if they wish to work as video game developers. These skills also carry over to developing a wide range of other types of software.

Computer Science or Information Technology minors complete the same core minor courses and select an additional set of courses based on personal interests.

Additionally, one interdisciplinary major in Software Engineering and Applied Mathematics (SEAM) is available and described in a separate section of the catalog. SEAM presents students solid foundation in software engineering, grounded in a mathematical infrastructure.

Our programs have close ties with local industry and offer students the opportunity to participate in paid internships or cooperative programs with various companies for university credit.

Computer science and information technology students at Carroll work on state-of-the-art computing facilities with the latest software application packages. They have access to Microsoft, Macintosh, and Unix/Linux computing platforms, and Oracle or Microsoft SQL Server Database Management Systems via the campus-wide network. There is equipment exclusively available for the use of computer science and information technology majors.

Computer Science Major (64 to 80 credits) **Bachelor of Science**

Students with any major emphasis must complete 16 credit hours of core courses for the Computer Science major along with the emphasis support and required support courses of their chosen emphasis in addition to all other university requirements.

Core Courses for the Computer Science Major (16 credits)

Computer Science 111, Introduction to Java
Computer Science 226, Data Structures Using Java
Computer Science 341, Software Design and Development
Computer Science 450, Projects for Computer Science Majors

Software Engineering Emphasis (48 additional credits)

CSC Support Courses for the Emphasis (32 credits)

Computer Science 107, Problem Solving Using Information Technology (2 credits)
Computer Science 109, Technological Productivity (2 credits)
Computer Science 110, Problem Solving through Programming
Computer Science 211, Database, Web Creation and Networks
Computer Science 271, Computer Organization (2 credits)
Computer Science 272, Computer Architecture (2 credits)
Computer Science 323, Programming Languages
Computer Science 351, Database Design
Computer Science 440, Software Engineering
Computer Science 480, Internship in Computer Science

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Required Support Courses (16 credits)

Communication 101, Principles of Communication

Mathematics 160 and 161, Calculus I and II or

Mathematics 140 and Mathematics 112

Mathematics 205, Discrete Mathematics

Information Systems Emphasis (56 additional credits)

CSC Support Courses for the Emphasis (28 credits)

Computer Science 107, Problem Solving Using Information Technology (2 credits)

Computer Science 109, Technological Productivity (2 credits)

Computer Science 110, Problem Solving through Programming

Computer Science 211, Database, Web Creation and Networks

Computer Science 220, Information Systems

Computer Science 351, Database Design

Computer Science 409, Information Technology Management in an
E-Commerce World

Computer Science 480, Internship in Computing

Required Support Courses (28 credits)

Accounting 205, Financial Accounting

Business 101, Introduction to Business

Communication 101, Principles of Communication

Economics 110, Introduction to Economics

Mathematics 112, Introduction to Statistics

Mathematics 140, Calculus and its Applications

Mathematics 205, Discrete Mathematics

ABET*-Suggested Curriculum Emphasis (64 additional credits)

CSC Support Courses for the Emphasis (28 credits)

Computer Science 271, Computer Organization (2 credits)

Computer Science 272, Computer Architecture (2 credits)

Computer Science 323, Programming Languages

Computer Science 421, Algorithms

Choose four courses from the following list:

Computer Science 319, World Wide Web Programming

Computer Science 303, Networking

Computer Science 307, Operating Systems and Web Master Fundamentals

Computer Science 351, Database Design

Computer Science 431, Artificial Intelligence

Computer Science 437, Computer Graphics

Computer Science 440, Software Engineering

Computer Science 436, Theory of Computation

Computer Science 401, Network Communications Analysis

Computer Science 402, Network Security

Required Support Courses (36 credits)

Mathematics 160, Calculus I

Mathematics 161, Calculus II

Mathematics 207, Calculus III

Mathematics 205, Discrete Mathematics

(Mathematics 206 acceptable instead of Mathematics 205 only for those who are pursuing a math minor)

Mathematics 312, Theory of Probability and Statistics

Two laboratory-based science courses that are in a two-semester sequence from the following list (other combinations, while possible, are subject to approval):

Physics 203 and Physics 204, or

Biology 120 and Biology 125, or

Chemistry 101 and Chemistry 102, or

Chemistry 109 and Chemistry 110

One additional laboratory-based science course

Communication 101, Principles of Communication

*ABET stands for Accreditation Board for Engineering and Technology

Computer Science Minor (24 credits)**Required Core Courses**

Computer Science 111, Introduction to Java

Computer Science 226, Data Structures using Java

Computer Science 271, Computer Organization (2 credits)

Computer Science 272, Computer Architecture (2 credits)

Computer Science 341, Software Design and Development

Choose two courses from the following list:

Computer Science 220

Computer Science 303

Computer Science 307

Computer Science 319

Computer Science 323

Computer Science 351

Computer Science 401

Computer Science 402

Computer Science 409

Computer Science 421

Computer Science 431

Computer Science 437

Computer Science 440

It is recommended that student refer to the following list to choose two courses based on an area of interest:

- Web Development: Computer Science 319 and Computer Science 351

- Computer Networking: Computer Science 303 and Computer Science 401

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- Software Engineering: Computer Science 409 and Computer Science 440
- Computer Science Core: Computer Science 323 and Computer Science 421
- Information Systems: Computer Science 220 and Computer Science 409
- Information Technology: Computer Science 309 and Computer Science 351
- Computer Game Development: Computer Science 431 and Computer Science 437

Information Technology Major with Emphasis on Web Application Development, Business and Social Applications, or Computer Networking (74 credits) Bachelor of Science

To complete an IT major with emphasis on Web Application Development, Business and Social Applications, or Computer Networking, students must complete 34 credit hours of the core courses for the IT major along with 16 credit hours of the support courses and 24 credit hours of the required courses of their chosen emphasis in addition to all other university requirements.

Core Courses (34 credits)

Computer Science 107, Problem Solving Using Information Technology (2 credits)

Computer Science 109, Technological Productivity (2 credits)

Computer Science 110, Problem Solving through Programming

Computer Science 211, Database, Web Creation, and Networks

Computer Science 220, Information Systems

Computer Science 271, Computer Organization (2 credits)

Computer Science 303, Networking

Computer Science 409, Information Technology Management in an E-Commerce World

Computer Science 451, Projects for Information Technology Majors

Computer Science 480, Internship in Information Technology

Required Support Courses (16 credits)

Business 101, Introduction to Business

Business 302, Principles of Management

Communication 202, Small Group Communication

Mathematics 112, Introduction to Statistics

Web Application Development Emphasis (24 additional credits)

Computer Science 112, Advanced Programming with C#

Computer Science 307, Operating Systems and Web Master Fundamentals

Computer Science 319, World Wide Web Programming

Computer Science 351, Database Design

Computer Science 352, Advanced Business Web Applications

Graphic Communication 320, Introduction to Multimedia Production

Business and Social Applications (24 additional credits)

Accounting 205, Financial Accounting

Business 301, Principles of Marketing

Business 305, Principles of Operations Management

Communication 370, Communication Technology and Society
Psychology 316, Thinking, Problem Solving, and Cognition
Sociology 217, Social Psychology

Computer Networking (24 additional credits)

Computer Science 111, Introduction to Java or
Computer Science 112, Advanced Programming with C#
Computer Science 217, Network Interconnection
Computer Science 307, Operating Systems and Web Master Fundamentals
Computer Science 351, Database Design
Computer Science 401, Advanced Network Protocols and Programming
Computer Science 402, Fundamentals of Network Security Design and
Implementation

**Information Technology Major with Emphasis on
Computer-Game Development (88 credits)
Bachelor of Science**

To complete an IT major with emphasis on Computer-Game Development, students must complete 64 credit hours of required core courses including 20 credits from Milwaukee Area Technical College (MATC) along with 24 credit hours of the support courses in addition to all other university requirements.

Core Courses (64 credits)

Computer Science 110, Problem Solving through Programming
Computer Science 111, Introduction to Java
Computer Science 211, Database, Web Creation, and Networks
Computer Science 226, Data Structures
Computer Science 303, Networking
Computer Science 341, Software Design
Computer Science 351, Database Design
Computer Science 431, Artificial Intelligence
Computer Science 437, Computer Graphics
Computer Science 451, Projects for Information Technology Majors (8 credits)

Courses taken at MATC:

VICOM-110, Introduction to Computer Simulation and Gaming (3 credits)
VICOM-115, CSG Production Lab (3 credit)
VICOM-129, CSG Architecture (2 credits)
VICOM-130, CSG Design (3 credits)
VICOM-140, Vicom Practices (2 credits)
VICOM-180, Multimedia Collaborative Lab (3 credits)
VICOM-181, CSG Collaborative Lab and Audio (4 credits)

Required Support Courses (24 credits)

Business 101, Introduction to Business

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Communication 202, Small Group Communication
Physics 101, Introductory Physics I
Physics 102, Introductory Physics II
Mathematics 140, Calculus and Its Applications
Graphic Communication 360, Digital Flash Gaming

Information Technology Minor (26 credits)

Required Core Courses

Computer Science 110, Problem Solving through Programming
Computer Science 211, Database, Web Creation and Networks
Computer Science 271, Computer Organization (2 credits)
Computer Science 409, Information Technology Management

Choose three courses from the following list:

Computer Science 111 or
 Computer Science 112
Computer Science 220
Computer Science 303
Computer Science 307
Computer Science 319
Computer Science 351
Computer Science 352
Computer Science 401
Computer Science 402
Graphic Communication 295
Graphic Communication 320
Graphic Communication 360

It is recommended that students refer to the following list to choose three courses based on an area of interest:

- Web Development: Computer Science 112, Computer Science 319 and Computer Science 351
- Computer Networking: Computer Science 303, Computer Science 304 and Computer Science 401
- Server and Database Administrator: Computer Science 111 or Computer Science 112, Computer Science 309 and Computer Science 351,
- Digital Production: Graphic Communication 295, Graphic Communication 320 and Graphic Communication 360
- Network Security: Computer Science 303, Computer Science 304, and Computer Science 402

Because of rapid advancement of computing technology, some computer science courses taken by students with one or more semester gaps between registrations (summer not included) and outside of a four year period may be subject to approval by computer science faculty before meeting graduation requirements.

- 107. Problem Solving Using Information Technology** **2 credits**
This course provides a foundation in problem-solving skills using information technology. Students will use Microsoft Excel software to solve “real-world” problems. (*Fa, Wn, Sp, Su*)
- 109. Technological Productivity** **2 credits**
This course uses Microsoft Windows and the Office suite of application software as a foundation for personal and organizational productivity. Students will be presented with an overview of computing specifics at Carroll University, and when/how to take advantage of the tools available in the Office applications (Word, Access, PowerPoint). Note that Microsoft Excel is currently the focus of the CSC 107 course. (*Fa, Wn, Sp, Su*)
- 110. Problem Solving through Programming** **4 credits**
This course is designed as a first-semester foundation course for those students planning to major or minor in computer science and for others with an interest in the area. The course is about developing problem solving and structured programming skills, using the computer as a tool for solving problems. It covers the development of computer programs while focusing on the use of Dijkstra’s structural programming principles with sequence, iteration, selection, and top-down structural program decomposition at its core. (*Fa, Sp*)
- 111. Introduction to Java** **4 credits**
This course studies the Java programming language, which is used to promote the student’s understanding of object-oriented concepts (classes, methods, abstraction, inheritance, polymorphism, and encapsulation) in conjunction with algorithm design, style, debugging and testing. (*Sp*) Prerequisite: CSC 110.
- 112. Advanced Programming with C#** **4 credits**
The course has essentially the same objectives as for CSC 111 but uses the programming language C#. The course is designed to be a continuation of CSC 110, in which more advanced programming concepts, constructs, and problem solving skills are addressed. Topics include, but are not limited to, object-orientation, inheritance, polymorphism, exception handling, event-driven programming, files and streams, and collections. Fundamentals of the .NET framework may also be covered. (*Sp*) Prerequisite: CSC 110.
- 211. Database, Web Creation and Networks** **4 credits**
The primary objectives of this course are to develop database skills using Microsoft Access and Web development skills using HTML and Microsoft Web-authoring software Expression Web. E-commerce business problems will be solved using a web front end and database back end. A secondary objective is an introduction to networks concentrating on Ethernet and TCP/IP. Also covered is understanding the internals of personal computers to aid their purchase for home or organizational use. This course also continues the discussion on ethical use of technology. (*Fa, Sp, Su*) Prerequisite: CSC 107 or CSC 109.

217. Network Interconnection

4 credits

This course introduces the networking technologies required to successfully build, maintain and troubleshoot a small-to-medium office network. The course includes topics on networking fundamentals, the TCP/IP and OSI models, and routing and switching fundamentals to meet network requirements of a small to medium business. The course will include laboratory work with device configuration, protocol analyzers and network simulators. (*Sp, even years*) Prerequisite: CSC 211.

220. Information Systems

4 credits

This course will provide the student with an understanding of the fundamental aspects of Information Systems. The student will be exposed to the various types of information systems found in a business environment; encompassing operational, tactical and strategic systems. The student will also learn of the developmental processes involved in creating, implementing and securing an information system. This class was formerly the two-credit CSC 201 and will meet this requirement from previous catalogs. (*Fa, Sp, Su*)

226. Data Structures Using Java

4 credits

This course focuses on the object-oriented paradigm, with particular reference to the design and implementation of data structures such as: stacks, queues, linked lists, and trees. Java collections framework and searching algorithms are also introduced. The course builds on the concepts introduced in CSC 111 to allow students to use and write their own classes and objects. (*Fa*) Prerequisite: CSC 111 or equivalent.

271. Computer Organization

2 credits

This course is intended as a foundation in the installation, maintenance and support of PCs and their components. Terminology and fundamentals of the hardware, software and networks integrated with an Intel processor is to be mastered. Simulated experience with PCs and their components is the foundation of this class. (*Sp, even years*) Prerequisite: CSC 211.

272. Computer Architecture

2 credits

This course is the study of technology and its advancement, specifically, computer architecture. Computer architecture is the study of the structure and operation of digital computers. This study will concentrate on the acquisition, processing, storage and output of data, as well as the connection and interaction between computers. (*Sp, even years*) Prerequisite: CSC 271.

303. Networking

4 credits

This course provides a unified view (both theoretical and applied) of the broad field of data communications and networking. Topics: data transmission, data encoding, data link control, multiplexing, circuit switching, packet switching, radio and satellite networks, local area networks (LANs), wide area networks, and protocols. Networking trends for the future will be covered. (*Fa*) Prerequisite: CSC 211.

304. Business Continuity Planning

4 credits

This course is designed to help students develop the skills needed to respond to network intrusion incidents, understand the impact and plan for real life disaster recovery sce-

narios. Students will perform a thorough analysis of a business, prepare a Business Impact Analysis (BIA), develop a contingency plan, and understand crisis communication with employees, customers and vendors. This course will help students develop the skills needed to successfully recover from a serious incident and successfully plan for that event. Prerequisite: CSC 303.

307. Operating Systems and Web Master Fundamentals **4 credits**

This class covers the elements and design of Win32 and UNIX/Linux operating systems, the fundamentals of system administration, and the installation, configuration and maintenance of the Microsoft IIS and Apache Web Servers. Problems such as concurrence, communication, and security will be addressed. (*Fa*) Prerequisite: CSC 211.

319. World Wide Web Programming **4 credits**

This hands-on course introduces the development of dynamic Web sites. It focuses on Web programming fundamentals and mastery of one of the current server-side technologies. (*Fa*) Prerequisite: CSC 211 and either CSC 111 or CSC 112.

320. Programming Using C++ **4 credits**

This course assumes the student has had programming experience in some other language, and wishes to learn the C/C++ environment. It focuses on the object-oriented paradigm in the language C++, real-time programming, and provides an introduction to creating Windows Applications using Microsoft Visual Studio .NET. Prerequisite: CSC 110 or equivalent.

323. Programming Languages **4 credits**

The objective of this course is to develop in students an understanding of the design and uses of different kinds of programming languages. Several programming languages will be examined including C, C++, Ada, and Lisp/Scheme. Issues considered include: the formal specification of programming language syntax, language design, translator design, and run time behavior of programs. Representatives of various kinds of languages such as assembly level, object-oriented, functional, logical, etc., are examined and students have the opportunity to solve problems in these languages. In addition, students may focus on a particular language of their choice to gain deeper understanding of its design issues. (*Sp, odd years*) Prerequisite: CSC 226.

341. Software Design and Development **4 credits**

This course presents a formal approach to state-of-the-art techniques in software design and development, and the means for students to apply the techniques. Formal models for capturing requirements for object-oriented and procedural designs are presented and used in the course. Other topics include Unified Modeling Language, Design Patterns, and various design principles and guidelines. (*Sp*) Prerequisites: CSC 226.

351. Database Design **4 credits**

The emphasis in this course is on the design and construction of databases as tools in business. Concepts covered include entity-relationship modeling, normalization, and efficient table design. Programming with SQL is stressed using a professional Database

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Management System. The role of databases in Web applications is particularly considered. (*Fa*) Prerequisites: CSC 111 or CSC 112 and CSC 211.

352. Advanced Business Web Applications

4 credits

Students learn how to build web-based business applications by using the technologies introduced in CSC 319 and the skills they have developed. Students develop Web-based applications linking Web sites to back-end databases while also learning how to build distributed, component-based web applications. Web services issues will also be discussed. Applications that scale are stressed in the context of performance, business goals, security, and other relevant topics. The current Web software development principles and methodologies are also stressed. (*Sp*) Prerequisite: CSC 319 and CSC 351.

390/490. Workshop in Computer Science and Information Technology

4 credits

Prerequisite: Approval of the divisional dean and consent of instructor.

391/491. Special Studies/Topics

1-4 credits

This course offers a study of a selected topic not covered in regular curriculum with lectures and/or discussions. The topic will be announced prior to registration. Prerequisite: Consent of instructor.

392/492. Seminar

4 credits

This is an advanced course of study involving individual research. Discussion of this research takes place through informal group participation. Prerequisite: Approval of the divisional dean and consent of instructor.

396/496. Research in Computer Science and Information Technology

4 credits

Advanced research is designed to permit individual students or groups of students to undertake special projects related to their educational interests and goals. Prerequisite: Approval of the divisional dean and consent of instructor.

398/498. Independent Study

1-4 credits

Independent study is designed to offer a study of selected areas under the supervision of one or more faculty. Four credits maximum applied toward degree. Prerequisite: Approval of divisional dean and consent of instructor.

401. Advanced Network Protocols and Programming

4 credits

The course will discuss advanced protocols that exist in the Internet today. This class will also cover network programming using sockets. This will let students study the Internet in depth in terms of software architectures and implementation. As programming exercises, students will implement client-server models as they exist in the Internet. (*Fa, odd years*) Prerequisite: CSC 303.

402. Fundamentals of Network Security Design and Implementation

4 credits

This course provides students with an in-depth look at the security risks and threats to an organization's electronic assets, and an overview of components used in an enterprise security infrastructure. Topics will include the theoretical background necessary to understand the various types of risks, as well as practical techniques to securing an enter-

prise network. The integration of the different components will be studied in detail. Skills covered are intended for IT professionals who work in a typically complex computing environment of a medium to large company. (*Sp, odd years*) Prerequisite: CSC 303.

409. Information Technology Management in an E-Commerce World 4 credits

The emphasis of this class is on the management of information technology within an organization and the use of information technology from a strategic, tactical and operational perspective. The current trends towards e-business and e-commerce are integrated throughout. The class is concerned with the management issues surrounding information technology today. Topics include technology trends, IT planning and strategy, management of end-user computing, network management, asset protection, ethical considerations, in-house or outsourcing the hosting of a Web site, choosing a suitable host, Web site privacy issues/statements, and people management skills. (*Sp, odd years*) Prerequisite: Junior standing.

421. Algorithms 4 credits

This course teaches essential strategies of algorithm design and analysis, including top-down design, divide and conquer, average and worst-case criteria, and asymptotic costs. Simple recurrence relations for asymptotic costs and choice of appropriate data structures such as arrays, lists, stacks, queues, trees, heaps, priority queues, graphs, hash tables may also be covered. Applications to sorting and searching, graph algorithms, matrix algorithms, shortest-path and spanning tree problems, and discrete optimization algorithms such as dynamic programming and greedy algorithms are also stressed. Prerequisite: CSC 226 and MAT 205.

431. Artificial Intelligence 4 credits

This course provides an introduction to the basic theoretical concepts of artificial intelligence, emphasizing the role of AI techniques for game programming. (*Sp, odd years*) Prerequisite: CSC 111.

436. Theory of Computation 4 credits

This course is concerned with the theory of computers, i.e., the forming of several abstract mathematical models that describe computers and similar machines and their capabilities. Topics covered include: Finite Automata, Pushdown Automata, Turing machines, the Chomsky Hierarchy and P and NP problems. Prerequisite: CSC 226 and MAT 205.

437. Computer Graphics 4 credits

For those students who wish to understand how graphics are used and created. The computer graphics fundamentals, transformations of objects, shape modeling, 3-D viewing, rendering for realism, and curve and surface design are studied. Prerequisite: CSC 226.

440. Software Engineering 4 credits

This course presents state-of-the art techniques in software design and development. Topics will include the software engineering lifecycle and current approaches to software development management, including formal methods, software metrics, agile method-

ologies and other innovative techniques. In addition the course will cover version control, software maintenance and quality assurance. A semester-long software development experience is provided. (*Fa*) Prerequisite: CSC 341.

450. Projects for Computer Science Majors

4 credits

This course requires students to work on a real-world project, and is a very demanding course open only to majors in their senior year. The course allows students to select, design, code, document and formally present a substantial project of their own choosing. Students should coordinate with an instructor of their choice to provide guidance and receive consent prior to registration. (*Sp, Su*) Prerequisites: Completion of ALL required CSC prefix coursework.

451. Projects for Information Technology Majors

4 credits

This course requires students to work on a real-world project of their own choosing, and is a very demanding course open only to majors in their senior year. The project allows students to use the knowledge gained in the coursework to produce a substantial product in the area of information technology by going through the entire development life-cycle. Students should coordinate with an instructor of their choice to provide guidance and receive consent prior to registration. (*Sp, Su*) Prerequisites: Completion of ALL required IT coursework.

455. Projects for Computer Science Minors

4 credits

This course gives the student a real world experience in a computer-related project and is designed for minors only. (*Sp, Su*) Prerequisites: Completion of ALL other minor requirements.

480. Internship in Computer Science or Information Technology

1-12 credits

The course provides professional work experience in computer science or information technology under the supervision of faculty and industry personnel. Written report is required at the end of internship. *S/U* graded. (*Fa, Sp, Su*) Prerequisites: Junior or senior standing and consent of instructor required prior to registration. The course may be repeated for a maximum of 12 credits, but each repetition requires a substantially different work experience. 40 hours of work is needed for each credit.