DEPARTMENT OF ENGINEERING

The Department of Engineering prepares students for careers that allow them to change the world for the better. The challenges of the 21st century for both the U.S. and the world are great, but for engineers and computer scientists, they offer exciting challenges and a world of possibilities. Our programs are aimed at developing creative problem solvers, who learn math, science and fundamentals so that they can apply them in solving the ever-changing problems of tomorrow. Our emphasis on application and learning by doing, all in a small class setting, prepares our graduates to successfully enter the workforce or pursue further education.

Quinnipiac's Bachelor of Science programs in Civil, Industrial, Mechanical and Software Engineering are accredited by the Engineering Accreditation Commission of ABET, abet.org (http://www.abet.org). The BS in Computer Science program is accredited by the Computing Accreditation Commission of ABET.

Bachelor of Science

- Bachelor of Science in Civil Engineering (http://catalog.qu.edu/engineering/engineering/civil-engineering-bs/)
- Bachelor of Science in Computer Science (http://catalog.qu.edu/engineering/engineering/computer-science-bs/)
- Bachelor of Science in Industrial Engineering (http://catalog.qu.edu/engineering/engineering/industrial-engineering-bs/)
- Bachelor of Science in Mechanical Engineering (http://catalog.qu.edu/engineering/engineering/mechanical-engineering-bs/)
- Bachelor of Science in Software Engineering (http://catalog.qu.edu/engineering/engineering/software-engineering-bs/)

Bachelor of Arts

- Bachelor of Arts in Computer Science (http://catalog.qu.edu/engineering/engineering/computer-science-ba/)

Master of Science

- Computer Science (http://catalog.qu.edu/graduate-studies/engineering/ms-computer-science/)
- Cybersecurity (http://catalog.qu.edu/graduate-studies/engineering/cybersecurity/)

Minors

- Minor in Computer Science (http://catalog.qu.edu/engineering/engineering/computer-science-minor/)
- Minor in Manufacturing (http://catalog.qu.edu/engineering/engineering/manufacturing-minor/)

Dual-Degree Programs

- Accelerated Dual-Degree Bachelor's/Master's (http://catalog.qu.edu/engineering/engineering/accelerated-four-year/) (3+1)
- Dual-Degree BA/MS or BS/MS in Cybersecurity (http://catalog.qu.edu/engineering/engineering/cyber-dual-degree/) (4+1)

Double-Degree Program

- Double-Degree BS in Industrial Engineering and BS in Health Science Studies (http://catalog.qu.edu/health-sciences/health-science/health-science-studies-bs/hss-ie-double-major/)

Micro-Credentials and Badges

- Ethical Hacking and Penetration Testing (http://catalog.qu.edu/graduate-studies/engineering/badge-ethical-hacking-penetration-testing/)

Certificate Programs

- Certificate in Engineering Management (http://catalog.qu.edu/engineering/engineering/engineering-management/)
- Certificate in Lean Six Sigma – Green Belt (http://catalog.qu.edu/engineering/engineering/lean-six-sigma/)
- Certificate in Six Sigma – Black Belt (http://catalog.qu.edu/engineering/engineering/lean-six-sigma-black/)

Civil Engineering (CER)

CER 210. Infrastructure Engineering. **3 Credits.**
This course identifies, analyzes and assesses built infrastructure, which is the foundation for modern society. The complex and interconnected lifecycles are investigated and demands on critical components are calculated. Students explore the nontechnical factors necessary for the functioning of infrastructure including supplies, trained personnel, public policy, ethics and cross-sector dependencies. The course provides a basis for understanding the complexity and cost of maintaining, rebuilding and developing infrastructure. Topics include general infrastructure concepts, water and wastewater, transportation, energy and buildings and cities. Several in-class scenarios are provided to synthesize the connectivity between the major items of infrastructure.
Prerequisites: None
Offered: Every year, Fall

CER 230. Infrastructure Engineering. **3 Credits.**
This course identifies, analyzes and assesses built infrastructure, which is the foundation for modern society. The complex and interconnected lifecycles are investigated and demands on critical components are calculated. Students explore the nontechnical factors necessary for the functioning of infrastructure including supplies, trained personnel, public policy, ethics and cross-sector dependencies. The course provides a basis for understanding the complexity and cost of maintaining, rebuilding and developing infrastructure. Topics include general infrastructure concepts, water and wastewater, transportation, energy and buildings and cities. Several in-class scenarios are provided to synthesize the connectivity between the major items of infrastructure.
Prerequisites: None
Offered: Every year, Fall

CER 240. Civil Engineering Site Design. 3 Credits.
This course provides students with the necessary background to select and develop sites for civil engineering projects as well as review the work of others. Proper site selection and engineering have a significant impact on the economics of a project and long-term utility of the constructed facility. Specifically, the course covers the skills of determining site layout and access, zoning requirements, establishing site contour and drainage, installation of utilities, elementary surveying, creation of drawings using a computer-aided drafting package, and the development of environmental impact statements.
Prerequisites: Take MA 152 or MA 153 and MA 154; or Sophomore standing in the major.
Corequisites: Take CER 240L.
Offered: Every year, Spring

CER 240L. Civil Engineering Site Design Lab. 0 Credits.
Lab to accompany CER 220.
Prerequisites: Take MA 153 and MA 154 Sophomore standing in the major.
Corequisites: Take CER 240.
Offered: Every year, Spring

CER 300. Special Topics in Engineering. 3 Credits.
Prerequisites: None
Offered: As needed

CER 315. Surface Water Hydrology. 3 Credits.
This course covers hydrologic processes relevant to surface water hydrology, including precipitation, evapotranspiration, infiltration, surface runoff and streamflow. Global issues, including climate change and sustainable development, are discussed.
Prerequisites: Take MER 310.
Offered: As needed

CER 320. Structural Analysis. 3 Credits.
This course addresses the analysis and design of basic structural forms such as beams, trusses and frames, which are found in bridges and buildings. Classical deflection techniques such as direct integration and virtual work; and indeterminate analysis techniques such as the force method and displacement methods (slope deflection, direct stiffness and moment distribution) are used to determine forces and deflections in elastic structures. Structural analysis computer programs are introduced and directly applied in the solution of graded analysis and design problems. Approximate analysis techniques are used to check the general accuracy of computer-based results.
Prerequisites: Take MER 220.
Offered: Every year, Spring

CER 325. Concrete Materials. 1 Credit.
This course introduces the design and control of concrete mixtures. Topics include cement hydration, durability, aggregates, supplementary cementitious materials, environmental impact, and the fresh and hardened concrete. Concrete cylinders are made, cast, cured, and mechanically tested. Students learn materials testing techniques, quality control and construction practices.
Prerequisites: Take MER 220 or MER 220L.
Offered: Every year, Fall

CER 325L. Concrete Materials Lab. 0 Credits.
This laboratory uses concrete mix design and strength testing labs to proportion the constituents of quality concrete and to provide a background in materials testing techniques, quality control and sound construction practices.
Corequisites: Take CER 325.

CER 330. Fundamentals of Environmental Engineering. 3 Credits.
This course introduces students to the field of environmental engineering with an emphasis on basic principles, design, problem solving, analytical skills and sustainable solutions to environmental engineering problems. Topics include water chemistry, mass balance, water treatment, water quality and pollution control.
Prerequisites: Take CHE 110, MA 153 and MA 154.
Corequisites: Take CER 330L.
Offered: Every year, Fall

CER 330L. Fundamentals of Environmental Engineering Lab. 0 Credits.
Lab to accompany CER 330.
Prerequisites: Take CHE 110.
Corequisites: Take CER 330.
Offered: Every year, Fall

CER 340. Introduction to Geotechnical Engineering and Foundation Design. 3 Credits.
Soil mechanics is the study of soil properties, which govern the use of soil as a construction or foundation material. The course is devoted to describing soils, analyzing soil stresses, determining consolidation settlement, designing earth embankments, determining earth pressures and designing foundations based on applicable engineering principles and recognition of the fundamental concepts of soil behavior.
Prerequisites: Take MER 210.
Offered: Every year, Fall

CER 340L. Introduction to Geotechnical Engineering and Foundation Design Lab. 1 Credit.
In this laboratory course, students examine soil properties and extract necessary parameters for design. This course focuses on the common testing methods of soils in geotechnical engineering practice following ASTM standards for classification of soils and basic design of foundations.
Prerequisites: Take MER 210.
Corequisites: Take CER 340.
Offered: Every year, Fall

CER 350. Hydrology/Hydraulic Design. 3 Credits.
This course studies both hydrology, which is the study of occurrence, movement and distribution of rainfall, and hydraulic design, which is the application of fluid mechanics, physical science and engineering disciplines in the design of structures and development of water resources. Hydrologic principles are applied to model and analyze the distribution and movement of rainfall in a watershed. Hydraulic principles are applied to analyze and design flow-through systems of reservoirs, channels and culverts. The course makes extensive use of computer simulation models used in engineering practice.
Prerequisites: Take MER 310.
Offered: Every year, Spring

CER 350L. Hydrology/Hydraulic Design Lab. 1 Credit.
This lab supports and reinforces concepts from the Hydrology/Hydraulic Design course. Hands-on laboratory and field activities are performed for the measurement of pipe flow and headloss, evaluation of pipe networks, pump characterization, rainfall measurement, open channel weirs and orifices and streamflow measurement. Various industry-standard software packages for water distribution systems, open channel hydraulics and stormwater management are introduced.
Prerequisites: Take MER 310.
Corequisites: Take CER 350.
Offered: Every year, Spring

CER 360. Construction Management. 3 Credits.
This course focuses on the implementation of various projects in which a civil engineer may be engaged, including planning and feasibility studies, design and construction. Students study topics relating to the management of construction, including scope of work, rough order-of-magnitude estimating, scheduling, planning, progress reporting, resource constraining and quality control. The roles of the contractor, owner, public entities and designer are explained.
Prerequisites: Take ENR 210.
Offered: As needed

CER 370. Materials Engineering for Civil Engineers. 3 Credits.
This course introduces the fundamental properties of civil engineering materials, including mechanical, chemical, physical, surface, fracture and rheological properties. The materials discussed are cements, metals, asphalt, wood and composites. Special effort is directed at learning new sustainable construction materials and practices, including alternative binders for concrete and methods for increasing the service life of civil engineering infrastructure.
Prerequisites: Take CHE 110.
Corequisites: Take MER 220.
Offered: As needed

CER 405. Ecological Engineering. 3 Credits.
Ecological engineering is the design of sustanable ecosystems that intergrate human society with its natural enviornment for the benefit of both. This course will explore the basic concerpts of ecological engineering for design applications with a focus on hydrologic restoration of terrestrial and aquatic habitats through ecological engineering approaches such as implementation of green stormwater infrastructure, stream and river restoration and wetland creation & restoration.
Prerequisites: Take CER 350 CER 350L or permission of instructor.
Offered: As needed

CER 410. Design of Steel Structures. 3 Credits.
The course synthesizes the fundamentals of statics, mechanics of materials and structural analysis and applies them to the design of structural members, with emphasis on satisfying real-world needs. Topics include an introduction to the design of structural systems, steel tension and compression members, beams and beam-columns and connections. All design is performed in accordance with codes and specifications used in current engineering practice. A comprehensive design problem requires development of a design methodology, consideration of alternative solutions and design of an optimal steel structure to meet stated functional requirements.
Prerequisites: Take CER 310 or permission of instructor.
Offered: As needed

CER 415. Advanced Structural Analysis. 3 Credits.
This course builds on the material covered in CER 310 to develop a better understanding of structural behavior. Matrix analysis methods, including an introduction to finite elements, are developed as the basis for modern, computer-based structural analysis. These and other advanced analytical techniques are used to analyze and design trusses, beams and frames. Coursework involves extensive use of the computer as an analytical tool. Students use state-of-the-art structural engineering analysis and design software.
Prerequisites: Take CER 310.
Offered: As needed

CER 420. Design of Concrete Structures. 3 Credits.
This course introduces the behavior and failure mechanisms of structural concrete. Current codes and industry standards are used to guide the practical design of beams, slabs and columns.
Prerequisites: Take CER 320.
Offered: Every year, Fall

CER 435. Geotechnical Aspects of Transportation Infrastructure. 3 Credits.
Students are exposed to the geotechnical aspects of transportation systems, with a strong focus on pavement design (both rigid and flexible). Basic transportation topics necessary for the geotechnical design of roads are covered.
Prerequisites: Take CER 340.
Offered: As needed

CER 445. Advanced Geotechnical Engineering and Foundation Design. 3 Credits.
This course focuses on the analysis and design of shallow and deep foundations. Other topics include field testing, structural design of footings, and the geotechnical aspects of retaining wall design and excavations.
Prerequisites: Take CER 340.
Offered: Every year, Spring

CER 450. Water and Waste Water Technology. 3 Credits.
Students study technical engineering solutions to problems regarding water processing, water distribution, wastewater collection, and wastewater treatment. Advanced technical topics include: water distribution and sewerage system design, unit process design and environmental biotechnology.
Prerequisites: Take CER 330.
Offered: As needed

CER 455. Advanced Environmental Engineering. 3 Credits.
Students extend what they learned in the Fundamentals of Environmental Engineering course. This course provides a more in-depth look at environmental policies and regulations concerning water and air and their implications on design. Case studies and design projects allow students to focus on both technical and nontechnical issues associated with environmental projects. Advanced technical topics include: biological treatment, cell growth kinetics, sludge treatment/disposal, landfills, air pollution control, hazardous waste, contaminant transport, quantitative risk assessment and advanced water treatment.
Prerequisites: Take CER 330.
Corequisites: Take CER 455L.
Offered: Every year, Spring

CER 455L. Advanced Environmental Engineering Lab. 0 Credits.
Lab to accompany CER 455.
Prerequisites: Take CER 330.
Corequisites: Take CER 455.
Offered: Every year, Spring

CER 465. Hazardous Waste and Environmental Site Assessment. 3 Credits.
This course provides an introduction to hazardous waste management and preliminary site investigations for environmental hazards. Topics include identification of wetlands, title searches, air photo interpretation for environmental hazards, visual site surveys, operation of environment monitors, current EPA regulations regarding site assessment and investigation, and sampling of surface materials. Additional coursework focuses on hazardous waste; in particular, the legal framework, chemistry, quantitative risk assessment and remediation.
Prerequisites: Take CER 330.
Offered: As needed

CER 470. Water Quality. 3 Credits.
This course introduces basic chemical principles and applications to the analysis and understanding of aqueous environmental chemistry in natural waters and wastewaters. Topics include modeling of chemical systems, dissolved oxygen, nutrients, temperature and toxic substances with applications to groundwater, rivers, lakes, estuaries and coastal waters.
Prerequisites: Take CER 330.
Offered: As needed

CER 475. Groundwater Hydrology and Contaminant Transport. 3 Credits.
Students analyze groundwater flow and contaminant transport in the subsurface. Topics include geologic and physical factors affecting the movement of water and contaminants, sources of pollution, mathematical formulation and solution of groundwater flow and transport problems, remediation methods and an introduction to computer simulation models.
Prerequisites: Take CER 330, CER 340, CER 350.
Offered: As needed

CER 485. Slope and Earth Structures Stability. 3 Credits.
Students deepen their understanding of the mechanical behavior of slopes and earthen structures. The focus of this course is on the design, construction and performance of slopes and earthen structures.
Prerequisites: Take CER 340.
Offered: As needed

CER 490. Engineering Professional Experience. 0-1 Credits.
Students gain experience by employing engineering skills in a professional setting under the guidance of practicing engineers. Students must obtain departmental approval and register prior to starting the experience.
Prerequisites: Take ENR 395 or permission of the instructor.
Offered: Every year, All

CER 497. Design of Civil Engineering Systems I. 3 Credits.
The first half of a two-semester sequence, this course is part of the culminating senior design sequence for students in the civil engineering program. This course focuses on the implementation of civil engineering projects, including the senior design project. Students study topics related to the stages and structure of construction, costing and take-off, scheduling, ethics, safety, sustainable construction and project planning. In the context of the senior design project, students investigate the project, develop functional requirements, and prepare a draft project schedule in preparation for the second half of the sequence.
Prerequisites: Take ENR 210, and Senior Standing.
Offered: Every year, Fall

CER 498. Design of Civil Engineering Systems II. 3 Credits.
This course provides an opportunity for students to apply and synthesize their knowledge of civil engineering. Multidisciplinary teamwork is emphasized. Coursework from the various subdisciplines of civil engineering provides the foundation for this course. Students develop requirements, generate alternatives, make practical engineering approximations, analyze feasibility and make decisions leading to a completed design. The design includes principles of sustainability taking into account realistic constraints. These may include economic, environmental, legal and cultural issues. Deliverables include a comprehensive design report including drawings and a client briefing. This course provides an integrative experience that supports the overarching academic program goal.
Prerequisites: Take CER 310, CER 330, CER 340, CER 350 or permission of instructor.
Offered: Every year, Spring

CER 499. Independent Study in Civil Engineering. 3 Credits.
On an individual or small group basis, students pursue advanced study of a research or design topic in civil engineering. The scope of the course is tailored to the needs of the project and desires of the student, in consultation with the faculty adviser. The student is required to define and analyze the problem, study the fundamentals involved, organize an approach, determine a procedure, perform research and/or achieve a solution, submit a written report and give a formal briefing. Requires permission of the instructor.
Prerequisites: None
Offered: Every year, Fall and Spring

Computer Science (CSC)

CSC 105. Computing: Multidisciplinary Approach. 3 Credits.
Computation is an increasingly important problem-solving tool in any discipline as the amount and variety of available information rapidly grows. This course is an introduction to computer programming and computational problem solving explored within the context of various application domains. Students will solve interesting problems taken from disciplines across campus as they develop their programming skills. This course is open to everyone. Although only a tool for exploration, the programming language used will be a current popular language such as Python.
Prerequisites: None
Offered: Every year, Fall and Spring
UC: Breadth Elective

CSC 106. Introduction to Programming for Engineers. 3 Credits.
This course serves as an introduction to computer science and computer programming for engineers. Topics include fundamental programming constructs, problem-solving techniques, basic data and control structures, and simple data structures and arrays. This course is for non-CSC and non-SER majors.
Prerequisites: None
Offered: Every year, Fall and Spring

CSC 107. Structured Programming Techniques. 1 Credit.
The main purpose of this course is to fill any gaps between Programming and Problem Solving course (CSC 110) and the Introduction to Programming for Engineers course (CSC 106). Topics include a basic programming refresher (in Java), binary number representation, debugging strategies and simple recursion.
Prerequisites: Take CSC 106; Minimum grade C-.
Offered: As needed

CSC 109. Special Topics. **3 Credits.**
Prerequisites: None
Offered: As needed, All

CSC 109H. Special Topics. **3 Credits.**
Prerequisites: None
Offered: As needed, All

CSC 110. Programming and Problem Solving. **3 Credits.**
This course serves as an introduction to computer science and computer programming. Topics include fundamental programming constructs; problem-solving techniques; basic data and control structures; testing; debugging; arrays; and an introduction to object-oriented programming. A lab is included.
Corequisites: Take CSC 110L.
Offered: Every year, Fall and Spring

CSC 110L. Programming and Problem Solving Lab. **1 Credit.**
Students gain experience in the practice of programming and problem solving by completing a series of hands-on activities, which increase in complexity, covering a range of topics from the CSC 110 course. This course is taken in conjunction with CSC 110.
Corequisites: Take CSC 110.
Offered: Every year, Fall and Spring

CSC 111. Data Structures and Abstraction. **3 Credits.**
This course is a continuation of CSC 110. Topics include advanced data structures (linked lists, stacks, queues, trees, hash tables), recursion, abstract data types, introductory algorithms, and intermediate object-oriented programming. A lab is included.
Prerequisites: Take CSC 110 and CSC 110L; or CSC 107 with program director approval; Minimum grade C-.
Corequisites: Take CSC 111L.
Offered: Every year, All

CSC 111L. Data Structures and Abstraction Lab. **1 Credit.**
Students gain experience in data structures programming by completing a series of activities, which increase in complexity, covering a range of topics from the CSC 111 course. This course is taken in conjunction with CSC 111.
Prerequisites: Take CSC 110 and CSC 110L; or CSC 107 with program director approval; Minimum grade C-.
Corequisites: Take CSC 111.
Offered: Every year, All

CSC 175. Introductory Topics in Computer Science. **1-3 Credits.**
This course explores introductory computer science topics not available in other courses as well as new topics as they emerge in this rapidly evolving discipline. Topics may be interdisciplinary. This course does not count as an elective in the major.
Prerequisites: Take CSC 110 CSC 106 or GDD 140; Minimum grade C-;
Offered: As needed

CSC 199. Independent Study. **1-6 Credits.**
Prerequisites: None
Offered: As needed

CSC 205. Introduction to Discrete Mathematics (MA 205). **3 Credits.**
This course introduces students to basic concepts and structures of discrete mathematics. Topics can include propositional and predicate logic, sets and set operations, functions, proof techniques, counting problems, probability and basic number theory. Applications include computer science, biology, social sciences, law and the physical sciences.
Prerequisites: Take CSC 110, CSC 110L or MA 110 or higher; Minimum grade C-.
Offered: Every year, Spring

CSC 210. Computer Architecture and Organization. **3 Credits.**
Students are introduced to the organization and architecture of computers. Topics related to computer organization include digital logic, data representation, computer arithmetic, and data path and control unit implementation. Architecture topics include machine language programming and instruction set design.
Prerequisites: Take CSC 111, CSC 111L; Minimum grade C-.
Offered: Every year, Spring

CSC 210L. Computer Architecture and Organization Lab. **1 Credit.**
Students design and implement digital circuits of increasing complexity using abstraction to manage complexity. Students implement Assembly Language programs that demonstrate the instruction set architecture interface between hardware and software. This course is taken in conjunction with CSC 210.
Corequisites: Take CSC 210.
Offered: Every year, Spring

CSC 215. Algorithm Design and Analysis. **3 Credits.**
This course presents a study of the design and analysis of algorithms. Topics include asymptotic analysis, complexity theory, sorting and searching, underlying data structures, recursion, greedy algorithms, divide and conquer, dynamic programming, and NP-completeness. Additional topics may include graph algorithms, probabilistic algorithms, distributed computing and parallel algorithms.
Prerequisites: Take CSC 111, CSC 111L; and CSC 205 or MA 205; Minimum grade C-.
Offered: Every year, Fall

CSC 225. Introduction to Software Development. **3 Credits.**
This course presents introductory software development concepts including group development, large-scale project work and theoretical aspects of object-oriented programming. The course expands on material from previous courses. Professional behavior and ethics represent an important component of this course.
Prerequisites: Take CSC 111 CSC 111L; Minimum grade C-.
Offered: Every year, Fall

CSC 240. Introduction to Computer Security. **3 Credits.**
This course introduces the general principles of computer security from an applied perspective. Topics covered include various forms of physical and cyber attacks, recognizing and defending against machine and network vulnerabilities, the basic building blocks of secure systems, basic cryptography and the social aspects of security.
Prerequisites: Take CSC 111, CSC 111L; Minimum grade C-.
Offered: As needed

CSC 275. Topics in Computer Science. **1-3 Credits.**
This course explores general computer science topics not available in other courses as well as new topics as they emerge in this rapidly evolving discipline. Topics may be interdisciplinary.
Prerequisites: Take CSC 111; Minimum grade C-;
Offered: As needed

CSC 299. Independent Study. **1-6 Credits.**
Prerequisites: None
Offered: As needed

CSC 300. Special Topics. **3 Credits.**
Prerequisites: Take CSC 215.
Offered: As needed, All

CSC 310. Operating Systems and Systems Programming. **3 Credits.**
Students are introduced to operating systems and the software to support these systems. Topics include operating system principles, concurrency, scheduling and dispatch, virtual memory, device management, security and protection, file systems and naming, and real-time systems.
Prerequisites: Take CSC 210, CSC 225; Minimum grade C-.
Offered: Every year, Fall

CSC 315. Theory of Computation. **3 Credits.**
This course provides an introduction to the classical theory of computer science. The aim is to develop a mathematical understanding of the nature of computing by trying to answer one overarching question: "What are the fundamental capabilities and limitations of computers?" Specific topics include finite automata and formal languages (defining a model of computation), computability (determining what can be computed and how to prove that something cannot be computed), and complexity (determining what makes some problems so much harder than others to solve, and examining what is the P versus NP question and why it is it important).
Prerequisites: Take CSC 215 or MA 301; Minimum grade C-.
Offered: Every other year, Spring

CSC 318. Cryptography. **3 Credits.**
Students study methods of transmitting information securely in the face of a malicious adversary deliberately trying to read or alter it. Participants also discuss various possible attacks on these communications. Students learn about classical private-key systems, the Data Encryption Standard (DES), the RSA public-key algorithm, discrete logarithms, hash functions and digital signatures. Additional topics may include the Advanced Encryption Standard (AES), digital cash, games, zero-knowledge techniques and information theory, as well as topics chosen by the students together with the instructor for presentations.
Prerequisites: Take MA 229 or CSC 215; Minimum grade C-.
Offered: Every other year, Spring

CSC 320. Compilers. **3 Credits.**
This course presents a study of the design and implementation of compilers. Topics include translators and compilers, lexical analysis, syntax analysis and parsing, runtime environments and code generation.
Prerequisites: Take CSC 210, CSC 215, CSC 225; Minimum grade C-.
Offered: Every other year, Spring

CSC 325. Database Systems. **3 Credits.**
Students are introduced to the theory and application of database systems. Topics include data modeling and the relational model, query languages, relational database design, transaction processing, databases and physical database design.
Prerequisites: Take CSC 215 and; CSC 225 or SER 225; Minimum grade C-.
Offered: Every other year, Fall

CSC 340. Networking and Distributed Processing. **3 Credits.**
This course introduces students to net-centric computing, the web as an example of client-server computing, building internet and web applications, communications and networking, distributed object systems, collaboration technology and groupware, distributed operating systems and distributed systems.
Prerequisites: Take CSC 215, CSC 225; Minimum grade C-.
Offered: Every other year, Spring

CSC 345. Computer Graphics. **3 Credits.**
This course is an introduction to theory and programming in computer graphics. Topics include graphic systems, fundamental techniques in graphics, basic rendering, basic geometric modeling, visualization, virtual reality, computer animation, advanced rendering and advanced geometric modeling.
Prerequisites: Take CSC 215 CSC 225; Minimum grade C-.
Offered: As needed

CSC 350. Intelligent Systems. **3 Credits.**
Artificial Intelligence is an umbrella topic covering efforts in a variety of fields all searching for one goal: to get computers to perform well at tasks at which humans excel. Topics include fundamental issues in intelligent systems, search and optimization methods, knowledge representation and reasoning, learning, agents, computer vision, natural language processing, pattern recognition, advanced machine learning, robotics, knowledge-based systems, neural networks and genetic algorithms.
Prerequisites: Take CSC 215, CSC 225; Minimum grade C-.
Offered: Every other year, Spring

CSC 375. Advanced Topics in Computer Science (SER 300). **3 Credits.**
This course explores advanced computer science topics not available in other courses, as well as new topics as they emerge in this rapidly evolving discipline. Topics may be interdisciplinary.
Prerequisites: Take CSC 215, CSC 225; Minimum grade C-.
Offered: Every year, Spring

CSC 399. Independent Study. **1-6 Credits.**
Prerequisites: None

CSC 490. Computer Science Internship. **1-6 Credits.**
Prerequisites: None
Offered: As needed

CSC 491. Senior Project I. **3 Credits.**
Senior Project I is the first part of a two-semester, capstone experience for computer science students. Students analyze and develop a solution to a major project that requires integration and application of knowledge and skills acquired in earlier coursework. Students develop professional experience by working on a team and communicating progress and results to a variety of audiences. Students explore the ethical and legal responsibilities of a computing professional.
Prerequisites: Take CSC 215, CSC 225; Minimum grade C-.
Offered: Every year, Fall

CSC 492. Senior Project II. **3 Credits.**
Senior Project II is the second part of a two-semester, capstone experience for computer science students. Students implement and evaluate a solution to a major project that requires integration and application of knowledge and skills acquired in earlier coursework. Students continue to develop professional skills in teamwork and communications, and knowledge of their responsibilities as computing professionals.
Prerequisites: Take CSC 491; Minimum grade C-.
Offered: Every year, Spring

CSC 493. Senior Thesis I. 1 Credit.
This course is the first part of a two-semester series in which students work independently under the guidance of a faculty member on the development of a senior thesis. The CSC 493/CSC 494 course sequence provides students with an opportunity to synthesize their knowledge of computer science. Students explore the profession of computing by engaging in the professional literature and exploration of professional ethics. Students meet regularly to present and discuss progress. During the first course in the sequence, students develop a proposal for their thesis, including a literature review, and submit to their adviser for approval.
Prerequisites: Senior status in the major.
Offered: Every year, Fall

CSC 494. Senior Thesis II. 3 Credits.
This course is the second part of a two-semester series in which students work independently under the guidance of a faculty member on a significant thesis culminating in the development of a senior thesis. The CSC 493/CSC 494 course sequence provides students with an opportunity to synthesize their knowledge of computer science. Students explore the profession of computing by engaging in the professional literature and exploration of professional ethics. Students meet regularly to present and discuss progress. During the second part in the sequence, students complete the thesis proposed in CSC 493.
Prerequisites: Take CSC 493; Minimum grade C-.
Offered: Every year, Spring

CSC 499. Independent Study. 1-6 Credits.
Prerequisites: None

CSC 500. Intelligent Systems. 3 Credits.
Artificial Intelligence is an umbrella topic covering efforts in a variety of fields all searching for one goal: to get computers to perform well at tasks at which humans excel. Topics include fundamental issues in intelligent systems, search and optimization methods, knowledge representation and reasoning, learning, agents, computer vision, natural language processing, pattern recognition, advanced machine learning, robotics, knowledge-based systems, neural networks and genetic algorithms.
Prerequisites: None
Offered: Every other year, Spring

CSC 510. Computer Architecture. 3 Credits.
This course provides a comprehensive presentation of the organization and architecture of high-performance computers, emphasizing both fundamental principles and the critical role of performance in driving computer design. The topics include CPU design, pipeline design, parallel computing and multi-cores, memory hierarchy, storage, GPGPU, communications and interconnect architectures.
Prerequisites: None
Offered: Every year, Spring

CSC 515. Algorithms & Design. 3 Credits.
This course presents an advanced study of the design and analysis of algorithms. Topics include asymptotic analysis, complexity theory, dynamic programming, order statistics, advanced data structures, graph algorithms, approximation algorithms, string matching, randomized algorithms, and parallel algorithms.
Prerequisites: None
Offered: Every year, Spring

CSC 520. Operating Systems. 3 Credits.
This course represents an advanced study of operating systems and the software to support these systems. Topics include operating system principles, concurrency, scheduling and dispatch, virtual memory, device management, security and protection, file systems and naming, and real-time systems.
Prerequisites: None
Offered: Every year, Fall

CSC 530. Embedded Systems. 3 Credits.
The vast majority of computers in use today are not visible. They are instead embedded in other things. Embedded systems can be found in everything from robots to smart home devices. This course explores the hardware and software of embedded systems, with particular emphasis on getting data in and out of embedded devices.
Prerequisites: None
Offered: Every year, Fall

CSC 575. Special Topics in Computer Science. 1-4 Credits.
This course explores computer science topics not available in other courses, as well as new topics as they emerge in this rapidly evolving discipline. Topics may be interdisciplinary.
Prerequisites: None
Offered: As needed, All

CSC 605. Foundations of Cybersecurity. 3 Credits.
This course introduces students to fundamental security principles and security defense. Students learn the concepts of information security risks, vulnerabilities, assets and threats.
Prerequisites: None
Offered: As needed

CSC 615. Computational Geometry. 3 Credits.
This course focuses on designing and analyzing algorithms for solving geometric problems arising from application domains including graphics, robotics, and GIS.
Prerequisites: None
Offered: As needed

CSC 625. Database Systems. 3 Credits.
This course provides an advanced study of the theory and application of database systems. Topics include data modeling and the relational model, query languages, relational database design, transaction processing, databases and physical database design.
Prerequisites: None
Offered: As needed

CSC 630. Parallel Processing and Design. 3 Credits.
This course explores parallel computing with emphasis on programming massively parallel processors such as graphics processor units (GPUs). The students will make extensive use of parallel programming schemes such as Compute Unified Device Architecture (CUDA). The topics covered are instruction and data level parallelism, CUDA programming, control flow and synchronization, shared memory programming, performance optimization.
Prerequisites: None
Offered: As needed

CSC 640. Computer Networks. 3 Credits.
This course provides an advanced study of the theory and application of net-centric computing, client-server computing, communications and networking, and distributed systems.
Prerequisites: None
Offered: As needed

CSC 645. Computer Graphics. **3 Credits.**
This course focuses on the theory and development of computer graphics technology. Topics include graphic systems, transformations in graphics, quaternions, rendering, geometric modeling, computer animation, ray tracing, and GPU programming (shaders).
Prerequisites: None
Offered: As needed

CSC 650. Neural Networks. **3 Credits.**
This course explores neural networks and will cover biological neurons, artificial neural networks, learning algorithms, perceptron, multilayer perceptron, various other neural network models, and applications of neural network techniques. This is a project-oriented class; hence, students are required to complete a project in groups of two. Projects can be based on any neural network topology.
Prerequisites: None
Offered: As needed

CSC 675. Advanced Topics in Computer Science. **1-4 Credits.**
This course explores advanced computer science topics not available in other courses, as well as new topics as they emerge in this rapidly evolving discipline. Topics may be interdisciplinary.
Prerequisites: None
Offered: As needed, All

CSC 691. MS Thesis I. **3 Credits.**
This course is a requirement for the thesis option within the MS in Computer Science. Students must demonstrate both breadth and depth of knowledge in their field of specialization. They also must demonstrate scientific research skills and present their findings to a thesis committee. and the greater molecular and cell biology community.
Prerequisites: None
Offered: Every year, All

CSC 692. Ms Thesis II. **3 Credits.**
Thesis II is a requirement for the thesis option of the MS in Computer Science program. Students complete their independent research project, write an original thesis describing their research results, and defend their thesis in front of a thesis committee.
Prerequisites: None
Offered: Every year, All

CSC 699. Independent Study. **1-4 Credits.**
This individual study in a specialized area is open to graduate students by special arrangement with the program director. This is a structured program of reading, problem solving, software development, and/or experimentation established through conferences with a member of the computing faculty.
Prerequisites: None
Offered: As needed, All

Cybersecurity (CYB)

CYB 501. Foundations of Cyber Security. **1 Credit.**
This course introduces students to fundamental security principles and security defense. Students learn the concepts of information security risks, vulnerabilities, assets and threats.
Prerequisites: None
Offered: Every year, Fall and Spring

CYB 502. Introduction to Cyber Threats. **1 Credit.**
This course introduces students to the analysis of cyber threats. Students learn to identify bad actors in cyberspace and assess their resources, capabilities, techniques and motivations. Students learn to describe different types of cyber attacks and their characteristics.
Corequisites: Take CYB 501.
Offered: Every year, Fall and Spring

CYB 503. Introduction to Cyber Defense. **1 Credit.**
Students learn about cyber defense tools and techniques. This course covers how to apply cyber defense tools and techniques to prepare a system to repel attacks.
Corequisites: Take CYB 502.
Offered: Every year, Fall and Spring

CYB 505. Introduction to Cybersecurity. **3 Credits.**
This course will introduce students to basic cybersecurity concepts, including risk management, threats, vulnerabilities, and defense techniques.
Prerequisites: None
Offered: Every year

CYB 506. Introduction to Programming for Security Professionals. **1 Credit.**
This course introduces students to basic scripting and programming concepts needed for security defense. Course topics include writing scripts for Windows and Linux; understanding basic programming security concepts; basic programming constructs, such as variables, types, loops, functions and data structures.
Prerequisites: None
Offered: Every year, Summer

CYB 509. Operating Systems Security. **1 Credit.**
This course introduces students to operating systems and the software to support these systems. Topics include operating system security configuration, control objectives, control maintenance and forensics. The course includes hands-on implementation of security controls, including access management, file and process security configuration, and security monitoring.
Prerequisites: None
Offered: Every year, Spring

CYB 510. Introduction to Security Technology. **3 Credits.**
This course will introduce students to concepts and practices around securing networks, securing operating systems, and securing data with cryptography.
Prerequisites: None
Offered: Every year, Fall and Spring

CYB 517. Introduction to Cryptography. **1 Credit.**
This course introduces students to cryptography algorithms, protocols and applications. Topics include history; applications, such as SSL and SSH; and protocols, such as hash functions, symmetric and asymmetric cryptography, and attack-vectors for systems.
Prerequisites: None
Offered: Every year, Spring

CYB 520. Concepts and Practices for Securing Data. **3 Credits.**
This course will introduce students to concepts and practices needed to secure data, in relational, non-relational and IoT platforms.
Prerequisites: None
Offered: Every year, Spring

CYB 524. Relational Database Security. 1 Credit.
This course introduces students to different relational database management systems (DMS) and DMS security concerns and methods. Topics covered include hashing and encryption, database access controls, unauthorized access, data corruption and injection.
Prerequisites: None
Offered: Every year, Spring

CYB 526. Non-Relational Database Security. 1 Credit.
This course introduces students to the theory, application and security of nonrelational database systems. It focuses on data management, query and security aspects of nonrelational databases. Topics include a comparison between relational and nonrelational database models, NoSQL storage types for different databases such as MongoDB, Hadoop, Amazon DynamoDB, document-based databases and graph databases.
Corequisites: Take CYB 524;
Offered: Every year, Spring

CYB 530. Programming for Security Professionals. 3 Credits.
This course will introduce students to programming concepts and practices needed for security defense, including scripting, machine data analytics and security automation.
Prerequisites: None
Offered: Every year, Spring and Summer

CYB 540. Introduction to Secure Networking. 1 Credit.
This course introduces students to the theoretical and practical aspects of designing, developing and defending computer networks. Topics include network models, media, architectures, devices, protocols, services, applications and use of network security tools.
Prerequisites: None
Offered: Every year, Spring

CYB 550. Cyber Policy. 3 Credits.
There are three parts to this course. The first part covers the applicable federal and state laws and policies related to cyber defense, pertaining to the storage and transmission of data. In the second part, students analyze and develop enterprise security policies. Finally, students learn how to implement machine security policies.
Prerequisites: None
Offered: Every year, Fall and Summer

CYB 613. Practical, Hands-On Healthcare Cyber Risk Management. 3 Credits.
This course will introduce students to concepts and practices needed to manage HIPAA compliance and security risks, and how to organize and facilitate these practices within an enterprise health organization.
Prerequisites: None
Offered: Every year, Fall

CYB 615. Introduction to Ethical Hacking Operational Reconnaissance, and Penetration Testing.. 3 Credits.
Students will learn the basics of conducting a penetration test, including understanding the legal requirements, how to conduct reconnaissance operations, operating common penetration testing tools and how to document the results of a penetration test.
Prerequisites: None
Offered: Every year, Summer

CYB 660. Programming for Security Analytics. 1 Credit.
This course introduces students to basic command-line methods used in machine data analytics. Student learn how to collect machine logs, search log data, and identify anomalies in logs.
Corequisites: Take CYB 506.
Offered: Every year, Summer

CYB 661. Programming for Security Automation. 1 Credit.
This course focuses on programming methods that are applicable to security automation. Students gain experience in automation using Python and Cloud native CLI to facilitate such tasks as automated code scanning; automated application scanning in testing and staging; automated network, server, container configuration checks; and continuous monitoring of development pipeline components and job scheduling.
Corequisites: Take CYB 660.
Offered: Every year, Summer

CYB 662. Secure Web Applications Design. 1 Credit.
This course covers the design and architecture of secure web applications, such as: traditional three-tier architectures, SOA, microservices, FaaS; application protocols; authentication and session management; client and server-side controls; input-based vulnerabilities and web application attack trends.
Corequisites: Take CYB 661.
Offered: Every year, Summer

CYB 663. Secure Web Applications Engineering. 1 Credit.
In this course, students learn processes and practices needed to secure applications within the Software Development Life Cycle (SDLC). The course covers traditional SDLC processes and methods to secure modern Cloud native development processes and using concepts of DevSecOps.
Corequisites: Take CYB 662.
Offered: Every year, Summer

CYB 664. Web Applications Security Testing. 1 Credit.
This course introduces students to web application security testing. Topics include application security metrics, selecting the right testing tool and integrating the results into the development life cycle. Students gain hands-on experience using these tools in practical settings.
Corequisites: Take CYB 663.
Offered: Every year, Summer

CYB 665. Workforce Access Security. 1 Credit.
This course focuses on authentication and user access technologies and practices within the enterprise. Topics include Active Directory services and architecture, and enterprise network access protocols.
Prerequisites: None
Offered: Every year, Fall

CYB 667. B2C Access Security. 1 Credit.
This course focuses on authentication and user access technologies and practices within B2C access. Topics include standards-based B2C authentication and access management protocols.
Corequisites: Take CYB 665.
Offered: Every year, Fall

CYB 669. B2B Access Security. 1 Credit.
This course covers access concepts based on B2B communication APIs, such as standard-based protocols and B2B on-boarding, for mobile, social and IoT applications.
Corequisites: Take CYB 667.
Offered: Every year, Fall

CYB 670. IoT Security. 1 Credit.
This course covers security as it pertains to embedded devices, embodied by the growth of the Internet of Things (IoT). Students learn about the specific security issues related to embedded devices, including Linux malware, DDoS attacks, botnets, cryptography and personal privacy.
Corequisites: Take CYB 526.
Offered: Every year, Spring

CYB 675. Ethical Hacking and Penetration Testing. 2 Credits.
This course will introduce students to concepts and practices of ethical hacking and penetration testing. Students will learn how to plan, organize, and perform penetration testing on a simple network.
Prerequisites: None
Offered: Spring

CYB 680. Introduction to Cloud Security. 1 Credit.
In this course, students learn fundamentals of Cloud computing and Cloud security. This course covers topics such as shared responsibility models for IaaS, PaaS, SaaS and FaaS, and Cloud Security Alliance CCM. Students get hands-on experience creating secure systems within a commercial Cloud vendor environment.
Prerequisites: None
Offered: Every year, Fall

CYB 681. Securing Workloads in AWS. 1 Credit.
This course covers concepts and practices for securing AWS workloads. Students are introduced to security controls, such as access controls using IAM, logging and auditing, and other AWS security services.
Corequisites: Take CYB 680.
Offered: Every year, Fall

CYB 682. Securing Workloads in Azure. 1 Credit.
This course covers concepts and practices for securing Azure workloads. Students are introduced to security controls, such as access controls using IAM, logging and auditing, and other AWS security services.
Corequisites: Take CYB 680.
Offered: Every year, Fall

CYB 683. Resilient System Design and Development. 1 Credit.
This course introduces students to the concepts of secure system design and cyber resilience. The content of this course includes best security processes recommended in NIST 800-160 and techniques and technologies needed for secure system design and development.
Prerequisites: Take CYB 680.
Offered: Every year, Spring

CYB 684. Resilient System Testing. 1 Credit.
This course introduces students to state-of-the-art concepts and methods to evaluate cyber resiliency. Topics include breach and attack simulation, configuration assessment and compliance. Hands-on experience with systems testing tools is part of this course.
Corequisites: Take CYB 683.
Offered: Every year, Spring

CYB 685. Operating Resilient Systems. 3 Credits.
This course includes hands-on experience with tools for security activities such as intrusion detection and cloud security monitoring. Other topics this course covers include Site Reliability Engineering (SRE), maintaining situational awareness and dynamic threat.
Corequisites: Take CYB 684.
Offered: Every year, Spring

CYB 690. Introduction to Secure Authentication And Access. 3 Credits.
Students will be introduced to concepts and practices for secure workplace access, secure B2C access and secure B2B access.
Prerequisites: None
Offered: Every year, Fall

CYB 691. MS Cybersecurity Capstone. 3 Credits.
This capstone course is designed to enable students to directly utilize what has been learned in the tools and applications courses in order to analyze and offer solutions for a major cybersecurity challenge. A definition of the problem, analysis of options and a comprehensive presentation of findings and solutions are required components of the course.
Prerequisites: Permission of the Program Director.
Offered: Every year, Spring and Summer

CYB 695. Cloud Security. 3 Credits.
This course will introduce students to concepts in cloud security as well as practices in AWS and Azure clouds.
Prerequisites: None
Offered: Every year, Fall

CYB 696. Introduction to Designing, Testing, and Operating Resilient Systems. 3 Credits.
Students will be introduced to basic concepts of designing, testing and operating resilient systems, including hands-on defense of simulated cyber attack.
Prerequisites: None
Offered: Every year, Fall and Spring

Engineering (ENR)

ENR 105. Learning Strategies Seminar. 0-1 Credits.
The purpose of this course is to introduce students to evidence-based learning strategies and to help students become self-regulated learners who are capable of achieving their full academic potential. Students reflect upon the fundamental nature of learning and what types of learning activities best facilitate their learning process. In addition, students also explore topics related to achievement motivation and growth mindset. The ultimate goal of this course is to help students not only develop a deeper understanding of these topics, but learn ways that the strategies and tools discussed in class readings and discussions can inform their personal study habits.
Prerequisites: None
Offered: Every year, Fall and Spring

ENR 110. The World of an Engineer. 3 Credits.
This course introduces students to the study and practice of engineering, including overviews of specific disciplines. Participatory focus involves group design projects, hands-on learning, computer work, team building and engineering ethics discussions. In an inquiry-based learning framework, students are introduced to the Grand Challenges for Engineering, as defined by the National Academy of Engineering, to consider global issues from a multidisciplinary perspective.
Prerequisites: None
Offered: Every year, Fall
UC: Breadth Elective

ENR 189. Independent Study. 3 Credits.
Prerequisites: None
Offered: As needed

ENR 210. Engineering Economics and Project Management. 3 Credits.
This course provides an introduction to the concepts of economics/finance/costing and explains how these affect the functioning of engineering projects and contribute to decision making in engineering operations. A portion of the course covers the concepts of project management, team building and leading teams that are used throughout the program and in professional practice.
Prerequisites: Take MA 141 or MA 151.
Offered: Every year, Spring

ENR 300. Special Topics in Engineering Project Management (CAPM) Designation. 1-3 Credits.
Prerequisites: None
Offered: As needed

ENR 395. Professional Development Seminar. 1 Credit.
Through discussions, case studies and guest speakers, students are introduced to topics on engineering professionalism, ethics and licensure as well as relevant innovations in engineering to prepare them to enter the workplace as engineering professionals.
Prerequisites: Junior status in the major or permission of adviser.
Offered: Every year, Fall

ENR 410. School of Computing and Engineering Integrative Capstone. 3 Credits.
This course provides students with a culminating and integrative learning experience grounded in their University Curriculum, their major classes, and co-curricular activities. Students explore and evaluate potential solutions to an aspect of one of the 14 Grand Challenges for Engineering, with a focus on the global dimension of the solution. The course may include a service learning or study abroad component.
Prerequisites: Senior status in the major required.
Offered: Every year, Fall and Spring

ENR 490. Engineering Professional Experience. 0-1 Credits.
Students gain experience by employing engineering skills in a professional setting under the guidance of practicing engineers. Students must obtain departmental approval and register prior to starting the experience.
Prerequisites: Take ENR 395 or permission of the adviser.
Offered: As needed

ENR 490H. Engineering Professional Experience. 0-1 Credits.
Students gain experience by employing engineering skills in a professional setting under the guidance of practicing engineers. Students must obtain departmental approval and register prior to starting the experience.
Prerequisites: Take ENR 395 or permission of the adviser.
Offered: As needed

Industrial Engineering (IER)

IER 220. Production Systems (MER 225). 3 Credits.
This course provides an introduction to production systems, classification, general terminology, technical aspects, economics and analysis of manufacturing systems. Students learn the fundamentals of automation and control technologies as well as manufacturing support systems.
Prerequisites: Sophomore status or permission of the instructor.
Offered: Every year, Fall

IER 230. Lean Systems Engineering (MER 235). 3 Credits.
This course provides a comprehensive and hands-on introduction to Lean Systems and its wide applications, with special emphasis on the Toyota Production System.
Corequisites: Take IER 320 or IER 220 or MER 225.
Offered: Every year, Fall

IER 235. Systems Engineering and Management. 3 Credits.
This course discusses the theory and methods used to design, analyze and manage engineered systems. Students review the principles of system life-cycle management including requirements analysis, system design, functional decomposition, configuration management and systems evaluation. Topics of engineering management emphasizing human relationships, motivational theory and human-systems integration also are addressed.
Prerequisites: None
Offered: Every year, Spring

IER 240. Physical Human Factors and the Workplace (MER 245). 1 Credit.
This course analyzes the impacts of the physical factors of the human decision makers on workflow and efficiency. Basic concepts of anthropometry, biomechanics, work physiology, stress and workload as well as work measurement are introduced. Special emphasis is placed on the capabilities and limitations of humans, in human-centered design of systems and products.
Prerequisites: Sophomore status or permission of the instructor.
Offered: Every year, Fall

IER 265. Cognitive Human Factors and the Workplace (MER 265). 2 Credits.
This course analyzes the impacts of the cognitive factors of the human decision makers on workflow and efficiency. Basic concepts of cognition, as well as sensory systems, such as visual and auditory, are introduced, leading to the analysis of design topics, including displays, controls, shiftwork and work-rest schedules. Special emphasis is placed on the capabilities and limitations of humans, in human-centered design of systems and products.
Prerequisites: Sophomore status or permission of the instructor.
Offered: Every year, Fall

IER 280. Data Analytics I. 3 Credits.
The course presents basic techniques of decision making concentrating on both theoretical and modeling aspects. This course integrates the art and science of decision making for single and multiple objective environments to support the decision-making phase of the Systems Decision Process (SDP). The focus of the course is modeling problem structure, uncertainty, risk and preference in the context of decision making.
Corequisites: Take MA 285.
Offered: Every year, Spring

IER 310. Operations Research I (MER 315). 3 Credits.
This course provides a rigorous introduction to the principles of operations research with a focus on linear programming models and simplex method, duality and sensitivity analysis; transportation and assignment problems; network models; integer and nonlinear programming; an introduction to queuing theory and Markov Chains.
Prerequisites: Take one of the following: Take MA 141 or MA 151
Offered: Every year, Fall

IER 315. Fundamentals of Six Sigma - Black Belt. 3 Credits.
Define-Measure-Analyze-Improve-Control (DMAIC) approach in Six Sigma is an organizational improvement strategy used widely in business applications and Black Belt is the highest belt level among white, yellow, green, and black belts. Students are introduced to the DMAIC steps for improvement of a process and using data-driven measuring, analysis, improvement and controlling techniques to solve the defined problem at Black Belt level. Topics include quality improvement philosophies, modeling process quality, statistical process control, lean techniques, human factors, analysis of data sets, data analytics applications on collected data by using sampling strategies, design of control charts, use of statistical distributions for data analysis and process capability. This course is not for Industrial Engineering majors.
Prerequisites: Take MA 170 EC 272 PS 206 MA 206 MA 285 or another statistics course approved by the instructor. Minimum Grade C-;
Offered: As needed

IER 360. Operations Planning and Control. 3 Credits.
This course focuses on analytical techniques for work scheduling and materials planning in the manufacturing, service and health care industries. The main objective is to develop the ability to use engineering tools for industrial engineering practice in operations and materials management. Topics include forecasting, production and material planning, inventory analysis and scheduling techniques.
Prerequisites: Take MA 285.
Offered: As needed

IER 365. Scheduling in Manufacturing and Health Care with Machine Learning Applications. 3 Credits.
This course introduces students to several scheduling techniques and improvement methodologies utilized in manufacturing and health care. Improvement of manufacturing scheduling by using deterministic optimization modeling for single and parallel machine workflow as well as various shop models such as job shops, flow shops, and open shops are covered. The health care scheduling coverage of the course is based on accessibility to health care systems, scheduling of operations, and wait times of patients. Optimization of health care operations by using mathematical formulation is emphasized. Additionally, machine learning concepts such as supervised learning, unsupervised learning, decision trees, and random forest concepts are covered with applications in manufacturing and health care.
Prerequisites: Take MA 151.
Offered: As needed

IER 370. Industrial Robotics (MER 375). 3 Credits.
Students are introduced to robotics and their use in industrial applications. The topics covered in this course include robotics basic programming, types of robots, drive systems for robots, sensors' use in robotics, robot and computer interaction, improvement and analysis of systems' design using robotics, analysis of systems' design using robotics, and robotics applications in manufacturing, health care and service areas.
Prerequisites: Take CSC 110, CSC 110L, CSC 106 or CSC 109.
Offered: As needed

IER 375. Statistical Process Control. 3 Credits.
The main focus in this course is to understand and implement the Define-Measure-Analyze-Improve-Control (DMAIC) approach in Six Sigma. Therefore, defining a problem for improvement of a process and using data-driven measuring, analysis, improvement and controlling techniques to solve the defined problem are the essentials of this course. Topics include quality improvement philosophies, modeling process quality, statistical process control, control charts for variables and attributes, single- and multivariable regression analysis of data sets, sampling strategies, economic design of charts, use of statistical distributions for data analysis and process capability.
Prerequisites: Take MA 285.
Offered: Every year, Fall

IER 380. Data Analytics II. 2 Credits.
This course focuses on analytical skill development for extracting meaningful information from data sets by using technology. Analytical skills includes linear and non-linear regressions, ANOVA, hypothesis testing, and predictive data analysis. The technological skillset development includes reading, analyzing and interpreting data sets by learning how to use a software package.
Prerequisites: Take IER 280.
Corequisites: Take IER 381.
Offered: As needed

IER 381. Data Analytics and Advanced Programming. 1 Credit.
This course focuses on analytical skill development for extracting meaningful information from data sets by using technology. Analytical skills includes linear and non-linear regressions, ANOVA, hypothesis testing, and predictive data analysis. The technological skillset development includes reading, analyzing and interpreting data sets by learning how to use a software package.
Prerequisites: Take CSC 110, CSC 110L; or CSC 106.
Corequisites: Take IER 380.
Offered: As needed

IER 400. Special Topics in Industrial Engineering. 1-4 Credits.
Prerequisites: None
Offered: As needed

IER 401. Introduction to Engineering Management. 3 Credits.
This course concentrates on the general methodology of managing an engineering project from concept to operational use, with emphasis on the functions, roles, and responsibilities of the engineering manager. Topics include career aspects of engineering management; business factors affecting the engineering projects and the manager; technical engineering project organization, planning, execution, and communications; project life cycle; basic risk analysis; design review; design control assessment; reporting; and reaction to critical problems. Student groups will be working on an engineering project scenario that simulates the development of a computing or engineering project with time, cost, and quality decisions to be made as the engineering project manager during the execution of the project.
Prerequisites: Take MA 170 or MA 285 and Junior Status in Major
Offered: Every year, Fall

IER 402. Engineering Quality Management & Decision Making. 3 Credits.
In this course, students will gain knowledge in the application of quality improvement methodology for project management purposes. Emphasis will be placed on philosophical approaches to quality improvement and quantitative methods taking place in engineering projects. The following topics will be included: Corporate Quality Programs, Applications for Quality Improvement, Measurement Systems Analysis, Experimental Design, Root Cause Analysis, and Design for Quality. The participants will also be introduced to decision-making tools needed to analyze data sets.
Prerequisites: Take IER 401.
Offered: Every year, Spring

IER 410. Designing and Managing the Supply Chain. 3 Credits.
This course provides an introduction to the techniques of supply chain management, focusing on logistics, purchasing and product development processes. The main objective is develop competence in quantitative methods for analyzing and solving supply chain problems in a variety of industries that include manufacturing, services and health care. Topics include supply chain performance, network design, product availability and sustainable supply chain management.
Prerequisites: Take IER 360.
Offered: As needed

IER 420. Industrial Control Systems (MER 425). 3 Credits.
Students explore classical control systems through modern control methods based on state variable models, feedback models, controllers and full-state observers. Students gain experience in computer-aided design and analysis using Matlab.
Prerequisites: Take IER 220 or MER 225.
Offered: As needed

IER 425. Quality Engineering and Inspection Systems. 3 Credits.
The focus of this course is to select and implement quality control solutions for industrial processes. Practical quality control systems are examined for applicability and relevance. Topics include the costs of quality, automated and manual measurement, quality control integration, sampling requirements, ANSI and ISO blueprint reading and geometric dimensioning along with the tolerance calculations. The course demonstrates various systems used in quality control plans and key factors required in developing a quality conscious atmosphere.
Prerequisites: Take IER 230.
Offered: As needed

IER 440. Simulation. 3 Credits.
This course includes a simulation of complex systems with applications in industrial engineering. Topics include modeling and developing custom solutions in one or more high-level computer packages; input distribution modeling; emphasizing examples, applications and cases.
Prerequisites: Take MA 285.
Offered: Every year, Spring

IER 450. Health Care Systems Engineering. 3 Credits.
This course introduces students to health care organizations, including hospitals, clinics, multihospital systems and other facilities as an integrated delivery system. By emphasizing practical application of diverse operations involved in such a system, various quantitative modeling and optimization techniques are discussed and applied to solve problems.
Prerequisites: Take IER 230
Offered: Every year, Spring

IER 460. Facilities Layout and Material Handling. 3 Credits.
The focus of this course is the design of industrial facilities with consideration of work organization and layout. Students study product and process designs as a part of facilities planning, material handling systems, flow systems, departmental planning and layout algorithms, space requirements for facilities, and receiving and shipping principles. The course also covers the engineering techniques used for determining the best location of a brand new facility.
Prerequisites: Take IER 320 or IER 220.
Offered: Every year, Fall

IER 470. Industrial Robotics and Advanced Programming. 3 Credits.
Students continue to develop and advance their robotics knowledge introduced in IER 370 - Industrial Robotics - by adding more to their basic robotics programming knowledge. Participants of this course continue to learn about advanced robotics applications in manufacturing, health care, service and systems design.
Prerequisites: Take IER 370.
Offered: As needed

IER 475. Human Reliability. 1 Credit.
This course focuses on the principles, methods and tools for the analysis, design and evaluation of human decision making within human-centered systems. The impacts of human perceptual and cognitive factors are analyzed, leading to design principles for error-prevention. This course is complementary to IER 265, Cognitive Human Factors and the Workplace. Sophomore status required.
Prerequisites: None
Offered: Every year, Fall

IER 485. System Reliability. 2 Credits.
This course provides an introduction to failure rates, failure risk analysis and system configurations, such as series, parallel and redundant systems. It also discusses design for reliability and optimal maintenance and replacement policies.
Prerequisites: Take MA 285, MA 142 or MA 152.
Offered: Every year, Fall

IER 489. Advanced Independent Study in IE. 1-6 Credits.
This is a tutorial course or an individual project in which the student pursues advanced study in systems engineering or engineering management. The scope of the course is tailored to the desires of the student in consultation with a faculty adviser. Communication skills are developed with both written reports and oral presentations. Requires approval of faculty member.
Prerequisites: None
Offered: Every year, Fall and Spring

IER 490. Engineering Professional Experience. 0-1 Credits.
Students gain at least 240 hours of experience by employing industrial engineering skills in a professional setting. Students must obtain departmental approval and register prior to starting the experience. Prerequisite may be waived with permission of adviser.
Prerequisites: Take ENR 395.
Offered: Every year, All

IER 491. Capstone Project I. **3 Credits.**
This is the first part of a two-semester capstone design experience for senior industrial engineering students. Students apply knowledge gained throughout the curriculum to a significant project. Furthermore, this course aims to strengthen the students' oral and written communication skills as well as teamwork and conflict resolution. Students work in teams to formulate issues and collect data at an external organization before beginning to perform analysis and propose solutions in the subsequent course--IER 498.
Corequisites: Take IER 330 or IER 230; IER 430 or IER 375.
Offered: Every year, Fall

IER 492. Six Sigma - Black Belt Project Exp I. **3 Credits.**
This is the first part of a two-semester Six Sigma - Black Belt project experience for students. Students are introduced to the Define-Measure-Analyze-Improve-Control (DMAIC) steps for improvement of a process and using data-driven measuring, analysis,improvement and controlling techniques to solve the defined problem at Black Belt level of Six Sigma. Topics include quality improvement philosophies,modeling process quality, statistical process control, lean techniques,human factors, analysis of data sets, data analytics applications on collected data by using sampling strategies, design of control charts, use of statistical distributions for data analysis and process capability. Furthermore, this course aims to strengthen the students' oral and written communication skills as well as team work and conflict resolution. Students work in teams to formulate issues and collect data at an external organization before beginning to perform analysis and propose solutions in the subsequent course IER 497.This course is not for Industrial Engineering majors.
Prerequisites: Take MA 170, EC 272, PS 206, MA 206, MA 285 or another statistics course approved by the instructor. Minimum grade C-.
Offered: As needed

IER 497. Six Sigma - Black Belt Project Experience II. **3 Credits.**
This is the second part of a two-semester capstone design experience for industrial engineering students. The purpose of a capstone project is to give senior students the opportunity to apply knowledge gained throughout the curriculum to a significant project. After formulating the problem and commencing data collection in IER 492, the student teams continue their project in IER 497 by completing data collection, performing analysis and modeling, and finally recommending solutions to help address the client issue(s).
Prerequisites: Take IER 492;
Offered: As needed

IER 498. Capstone Project II. **3 Credits.**
This is the second part of a two-semester capstone design experience for industrial engineering students. The purpose of a capstone project is to give senior students the opportunity to apply knowledge gained throughout the curriculum to a significant project. After formulating the problem and commencing data collection in IER 491, the student teams continue their project in IER 498 by completing data collection, performing analysis and modeling, and finally recommending solutions to help address the client issue(s).
Prerequisites: Take IER 491.
Corequisites: Take IER 280 IER 310 IER 360;
Offered: Every year, Spring

Mechanical Engineering (MER)

MER 110. 3D Solid Modeling and Printing for Innovators. **3 Credits.**
This course introduces students to 3D solid modeling, allowing users to develop full solid models in a simulated environment for both design and analysis. 3D modeling software finds worldwide use across many disciplines by students, designers, engineers, inventors, artists, and other professionals to produce simple and complex parts, assemblies, and drawings. One can fabricate the models using 3D printing. Students build their own 3D models and use 3D printing to produce a physical prototype. Students also explore applications for this technology, from the biomedical field to architectural design to fashion, gaining an appreciation for its impact in their own lives. No experience is required.
Prerequisites: None
Offered: Fall and Spring
UC: Breadth Elective

MER 210. Fundamentals of Engineering Mechanics and Design. **3 Credits.**
This course provides a foundation in the principles of statics and mechanics of materials while introducing the engineering design process to prepare students for further engineering studies. Equilibrium principles are used to analyze forces on statically determinate rigid bodies and structures.
Corequisites: Take MA 151 (can be taken previous or concurrent).
Offered: Every year, Spring

MER 210L. Fundamentals of Engineering Mechanics and Design Lab. **1 Credit.**
Students learn and practice hands-on techniques relevant to statics, such as equilibrium, friction, truss analysis and tension/compression. All experimental results obtained in the lab are analyzed in the context of the theoretical framework presented in the course.
Corequisites: Take MER 210.
Offered: As needed

MER 220. Mechanics of Materials. **3 Credits.**
Students study the behavior of materials under normal, shear, torsional, bending and combined loads. Loading, geometry, functional environment and material properties of machine or structural elements are used to relate the forces applied to a body to resulting internal forces and deformations in order to evaluate performance. Practical applications involving the design of mechanical and structural elements under various loading conditions are emphasized.
Prerequisites: Take MA 151. Take MER 210, Minimum grade of C-.
Offered: Every year, Fall and Spring

MER 220L. Mechanics of Materials Lab. **1 Credit.**
Students learn and practice hands-on techniques relevant to mechanics of materials, such as tension, torsion, and bending. All experimental results obtained in the lab are analyzed in the context of the theoretical framework presented in the course.
Corequisites: Take MER 220.
Offered: Every year, Fall and Spring

MER 221. Dynamics. **3 Credits.**
Dynamics examines the motion of particles, systems of particles and rigid bodies under the influence of forces. It focuses on the use of Newton's Second Law, the Work-Energy Principle and the Impulse-Momentum Principle. The course progresses from rectilinear and curvilinear motion of single particles, through vector motion of systems of particles, to general motion of rigid bodies.
Prerequisites: Take MER 210; Minimum grade C-; and PHY 121.
Offered: Every year, Fall and Spring

MER 225. Production Systems (IER 220). 3 Credits.
This course provides an introduction to production systems, classification, general terminology, technical aspects, economics and analysis of manufacturing systems. Students learn the fundamentals of automation and control technologies as well as manufacturing support systems.
Prerequisites: Sophomore status or permission of the instructor.
Offered: Every year, Fall

MER 230. Engineering Materials. 3 Credits.
This course explores the relationship between the microscopic structure and macroscopic properties of materials used in engineering applications. The origin of mechanical and physical properties is studied. Emphasis is placed on an understanding of the fundamental aspects of atomic and microstructural concepts for proper materials selection and enhancement of engineering properties. Materials studied are metals, ceramics, polymers and composites.
Prerequisites: Take MER 220, CHE 110.
Offered: Every year, Fall

MER 230L. Engineering Materials Lab. 1 Credit.
Students learn and practice hands-on techniques relevant to engineering materials, such as measuring mechanical and physical properties and strengthening mechanisms. All experimental results obtained in the lab are analyzed in the context of the theoretical framework presented in the course.
Corequisites: Take MER 230.
Offered: Every year, Fall

MER 235. Lean Systems Engineering (IER 230). 3 Credits.
This course provides a comprehensive and hands-on introduction to Lean Systems and its wide applications, with special emphasis on the Toyota Production System.
Corequisites: Take IER 320 or IER 220 or MER 225.
Offered: Every year, Fall

MER 240. Introduction to Mechanical Engineering Design. 1 Credit.
This course introduces mechanical engineering design as an iterative decision-making process. An engineering design problem reinforces the design process instruction and culminates in a student competition.
Prerequisites: Take MER 250, Minimum grade C-.
Offered: Every year, Spring

MER 245. Physical Human Factors (IER 240). 1 Credit.
This course analyzes the impacts of the physical factors of the human decision makers on workflow and efficiency. Basic concepts of anthropometry, biomechanics, work physiology, stress and workload as well as work measurement are introduced. Special emphasis is placed on the capabilities and limitations of humans, in human-centered design of systems and products. Sophomore status required.
Prerequisites: Sophomore status or permission of the instructor.
Offered: Every year, Fall

MER 250. Computer Aided Design. 3 Credits.
Students explore the use of computer methods as an aid to solving engineering problems. Topics include 3D solid modeling, graphical presentation of information, engineering analysis and engineering computer programming. Students learn to apply a variety of engineering-related programs or routines. Students write, document, and use programs of their own in design scenarios. Considerable emphasis is placed on use of the computer as a tool in the engineering design process.
Prerequisites: Take MA 151 CSC 106 or CSC 110;
Offered: Every year, Fall and Spring

MER 265. Cognitive Human Factors and the Workplace (IER 265). 2 Credits.
This course analyzes the impacts of the cognitive factors of the human decision makers on workflow and efficiency. Basic concepts of cognition, as well as sensory systems, such as visual and auditory, are introduced, leading to the analysis of design topics, including displays, controls, shiftwork and work-rest schedules. Special emphasis is placed on the capabilities and limitations of humans, in human-centered design of systems and products. Sophomore status required.
Prerequisites: Sophomore status or permission of the instructor.
Offered: Every year, Fall

MER 310. Fluid Mechanics. 3 Credits.
This course focuses on fluid mechanics while introducing and integrating corresponding topics of thermodynamics. Properties of fluids and hydrostatics as well as conservation principles for mass, energy and linear momentum are covered. Principles are applied to incompressible flow in pipes, external flows, Bernoulli's equation, dimensional analysis, Navier-Stokes, boundary layer development, lift and drag. Laboratory exercises are incorporated into classroom work.
Prerequisites: Take MA 251, PHY 121, MER 210.
Corequisites: Take MA 365 or MA 265.
Offered: Every year, Fall

MER 315. Operations Research I (IER 310). 3 Credits.
This course provides a rigorous introduction to the principles of operations research with a focus on linear programming models and simplex method, duality and sensitivity analysis; transportation and assignment problems; network models; integer and nonlinear programming; an introduction to queuing theory and Markov Chains
Prerequisites: Take MA 153; or MA 151 and MA 229; or MA 141 and MA 229; or MA 142; or MA 152;
Offered: Every year, Fall

MER 320. Thermodynamics. 3 Credits.
This course focuses on thermodynamics. It applies conservation principles for mass, energy and linear momentum as well as the second law of thermodynamics. Principles are applied to power generation systems, refrigeration cycles and total air conditioning. Thermodynamic principles also are applied to the automotive system to examine engine performance (Otto and Diesel cycles) and to high performance aircraft to examine the Brayton cycle.
Prerequisites: Take CHE 110. Must be of junior standing.
Corequisites: Take MA 251 prior to or at the same time.
Offered: Every year, Spring

MER 330. Introduction to Circuits. 3 Credits.
Students are introduced to DC circuit analysis, DC circuit design and AC circuit analysis. The course also includes electrical engineering topics required to prepare students for the Fundamentals of Engineering examination as a part of professional licensure. Students learn the language, tools and problem-solving techniques used in basic electrical circuit analysis.
Corequisites: Take PHY 122
Offered: Every year, Fall and Spring

MER 330L. Introduction to Circuits Lab. 1 Credit.
Students learn and practice hands-on techniques relevant to circuit analysis, such as bread board prototyping, voltage and current measurements, soldering, and basic data acquisition. All experimental results obtained in the lab are analyzed in the context of the theoretical framework presented in the course.
Corequisites: Take MER 330.
Offered: Every year, Fall and Spring

MER 340. Manufacturing/Machine Component Design. 3 Credits.
This course introduces machine component design and manufacturing, relating fundamental engineering science to machine components. It covers load, stress and strain analyses, and fatigue. The course progresses to the study of machine component design, including mechanical components such as linkages, fasteners, springs, bearings, gears and shafts.
Prerequisites: Take MER 220, MER 221 MER 250; Minimum grade C-.
Offered: Every year, Fall and Spring

MER 340L. Manufacturing/Machine Component Design Lab. 1 Credit.
Working primarily in the machine shop, this laboratory provides experiential learning in the context of manufacturing. Students learn techniques, use tools and operate machines used in a manufacturing environment under appropriate supervision. A series of measurement and fabrication exercises culminate in the team-oriented design and manufacture of a mechanical engineering product.
Corequisites: Take MER 250 Must be of Junior Standing;
Offered: Every year, Fall

MER 350. Mechanical Engineering Design. 3 Credits.
This course is the first in a two-course sequence which integrates all previously acquired knowledge and skills. Students begin their major design experience project, applying the mechanical engineering design process to a real-world engineering problem addressing social, political, economic, technical, global and environmental issues. Students continue their project in MER 498.
Prerequisites: Take MER 240 MER 340 MER 340L MER 330 MER 330L Minimum grade C-.
Corequisites: Take MER 230
Offered: Every year, Fall

MER 360. Heat Transfer. 3 Credits.
The three modes of heat transfer--conduction, convection and radiation--are studied in detail, and these concepts are applied to analyze various engineering systems. The principles of conduction, and convection are applied to the analysis of heat exchangers and all three modes of heat transfer are applied together to study scenarios of multi-mode heat transfer.
Prerequisites: Take MER 320 MER 310;.
Offered: Every year, Fall

MER 375. Industrial Robotics (IER 370). 3 Credits.
Students are introduced to robotics and their use in industrial applications. The topics covered in this course include robotics basic programming, types of robots, drive systems for robots, sensors' use in robotics, robot and computer interaction, improvement and analysis of systems' design using robotics, analysis of systems' design using robotics, and robotics applications in manufacturing, health care and service areas.
Prerequisites: Take CSC 110, CSC 110L, CSC 106 or CSC 109.
Offered: As needed

MER 387. Introduction to Applied Aerodynamics. 3 Credits.
The fundamental laws of fluid mechanics are used to develop the characteristic forces and moments generated by the flow about aerodynamic bodies. Lift, drag and aerodynamic moments are studied for airfoils (2D) and finite wings (3D) in the subsonic flow regime. Aircraft performance and design parameters are developed in both the classroom and laboratory sessions. The laboratory sessions include low-speed wind tunnel testing.
Prerequisites: Take MER 221, MER 310.
Corequisites: Take MER 320.
Offered: Every year, Spring

MER 388. Helicopter Aeronautics. 3 Credits.
This course examines the aerodynamics of helicopter flight in relation to hover, translating and partial power flight. Theory and experimental results are used to predict aircraft performance. The course analyzes the dynamic response of the rotor system and the performance aspects of the vehicle as a whole. This is followed by a design workshop, during which students complete the initial sizing of a helicopter to meet specific mission requirements. The course includes a laboratory examining rotor power and thrust utilizing a whirl stand apparatus, and one field trip to a commercial helicopter company.
Prerequisites: Take MER 210, MER 250, MER 310.
Offered: Every year, Spring

MER 399. Special Topics. 1-3 Credits.
Prerequisites: None
Offered: As needed

MER 425. Industrial Control Systems (IER 420). 3 Credits.
Students explore classical control systems through modern control methods based on state variable models, feedback models, controllers and full-state observers. Students gain experience in computer-aided design and analysis using Matlab.
Prerequisites: Take IER 220 or MER 225.
Offered: As needed

MER 450. Environmentally Conscious Design and Manufacturing. 3 Credits.
Students learn to identify, quantify and reduce environmental impacts caused by products. Impact reduction methods form the course's core subject matter. Such methods include: design for recycling, design for remanufacture, life cycle assessment, biomimetics and others. The course also provides an overview of motivational legislation from North America and Europe. Through lecture, discussion, assignments, case studies, and a semester project, students achieve a critical understanding of the role environmental issues play in mechanical engineering.
Prerequisites: Take MER 340.
Offered: Every year, Fall

MER 460. Mechanical Measurement and Data Acquisition. 3 Credits.
In this course, students learn how to perform computer-based measurements of various mechanical phenomena such as displacement, temperature, force, strain, torque, pressure, flow, vibration and acceleration. This is a hands-on course that starts with the basics of sensors and transducers, and walks the students through signal conditioning electronics, instrumentation, data acquisition and signal analysis. A significant portion of this course focuses on LabVIEW, an industry-standard graphical programming language that is widely used for data acquisition and analysis.
Prerequisites: Take CSC 110, CSC 110L or CSC 106; and MER 330, MER 330L.
Offered: Every year, Fall

MER 470. Dynamic Modeling and Control. 3 Credits.
This course covers dynamic modeling and control of linear systems. It includes an overview of classical control theory as the foundation for control applications in mechanical, electrical and aeronautical systems. Mathematical models are developed for various physical systems, and represented in time-domain, Laplace domain, and State-Space. Control system analysis and design techniques are studied within the context of transient and steady-state response.
Prerequisites: Take MER 221, MER 330, MER 330L, MER 250; and MA 265 or MA 365.
Offered: Every year, Spring

MER 470L. Dynamic Modeling and Controls Lab. 1 Credit.
Laboratory exercises include electronic instrumentation of sensors and actuators and microcontroller-based control-system implementations (open-loop and closed-loop). In addition, students learn to simulate dynamic models and controllers using MATLAB and Simulink and perform experimental validation of simulated models.
Prerequisites: Take MER 330L.
Corequisites: Take MER 470.
Offered: Every year, Spring

MER 475. Mechatronics. 3 Credits.
This course presents an introduction to the field of mechatronics. Mechatronics combines elements of mechanics, electric circuits, programming and engineering design in order to create useful electro-mechanical and robotic devices. This is a hands-on, project-based course where students learn basic electronic and programming techniques to integrate various sensors, motors and actuators into moving mechanical platforms.
Prerequisites: Take CSC 110 or CSC 109 or CSC 106; and MER 330 MER 330L, MER 340, MER 340L.
Offered: As needed

MER 489. Advanced Study in Mechanical Engineering. 3 Credits.
The student pursues advanced study of a topic in mechanical engineering on an individual or small-group basis, independent of a formal classroom setting. Similar to graduate level research, the scope of the selected project is tailored to the interests of the student, based on resources and in consultation with a faculty adviser. To develop research skills, the student is integral in all phases of project completion by defining objectives, studying fundamentals and background material, outlining the approach, conducting analysis and communicating results. Requires permission of the instructor.
Prerequisites: None
Offered: Every year, Fall and Spring

MER 490. Engineering Professional Experience. 0-1 Credits.
Students gain experience by employing engineering skills in a professional setting under the guidance of practicing engineers. Students must obtain departmental approval and register prior to starting the experience.
Prerequisites: Take ENR 395 or permission of instructor.
Offered: Every year, All

MER 491. Biomedical Engineering. 3 Credits.
In this introductory course to biomedical engineering, students analyze biomedical implantable and prosthetic devices and explore topics such as biocompatibility, biomechanical properties of biological tissue, device design, as well as factors that go into medical device development and testing. Hands on labs are incorporated into the course to provide a more in-depth immersion into specific course topics. This course focuses on developing lifelong learning skills and service learning. As part of this focus area, students develop a STEM activity to teach a biomedical engineering topic to elementary students.
Prerequisites: Take MER 220, and CSC 106.
Offered: Every year, Spring

MER 498. ME Major Design Experience. 3 Credits.
This course integrates math, science and engineering principles using a comprehensive engineering design project. Open-ended, client-based design problems emphasize a multidisciplinary approach to total system design. Design teams develop product specifications, generate alternatives, make practical engineering approximations, perform appropriate analysis to support technical feasibility, and make decisions leading to designs that meet stated requirements. System integration, computer-aided design, maintainability and fabrication techniques are addressed.
Prerequisites: Take MER 350.
Offered: Every year, Spring

MER 499. Senior Design Project II. 3 Credits.
A two-semester, six credit capstone design experience for mechanical engineering students involving analysis and synthesis of unstructured problems in practical settings. Students work in teams to formulate issues, propose solutions, and communicate results in formal written and oral presentations.
Prerequisites: Take MER 340.
Offered: Every year, Spring

Software Engineering (SER)

SER 120. Object-Oriented Design and Programming. 3 Credits.
This course serves as an introduction to the principles of design and development using object-oriented techniques such as inheritance, polymorphism and encapsulation. Students apply OO techniques to develop event-driven programs. Code craftsmanship is emphasized. Students also learn to apply and recognize design patterns for OO software and to use standard application development frameworks.
Prerequisites: Take CSC 110 and CSC 110L; or CSC 107 with Program Director approval; Minimum grade C-.
Corequisites: Take SER 120L.
Offered: Every year, Fall and Spring

SER 120L. Object-Oriented Design and Programming Lab. 1 Credit.
Students gain experience in object-oriented programming and design by completing a series of activities, covering a range of topics from the Object-Oriented Design and Programming course (SER 120). This course is taken in conjunction with SER 120.
Prerequisites: Take CSC 110 and CSC 110L; or CSC 107 with Program Director approval; Minimum grade C-.
Corequisites: Take SER 120.
Offered: Every year, Fall and Spring

SER 175. Introductory Tpoics in Software Engineering. 1-3 Credits.
This course explores introductory software engineering topics not available in other courses as well as new topics as they emerge in this rapidly evolving discipline. Topics may be interdisciplinary. This course does not count as an elective in the major.
Prerequisites: Take CSC 110 CSC 106 or GDD 140; Minimum grade C-;
Offered: As needed

SER 210. Software Engineering Design and Development. 3 Credits.
This course serves as an introduction to software engineering using object-oriented analysis and design. The course emphasizes the development of robust and high-quality software systems based on object-oriented principles. Implementations are performed using state-of-the-art programming languages and application development frameworks.
Prerequisites: Take SER 120, SER 120L; Minimum grade C-.
Offered: Every year, Spring

SER 225. Introduction to Software Development. 3 Credits.
This course presents introductory software development concepts including group development, large-scale project work and theoretical aspects of object-oriented programming. The course expands on material from previous courses. Professional behavior and ethics represent an important component of this course.
Prerequisites: Take CSC 111, CSC 111L; Minimum grade C-.
Offered: Every year, Fall

SER 275. Topics in Software Engineering. 1-3 Credits.
This course explores general software engineering topics not available in other courses, as well as new topics as they emerge in this rapidly evolving discipline. Topics may be interdisciplinary.
Prerequisites: Take SER 120; Minimum grade C-;
Offered: As needed

SER 300. Advanced Topics in Computer Science (CSC 375). 3 Credits.
This course explores advanced computer science topics not available in other courses, as well as new topics as they emerge in this rapidly evolving discipline. Topics may be interdisciplinary.
Prerequisites: Take CSC 215, CSC 225; Minimum grade C-.
Offered: Every year, Spring

SER 305. Advanced Computational Problem Solving. 3 Credits.
This course presents computational problem solving and advanced algorithmic thinking techniques. It expands on material from previous courses. Students also learn about advanced APIs and software development frameworks, including APIs for advanced collections and concurrent programming, and gain additional experience with frameworks for testing and building software systems.
Prerequisites: Take CSC 215, SER 120, SER 120L; Minimum grade C-.
Offered: Every year, Fall

SER 310. Human-Computer Interaction. 3 Credits.
This course addresses concepts in human-computer interaction (HCI). Students learn about interaction design, information visualization, and usability. The course covers cognitive aspects of HCI and methods for evaluating user interfaces.
Prerequisites: Take CSC 215, CSC 225; Minimum grade C-.
Offered: As needed

SER 320. Software Design and Architecture. 3 Credits.
Students explore software design methodologies, architectural styles, design principles and design techniques. The course examines the principles and methods of architectural design and detailed design of complex, large-scale software systems and covers a number of architectural styles including classical and emerging styles.
Prerequisites: Take SER 340; Minimum grade C-.
Offered: Every year, Spring

SER 325. Databases (CSC 325). 3 Credits.
Students are introduced to the theory and application of database systems. Topics include data modeling and the relational model, query languages, relational database design, transaction processing, databases and physical database design.
Prerequisites: Take CSC 215 and CSC 225 or SER 225 Minimum grade C-.
Offered: Every other year, Spring

SER 330. Software Quality Assurance. 3 Credits.
This course acquaints students with various aspects of software quality assurance. Students learn about dynamic analysis approaches, such as testing and runtime assertions, static analysis approaches, such as reviews and finite-state verification, and processes for promoting software quality. Emphasis is placed on testing, including testing processes, such as unit, integration, system, acceptance and regression testing, and test case selection techniques, such as black-box and white-box testing. The relationship between ethics and software quality assurance is explored.
Prerequisites: Take SER 210; Minimum grade C-.
Offered: Every year, Spring

SER 340. Full-Stack Development 1:Software Requirements Analysis. 3 Credits.
This course covers basic concepts and principles of software requirements engineering including techniques, processes and tools for specifying software requirements. Students learn software prototyping and front-end web development using the latest technologies. Topics include: Layout and responsive design, interactive web development, and functional web programming.
Prerequisites: Take SER 210; Minimum grade C-.
Offered: Every year, Fall

SER 341. Full-Stack Development 2: Software Design. 3 Credits.
This course covers software design methodologies, architectural styles, design principles and design techniques. Students learn back-end web development including building a web service, non-relational databases, routing, aunthentication and state-of-the-art front-end frameworks.
Prerequisites: Take SER 340 Minimum grade of C-
Offered: Every year, Spring

SER 350. Software Project Management. 3 Credits.
This course acquaints students with various aspects of software project management. Students learn about project initiation and scope definition; project planning, enactment and closure; measuring and controlling software artifacts and processes; risk management; and human aspects of software project management. Students use various tools for software project management and obtain hands-on experience by acting as managers of an ongoing software project.
Prerequisites: Take SER 210 SER 225; Minimum grade C-.
Offered: Every year, Fall

SER 359. Transfer Equivalent. 3 Credits.
Prerequisites: None

SER 360. Software Engineering in Health Care. 3 Credits.
Biomedical informatics is one of the fastest growing economic sectors in the world. Software, and thus software engineering, has an important role in biomedical informatics. Students in this course explore the applicability of software engineering techniques to health care. Topics include electronic health records; modeling and analysis of medical processes with the goal of improving safety and efficiency; software solutions for providing clinical decision support; and bioinformatics.
Prerequisites: Take CSC 215, CSC 225; Minimum grade C-.
Offered: Every other year, Fall

SER 375. Advanced Topics in Software Engineering. 1-3 Credits.
Software engineering is a rapidly evolving discipline. This course explores advanced software engineering topics that are not covered in any current software engineering course, or expands on topics currently offered in the catalog. A specific course's focus may be interdisciplinary.
Prerequisites: Take SER 225; Minimum grade C-.
Offered: As needed

SER 399. Independent Study. 1-3 Credits.
Independent study courses are individual examinations of topics within the discipline not covered by conventional courses. Students who wish to engage in independent study must work with a departmental faculty. Students and faculty must agree on a topic, structure and meeting schedule.
Prerequisites: None
Offered: As needed

SER 490. Engineering Professional Experience. 0-1 Credits.
Students gain practical experience in applying theory obtained in previous course experiences by employing engineering skills in a professional setting under the guidance of faculty and mentors. Students must obtain departmental approval and register prior to starting the experience. If approved, an internship could satisfy this requirement. Prerequisite may be waived with permission of adviser.
Prerequisites: Take ENR 395; Minimum grade C-.
Offered: Every year, All

SER 491. Senior Capstone I. 3 Credits.
This is the first part of a two-semester, capstone design experience for software engineering students. It involves analysis and synthesis of unstructured problems in practical settings. Students work in teams to formulate issues, propose solutions and communicate results in formal written and oral presentations
Corequisites: Take SER 340.
Offered: Every year, Fall

SER 492. Senior Capstone II. 3 Credits.
This is the second part of a two-semester, capstone design experience for software engineering students. Students work in teams to refine software artifacts developed in SER 491 and produce a prototype of a software system. Results are communicated in formal written and oral presentations.
Prerequisites: Take SER 491; Minimum grade C-.
Offered: Every year, Spring