SCHOOL OF ENGINEERING AND COMPUTER SCIENCE

https://engineering.pacific.edu/engineering
Phone: (209) 946-2151
Location: John T. Chambers Technology Center
Elizabeth Orwin, Dean

Programs Offered

Bachelor of Science in Bioengineering *(Stockton Campus)*
Bachelor of Science in Civil Engineering *(Stockton Campus)*
Bachelor of Science in Computer Engineering *(Stockton Campus)*
Bachelor of Science in Computer Science *(Stockton Campus)*
Bachelor of Science in Data Science *(Stockton Campus)*
Bachelor of Science in Electrical Engineering *(Stockton Campus)*
Bachelor of Science in Engineering Management *(Stockton Campus)*
Bachelor of Science in Engineering Physics *(Stockton Campus)*
Bachelor of Science in Mechanical Engineering *(Stockton Campus)*
Bachelor of Science in Product Design and Entrepreneurship *(Stockton Campus)*
Bachelor of Science in Sustainability *(Stockton Campus)*
Master of Science in Computer Science *(Stockton Campus, Online)*
Master of Science in Cybersecurity *(Stockton Campus, Online)*
Master of Science in Data Science *(Stockton Campus)*
Master of Science in Engineering *(Stockton Campus)*

Minors

Computer Engineering
Computer Science
Data Science
Engineering Management
Environmental Engineering
Project Management (for non-engineering majors)
Structural Engineering
Sustainability
Technology (for non-engineering majors)
Technological Innovation and Entrepreneurship

Certificates Offered

Certificate in Cybersecurity Management-Cloud, Mobile and Privacy
Certificate in Cybersecurity Operations
Certificate in Securing Enterprise Systems

MS Engineering Concentrations

Civil Engineering (Environmental, Structural)
Computer Engineering / Electrical Engineering
Engineering Management
Mechanical Engineering

Mission

The mission of the School of Engineering and Computer Science is to deliver transformative learning experiences that prepare our graduates to meet society's greatest challenges.

Engineering

No single definition of engineering is adequate; however, engineering is well described as the application link between science and society. Engineers must have the ability to apply theoretical knowledge to practical situations. They are agents through whom science influences our society.

At the School of Engineering and Computer Science, engineers must develop dual competencies - technical and social. They must understand the principles of science as well as the nature of human needs and behavior and the impact of technology on society. The modern engineer deals with socially relevant matters that include pollution, energy resources, sustainability, health care and public transportation systems. Engineers are experts in manufacturing processes, communications systems, medical electronics, the space program and numerous other endeavors that provide citizens of the world with a safer, more enjoyable life.

The Engineering Program at University of the Pacific consists of three well-integrated parts:

1. Mathematics, natural sciences and a broad range of courses in the humanities and social sciences;
2. Engineering courses, which provide the specialized training for professional competence in engineering;
3. On-the-job experience in the Cooperative Education (Co-op) Program described below.

Through this threefold program, theory and practice are brought together; human problems and engineering come into sharp focus; and students find increased meaning in their studies.

By studying at a private university with a strong liberal arts heritage, Pacific engineering students interact with students whose objectives, attitudes and approaches to human problems are different from their own. They experience meaningful associations with students from a variety of social, political and cultural backgrounds.

Computer Science

The Computer Science Department provides an education in computer science which features current and emerging technologies and experiential learning. This program offers a strong background in the theory and practice of computer science. Students select a concentration based on their post-graduation plans. Selection of an area of concentration guides students in the selection of elective courses. Students trained in computer science are among the change agents responsible for forging new computing breakthroughs and new interactions with other disciplines.

The computer science program includes a general education component, a math and science component, a computer science core component and upper division electives. The electives may be chosen based on a selected area of concentration or may be determined by the student in consultation with their academic advisor.

Degrees in Engineering and Computer Science

The School of Engineering and Computer Science offers eight Bachelor of Science (BS) degree programs: Bioengineering, Civil Engineering, Computer Engineering, Computer Science, Electrical Engineering, Engineering Management, Engineering Physics, and Mechanical Engineering. The curricula are divided into lower-division and upper-division segments.

The lower-division engineering curriculum stresses fundamentals in science, mathematics and engineering. The first two years are similar for

all engineering majors. The upper-division curricula combine courses for the degree major with work experience through the Co-op Program.

The Computer Science Department offers a BS degree in Computer Science. A minor program is also available. The curriculum for the Computer Science program includes a core of courses that give students a solid understanding of fundamental computing knowledge and skills. The major has a variety of concentrations that offer a course of study around a theme. The concentrations offer a flexible range of courses that promote a student's specific interests and post-graduate plans. They also guide the selection of elective courses. The available concentrations are Networking and Computer Security, Graphics and Simulation, and Software Development. Students may also choose to select a custom set of electives in consultation with their academic advisor, for a degree without a specific concentration.

The School of Engineering and Computer Science offers two Master of Science (MS) programs: the MS in Data Science and the MS in Engineering. The Masters of Science in Engineering (MSE) degree has four concentration options in:

1. Civil Engineering
2. Computer Engineering, Electrical Engineering
3. Engineering Management
4. Mechanical Engineering

The MSE degree is designed to strengthen students' technical, analytical, and professional breadth and depth. Students are introduced to techniques and best practices of professional research and learn the foundations for assessing the merits of published technical findings.

Accelerated Blended Program

The accelerated Blended Program provides an excellent opportunity for students to begin their graduate work while completing their undergraduate degree requirements. Students can pursue the accelerated Blended Program which allows them to complete their bachelors and masters degree in as little as five years. This five year period includes some summer sessions, depending upon whether advanced placement units were earned prior to starting at Pacific.

Students begin by enrolling in an undergraduate program in the Pacific SOECS. Following acceptance into the Blended Program, students may begin taking graduate level courses at any time after they reach senior status which allows the bachelors and masters degrees to blend together. The two degrees are awarded on the same date.

Accreditation

The Bioengineering (B.S.) program is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org (https://www.abet.org/), under the commission's General Criteria and Program Criteria for Bioengineering and Biomedical and Similarly Named Engineering Programs.

The Computer Engineering (B.S.) program is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org (https://www.abet.org/), under the commission's General Criteria and Program Criteria for Electrical, Computer, Communications, Telecommunication(s), and Similarly Named Engineering Programs.

The Civil Engineering (B.S.) program is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org (https://www.abet.org/), under the commission's General Criteria and Program Criteria for Civil and Similarly Named Engineering Programs.

The Computer Science (B.S.) program is accredited by the Computing Accreditation Commission of ABET, https://www.abet.org (https://www.abet.org/), under the commission's General Criteria and Program Criteria for Computer Science and Similarly Named Computing Programs.

The Electrical Engineering (B.S.) program is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org (https://www.abet.org/), under the commission's General Criteria and Program Criteria for Electrical, Computer, Communications, Telecommunication(s), and Similarly Named Engineering Programs.

The Engineering Physics (B.S.) program is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org (https://www.abet.org/), under the commission's General Criteria and Program Criteria for Engineering, General Engineering, Engineering Physics, Engineering Science, and Similarly Named Engineering Programs.

The Engineering Management (B.S.) program is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org (https://www.abet.org/), under the commission's General Criteria and Program Criteria for Engineering Management and Similarly Named Engineering Programs.

The Mechanical Engineering (B.S.) program is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org (https://www.abet.org/), under the commission's General Criteria and Program Criteria for Mechanical and Similarly Named Engineering Programs.

Student Organizations

All students are encouraged to actively participate in a professional society appropriate to their major.

National Honor Societies

Tau Beta Pi (Engineering Honor Society - all engineering majors)
Eta Kappa Nu (Honor Society for Electrical, Computer Engineering, Engineering Physics majors)

Student Affiliates of Professional Organizations

American Society of Civil Engineers (ASCE)
American Society of Mechanical Engineers (ASME)
Association for Computing Machinery (ACM)
Institute of Electrical and Electronic Engineers (IEEE)
National Society of Black Engineers (NSBE)
Society of Hispanic Professional Engineers (SHPE)
Society of Women Engineers (SWE)
Society of Automotive Engineers (SAE)
Associated Engineering Students (AES)
Associated Students of Engineering Management (ASEM)
Biomedical Engineering Society (BMES)
Theta Tau (Professional Engineering Fraternity)

Pacific MESA Center

The Pacific Mathematics, Engineering and Science Achievement (MESA) Center is the home of two programs: The MESA Schools Program (MSP) and the MESA Engineering Program (MEP).

Both MSP and MEP programs serve educationally disadvantaged students who have traditionally not considered entering into math or science based professions. MSP goals are to create an academic community that increases the number of students who graduate from

high school and attend college, majoring in math-based fields. MSP provides hands-on math and science activities as well as academic enrichment to 1,900 students in the 6-12th grades. By providing a rigorous, all-sided learning environment that includes academic advising, peer group learning, career exploration, parent involvement, and other services, students' confidence, expectations, and successes have soared. Specific MEP goals are to increase matriculation, retention, and graduation rates of the students enrolled in the School of Engineering and Computer Science. MEP seeks to fulfill the above goals through collaborations and partnerships with an Industrial Advisory Board, three student chapters of related professional organizations, the National Consortium for Minority Engineering Students Pursuing a Graduate Degree (GEM), the National Association for Minority Engineering Program Administrators (NAMEPA), and the National Action Council for Minorities in Engineering (NACME).

Pacific MESA Center activities and support features include: pre-college outreach, financial aid (scholarships), career fairs, awards banquets, hands-on math and science workshops, enhanced advising and counseling, tutoring, motivational seminars, Saturday and summer programs, and a student study center.

General Education Requirements for Undergraduate Engineering and Computer Science Programs

All engineering and computer science students must satisfy the requirements of the university's General Education program. Several of the General Education requirements are satisfied by engineering and computer science program requirements. Engineering and computer science students must satisfy the program requirements and do not need additional courses for these general education requirements.

1. Diversity & Inclusion requirement: Satisfied by ENGR 030.
2. World Perspectives & Ethics area of inquiry requirement: Satisfied by ENGR 030.
3. Quantitative Reasoning area of inquiry requirement: Satisfied by program mathematics requirements.
4. Scientific Inquiry area of inquiry requirement: Satisfied by program science requirements.

Undergraduate General Academic Policies

Engineering and Computer Science Prerequisite Requirement

All engineering and computer science course prerequisites must be passed with a C- or higher grade.

Courses Taken Pass/No Credit

A student may request to register for one (1) general education course per semester on a Pass/No Credit basis in either Category I or II of the general education program by filing the completed Pass/No Credit form in the Office of the Registrar before the deadline established by the Office of the Registrar (approximately the end of the second week of classes). This petition must include the approval of the professor teaching the course and the student's advisor. A maximum of 16 Pass/No Credit units may be applied to meet the GE degree requirements. All other classes, including Technical Writing, Independent Studies and the basic science or mathematics elective classes, must be taken for a letter grade.

Independent Studies and Undergraduate Research

Students who have an interest in a subject not offered as a regular course and who, by their overall performance at Pacific, have proven their ability to do independent work, may enroll in an independent study. The qualified student initiates discussions with his/her advisor and with a professor who is knowledgeable in the subject. If both parties are in agreement, the student must complete the Independent Study Form and submit it to the instructor before the end of the third week of classes. If the independent study is to be used to meet a general education requirement, it must also have the approval of the Department's General Education Coordinator. Students on academic probation are not permitted to enroll in independent study courses in any department of the University. The following School of Engineering and Computer Science policies apply:

1. The course(s) may not be substituted for a regularly scheduled course unless approved by the department.
2. If the course is to be used as an elective, approval by the student's advisor and the department chairperson is required.
3. All courses must be taken for a letter grade; the pass/no credit option is not allowed for independent study courses.
4. Only one independent study course may be taken per term.
5. Each course may be taken for one (1), two (2), three (3), or four (4) units. The unit value for the course is established between the student and the professor responsible for the course. The student's advisor is informed of this decision.
6. A maximum of eight (8) units of independent study and undergraduate research may be used to satisfy graduation requirements.

Course Substitutions

The substitution of course(s) from the printed major program is discouraged. When extenuating circumstances warrant consideration, the student meets with his/her advisor, and the final decision must have the approval of the department chair. Consideration is given to the source of the problem (school, student, etc.), severity of the hardship case, and what the department considers best for the individual.

If a course substitution is allowed, ABET guidelines must be followed.

Students who enter an engineering or computer science program with 28 or more units are exempt from ENGR 010.

Fundamental Skills Requirement

Students are required to satisfy all the University Fundamental Skills Requirements (i.e., Writing and Mathematics) prior to enrolling in any upper-division engineering or computer science courses.

Internal Transfer Requirements

Students at University of the Pacific wishing to transfer into the School of Engineering and Computer Science:

1. Must have satisfied all Pacific Fundamental Skills requirements
2. Must have completed Math 41 (or equivalent).
3. Must have a cumulative GPA of 2.5
4. International students must demonstrate English proficiency through either: TOEFL - 80/213/550 or IELTS 6.0.

Graduation Requirements (Engineering Degree Programs)

It is important that each student carefully monitor his or her academic program. Each student is expected to consult regularly with his or her faculty advisor. Meeting the graduation requirements is each student's

responsibility. If a student deviates from the printed curriculum, careful academic scheduling is required and a plan must be developed that indicates all courses needed for graduation, and when the classes will be taken. After the plan of classes is completed, the schedule must be approved by the student's faculty advisor and the Director of Cooperative Education.

In order to graduate, students must meet the following requirements:

1. Successful completion of at least 120 units.
2. Successful completion of all courses required in the student's major.
3. Successful completion of a minimum of 32 Cooperative Education credits and the Professional Practice Seminar.
4. A GPA of at least 2.0 on all letter-graded work completed at Pacific.
5. A GPA of at least 2.0 for all engineering and computer science courses completed at Pacific.
6. Engineering Management students must have at least a 2.0 GPA in their business/management classes.
7. Submission of application for graduation to the Office of the Registrar. Refer to the Academic Regulations section of the catalog.

Graduation Requirements (Computer Science Degree Program)

1. Successful completion of at least 120 units.
2. Successful completion of all courses required in the student's major.
3. A GPA of at least 2.0 on all letter-graded work completed at Pacific.
4. A GPA of at least 2.0 for all engineering and computer science courses completed at Pacific.
5. Submission of application for graduation to the Office of the Registrar. Refer to the Academic Regulations section of the catalog.

Limitation on Obtaining Two Degrees

The SOECS, in conjunction with the Office of the Registrar, approves the student who receives a second bachelor of science degree subject to the following conditions:

1. The student must meet all requirements for each degree and must file a study plan, approved by his/her advisor, with the Office of the Registrar.
2. The pursuit of a double degree is not a valid reason for waiving any SOECS or University requirements.

Bioengineering Courses

BENG 005. Introduction to Bioengineering. 2 Units.
This course introduces students to the various sub-disciplines (medical, chemical, electrical, mechanical, and computation) of bioengineering.

BENG 103. Biomaterials. 4 Units.
This course discusses biomaterials and lays the ground work for topics such as mechanical chemical, and thermal properties of replacement materials and tissues. Implantation of materials in the body are studies studied from the biological point of view. Prerequisites: Completion of all Fundamental Skills; CHEM 24 or CHEM 025 or CHEM 027; BIOL 061 with a "C-" or better.

BENG 104. Biomedical Imaging. 4 Units.
This course discusses major medical imaging modalities in radiology, including X-ray, CT, nuclear medicine, ultrasound, and MRI. Specific contents include physical principle of each imaging modality; instrumentation and data acquisition/image reconstruction strategy, clinical applications and imaging techniques. Prerequisites: MATH 055, PHYS 055, COMP 051 or ENGR 019.

BENG 108. Engineering Physiology. 5 Units.
This course is a lecture and lab-based review of the functions of the major organ systems of vertebrates with emphasis on the human body. Lectures cover basic anatomy, function and regulation of the nervous, endocrine, sensory, muscular, cardiovascular, respiratory, and excretory systems, with the underlying theme of maintaining homeostasis while responding to physiological disturbances. Lab exercises demonstrate basic physiological processes and emphasize techniques of instrument-based data acquisition and data presentation. Prerequisites: Completion of all Fundamental Skills; BIOL 61; CHEM 24 or CHEM 25 all with a "C-" or better or permission of instructor.

BENG 110. Bioinstrumentation and Experimental Design. 4 Units.
Introduction to engineering aspects of the detection, acquisition, processing, and display of signals from living systems; Experimental techniques for measurement of biomedical quantities such as biopotentials, force, pressure, and temperature are discussed. The course introduces statistical analysis including confidence intervals, hypothesis testing, analysis of variance, and linear regression as well as errors in measurement. Use of instruments in the laboratory; a measurement project. Corequisites: BENG 124 or ENGR 121. Prerequisites: MATH 057; ECPE 041 with a “C-” or better.

BENG 121. Biomedical Signal Processing. 4 Units.
Students analyze discrete-time signals and systems using z transforms and Fourier transforms, the fast Fourier transform and its applications, digital filters and their applications and implementation of DSP algorithms using Matlab and Simulink. Also listed as ECPE 121.

BENG 124. Biomechanics. 4 Units.
This course discusses concepts of engineering mechanics including stress, strain, deformation, and analysis of structures with application to biomechanical phenomena over a range of biological length scales. Engineering mechanics concepts are used to evaluate forces and moments acting on human joints, forces in musculoskeletal tissue, material properties of biological tissues, and disease state conditions. Prerequisites: Completion of all Fundamental Skills; ENGR 020 with a “C-“ or better. Prerequisite may be taken concurrently: MATH 057 with a “C-“ or better.

BENG 130. Biotransport. 4 Units.
This course focuses on momentum transport (viscous flow) and mass transport (diffusion and convection) in living systems. The fundamental principles of momentum and mass transfer are explored and laws of conservation applied to develop mathematical descriptions of physiological and engineering systems across a range of length scales. Students develop technical writing skills and learn to use computation fluid dynamics simulation tools. Prerequisites: Completion of all Fundamental Skills; MATH 057; PHYS 053 with a “C-“ or better.

BENG 140. Introduction to Tissue Engineering. 4 Units.
Tissue engineering is a multidisciplinary and collaborative field that applies the principles of engineering and biology toward the development of biological substitutes that restore, maintain, and improve tissue function. In this course, there will be an overview of tissue engineering, including discussion of cell sources, cell-material interactions, and assessment of engineering outcome through destructive and nondestructive means with case studies of specific types of tissue engineering including skin, bone, cartilage, bladder, and liver. Finally, ethical standards for different techniques in tissue engineering will be discussed. Prerequisites: Completion of all Fundamental Skills; BIOL 061; BENG 103 all with a “C-“ or better or permission of instructor.

BENG 154. Introduction to Magnetic Resonance Imaging. 4 Units.
Introduction to the physics, techniques, and applications of magnetic resonance imaging (MRI) in basic sciences and the clinic. Basics of nuclear magnetic resonance physics, and Fourier transform, MRI hardware, and MR imagining principles including signal generation, detection, and spatial localization techniques. Applications of MRI including tissue relaxometry measurement and diffusion weighted imaging of biological tissues, imagining of anatomy, and function. Prerequisites: Completion of all Fundamental Skills; BENG 104 with a "C-" or better of permission of instructor.

BENG 171. Bioelectricity. 4 Units.
This course provides the student with an understanding of the origins, function, and measurement of electrical potentials and currents within biological tissues, such as nerve, muscle, and heart. Topics include: the bioelectrical properties of ion channels, neurons, the synapse and neuromuscular junction, adaptation and learning in small networks of neurons, the functional organization of bioelectrical systems, and bioelectrical measurement and stimulation of tissues such as the heart and brain. Prerequisites: Completion of all Fundamental Skills; ECPE 041/ECPE 041L; Prerequisite may be taken concurrently: MATH 057 with a "C-" or better.

BENG 175. Human/Brain Machine Interface. 3 Units.
Human/Brain Machine interface (HMI/BMI) is a direct communication pathway between human signals such as heart activity, electro dermal activity, and brain with an external device. Bioelectrical activity can be employed directly to provide information or predict the human alertness, stress level, health or control external devices such as an external keyboard and robotic arm. This topic includes the physiology of generation of human vital signals, designing interface device, and developing offline and real-time computational algorithms for controlling external devices. Prerequisite: Completion of all Fundamental Skills; ENGR 19 or COMP 51 or COMP 61 with a "C-" or better; MATH 53 or COMP 157 with a "C-" or better; and junior standing.

BENG 187. Professional Practice. 1-18 Units.

BENG 191. Independent Study. 1-4 Units.
Special individual projects are undertaken under the direction of one or more faculty members who are knowledgeable in the particular field of study. Permission of department chairperson and faculty members involved.

BENG 194. Bioengineering Project Proposal. 3 Units.
This course provides an introduction to the engineering design process. Students apply basic sciences, mathematics, and engineering topics to meet a stated objective. Students will write a proposal for a comprehensive design project, in which they establish design objectives and criteria, analyze solution alternatives, and synthesize a problem. Consideration for engineering standards, realistic constraints, ethics, and safety is included. Prerequisites: Completion of all Fundamental Skills, Junior or Senior standing, BENG 124 or BENG 103, may be taken concurrently, with a "C-" or better or permission of instructor.

BENG 195. Senior Project. 3 Units.
In this course, students will complete the engineering design process. Students will design and evaluate an engineering solution to an existing problem. Students apply basic sciences, mathematics and engineering topics to implement a solution that meets stated design objectives and criteria. Students will also test prototypes to evaluate design performance. Design documentation and demonstration are required. Includes both written and oral reports and presentations. Prerequisite may be taken concurrently: BENG 194 with a "C-" or better or permission of instructor.

BENG 197. Undergraduate Research. 1-4 Units.
This course is applied or basic research in bioengineering under faculty supervision. Permission of faculty supervisor and department chair. Students must be in good academic standing.

BENG 197D. Undergraduate Research. 1-4 Units.

BENG 202. Biosensor. 3 Units.
This course provides a comprehensive introduction to the basic features of biosensors. Discussion topics include types of most common biological agents and the ways in which they can be interfaced with a variety of transducers to create a biosensor for biomedical applications. The focus is on optical biosensors and systems (e.g. fluorescence spectroscopy, microscopy). Prerequisites: Graduate or blended students in the School of Engineering and Computer Science and BENG 103 with a "C" or better or permission of instructor.

BENG 205. Advanced Biomaterials. 3 Units.
Students study the strategies and fundamental bioengineering design criteria behind the development of cell-based tissue substitutes, artificial skin, muscle, tendons, bone, and extracorporeal systems that use either synthetic materials or hybrid (biological-synthetic) systems. Topics include biocompatibility, biological grafts and bioreactors. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science and BENG 103 with a "C" or better.

BENG 291. Graduate Independent Study. 1-4 Units.
Special individual projects are undertaken under the direction of one or more faculty. Prerequisite: Graduate or blended students in the School of Engineering and Computer Science or permission of instructor.

BENG 293. Special Topics. 1-4 Units.
Special courses are organized and offered from time to time to meet the needs or interests of a group of students.

BENG 297. Graduate Research. 1-4 Units.
Approval by the faculty supervisor and the department chairperson in required. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science or permission of instructor.

BENG 299. Thesis. 1-6 Units.
Minimum of six units is required for Thesis Option students. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science and permission of the research advisor.

Civil Engineering Courses

CIVL 015. Civil Engineering Graphics. 3 Units.
Coverage of the principles and applications of graphics in engineering design. Pictorial and isometric sketching and orthographic projection and use of auxiliary views and sections are used. Drafting standards and conventions, dimensioning and tolerances. Layout and assembly drawings, detail drawings and production drawings using AutoCAD software. Laboratory work is included. Prerequisite: ENGR 010 or IDEA 010 with a "C-" or better (may be taken concurrently).

CIVL 022. Geomatics. 3 Units.
This course is an introduction to geomatics engineering which includes in depth coverage of plane surveying and an introduction to Global Navigation Satellite Systems (GNSS), geodetics and geospatial sciences. Fundamental surveying methods and equipment will be presented in both a lecture and a hands-on laboratory section. Topics include: error theory, leveling, traverse computations, topography, coordinate systems, construction surveying, geometric design, Global Navigation Satellite Systems (GNSS), photogrammetry and the presentation of other emerging and relevant technologies. Prerequisite: MATH 041 with a "C-" or better or a passing score on the University's trigonometry placement test.

CIVL 060. Water Quality. 4 Units.
Students examine chemical reactions and processes in aquatic systems with engineering applications. Topics include chemical equilibrium and kinetics associated with acid-base, dissolution-precipitation, complexation, and reduction-oxidation reactions in natural and engineered environments. Laboratory work is included. Prerequisites: AP Chem with score of 4 or 5, CHEM IB Higher Level (score of 5, 6, or 7), CHEM 024 or CHEM 025 or CHEM 027; and MATH 051 with a "C-" or better.

CIVL 100. Structural Engineering. 4 Units.
Students examine the theory and applications of structural analysis and design. Topics include determination of loads, analysis of beams, trusses and frames, influence lines and indeterminate structures. Laboratory is included. Prerequisites: Completion of all Fundamental Skills; CIVL 15 or MECH 15; ENGR 19; Prerequisite can be taken concurrently: ENGR 121 with a "C-" or better (Spring).

CIVL 130. Fluid Mechanics I. 3 Units.
Students study the physical properties of fluids, statics and dynamics of incompressible fluids that include hydrostatics, conservation of mass, energy and momentum principles, laminar and turbulent flow with emphasis on pipe flow. Prerequisite: Completion of all Fundamental Skills and ENGR 120 with a "C-" or better. Corequisite: CIVL 130L.

CIVL 130L. Fluid Mechanics I Lab. 1 Unit.
Experimental analysis of concepts are discussed in CIVL 130. Prerequisite: Completion of all Fundamental Skills and ENGR 120 with a "C-" or better. Corequisite: CIVL 130.

CIVL 132. Environmental Engineering. 4 Units.
Students are introduced to the physical, chemical, and biological processes associated with water quality in natural environments and engineering systems. Topics include operation and design of water and wastewater treatment facilities as well as the occurrence, behavior and control of indoor and regional air pollution. Laboratory is included. Prerequisites: Completion of all Fundamental Skills; CIVL 015 or MECH 015; CIVL 060 with a "C-" or better.

CIVL 133. Water Resources Engineering. 4 Units.
Hydraulic and hydrologic analysis and design including pipe flow, open channel flow, elements of the hydrologic cycle, analysis of rainfall-runoff data, design applications, and the application of computers in hydrologic and hydraulic design. Laboratory is included. Prerequisites: Completion of all Fundamental Skills; CIVL 015 or MECH 015; CIVL 130 with a "C-" or better.

CIVL 134. Groundwater. 4 Units.
Aquifer properties, groundwater hydraulics in confined and unconfined aquifers under steady and unsteady flow conditions. Well hydraulics under ideal and non-ideal conditions. Constituent transport and fate in groundwater. Prerequisites: Completion of all Fundamental Skills; CIVL 130; MATH 057 with a “C-“ or better.

CIVL 136. Design of Water Quality Control Facilities. 4 Units.
This advanced course covers the physical, chemical, and biological processes that are involved in the design of water and wastewater treatment plant facilities as well as applicable design standards and regulations. Prerequisites: Completion of all Fundamental Skills, CIVL 130, CIVL 132 with a "C-" or better.

CIVL 138. Solid Waste Systems Design and Management. 3 Units.
This is an introductory course to solid waste systems, that analyzes of problems associated with storage, collection, transport, processing, and disposal of solid wastes. Students review of current and expected regulatory requirements and the planning and design of solid waste management components that include systems and processes for solid waste prevention, recycling/composting, incineration, and landfilling. Prerequisite: Completion of all Fundamental Skills and CIVL 132 with a "C-" or better.

CIVL 140. Geotechnical Engineering. 4 Units.
This course covers the fundamentals of geotechnical engineering including the characterization of soils and their behavior as an engineering material. Topics include classification of soils, compaction, permeability, and consolidation. Design applications include settlement predictions, strength characterization, soil exploration programs, and an overview of shallow and deep foundations. The course includes laboratory work. Prerequisites: Completion of all Fundamental Skills; CIVL 015 or MECH 015; ENGR 121 with a "C-" or better.

CIVL 141. Earth Structure Design. 4 Units.
Evaluation of drained and undrained field conditions and the relationship between temporary and permanent design conditions over time. In-situ tests, including SPT and CPT. Analysis of lateral stresses in soil masses. Design of slopes, cantilever retaining walls, sheet piles, anchored bulkheads, and mechanically-stabilized earth walls. Design includes analysis of effects of water and seismic conditions, including liquefaction. Prerequisite: CIVL 140.

CIVL 145. Engineering Geology. 4 Units.
This introductory course to is the study of geology in which geologic principles, data and techniques are applied to civil engineering problems. Also listed as GEOS 145. Prerequisites: Completion of all Fundamental Skills; GEOS 051 or GEOS 061 or CIVL 140 with a "C-" or better.

CIVL 150. Transportation Engineering. 4 Units.
Students study the considerations and procedures in the planning, design, and operation of various transportation systems with primary emphasis on highways. Prerequisites: Completion of all Fundamental Skills. Junior or Senior standing.

CIVL 151. Construction Engineering. 3 Units.
An introduction to construction engineering and construction management. Construction engineering topics include construction processes and construction econometrics. Construction management topics include estimating, planning, bidding, and scheduling. Prerequisites: Completion of all Fundamental Skills. Junior or Senior standing.

CIVL 160. Structural Analysis. 3 Units.
Students analyze the behavior of trusses and framed structures under gravity and lateral loads. Other topics include analysis of shear walls, the use of structural analysis software, and the buckling of frames. Prerequisites: Completion of all Fundamental Skills; CIVL 100 and MATH 057 with a "C-" or better.

CIVL 163. Introduction to Earthquake Engineering. 3 Units.
Determination of loads on structures due to earthquakes. Overview of seismology. Methods of estimating equivalent static lateral forces; response spectrum and time history analysis. Concepts of mass, damping and stiffness for typical structures. Design for inelastic behavior. Numerical solutions and code requirements. Prerequisites: Completion of all Fundamental Skills, ENGR 019, ENGR 121 with a “C-“ or better.

CIVL 164. Structural Timber Design. 4 Units.
Students will study the design of timber structural members, specifically tension, compression, flexural, and beam-column elements and connections to satisfy design code requirements. Prerequisite, may be taken concurrently: CIVL 100.

CIVL 165. Structural Steel Design. 4 Units.
Students study the design of steel structural members, specifically tension, compression, flexural, and beam-column elements and connections to satisfy design code requirements. Prerequisite: Completion of all Fundamental Skills. Prerequisite may be taken concurrently: CIVL 100 with a "C-" or better.

CIVL 166. Reinforced Concrete Design. 4 Units.
Students study the design and proportioning of structural members, specifically beams, columns, one-way slabs, footings, and walls to satisfy design criteria for reinforced concrete systems. Prerequisite: Completion of all Fundamental Skills. Prerequisite may be taken concurrently: CIVL 100 with a "C-" or better.

CIVL 171. Water and Environmental Policy. 3 Units.
This course introduces students to Federal and State of California environmental regulations pertaining to air, water, hazardous wastes, and toxic substances. Topics include an overview of water rights and environmental impact assessment, relevant case studies, and examples of monitoring and enforcement issues. Prerequisite: Completion of all Fundamental Skills. Must have Junior or Senior standing.

CIVL 173. Sustainable Engineering. 3 Units.
This interdisciplinary course provides an introduction to principles and practice of sustainable engineering. Topics include the analysis of economic, social, and environmental factors, life cycle assessment, resource use and waste generation in engineering products and processes. The course also examines case studies, readings, and class discussion emphasizes analysis and development of sustainable solutions. Prerequisite: Completion of all Fundamental Skills. Junior or Senior standing.

CIVL 180. Engineering Synthesis. 4 Units.
This course is a culminating experience wherein a group of students synthesize their previous class work into one project. Both technical and non-technical concerns are addressed. One or more faculty members and/or professional engineers are involved depending upon the fields covered in the project. Prerequisites: Completion of all Fundamental Skills; EMGT 170 and 2 of the following: CIVL 100, CIVL 132, CIVL 133, CIVL 140 with a "C-" or better. Senior standing.

CIVL 191. Independent Study. 1-4 Units.
Students undertake special individual projects under the direction of one or more faculty members. Permission of department chairperson and faculty member involved.

CIVL 193. Special Topics. 4 Units.

CIVL 197. Undergraduate Research. 1-4 Units.
This course is applied or basic research in civil engineering under faculty supervision. Permission of faculty supervisor and department chair. Student must be in good academic standing.

CIVL 231. Surface Water Quality Modeling. 3 Units.
Application of mass balance principles develop mathematical models that simulate the transport and fate of water quality constituents in rivers, estuaries, and lakes. Numerical methods that solve discrete systems of steady-state and transient equations using Excel and MATLAB are emphasized. Prerequisites: ENGR 019, CIVL 132, Graduate or blended students in the School of Engineering and Computer Science with a "C" or better or permission of instructor.

CIVL 233. Advanced Hydraulic Systems Analysis. 3 Units.
Analysis and modeling of steady and unsteady flows in pipe systems, pipe networks, gradually and rapidly varied flows and hydraulic structures in open channels. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science and CIVL 130 with a “C“ or better or permission of instructor.

CIVL 236. Physical and Chemical Treatment Processes. 3 Units.
Physical and chemical processes found in nature and used in engineered systems to treat water and air. Design of reactors and unit processes incorporate sedimentation, flocculation, precipitation, gas transfer, adsorption, filtration, and disinfection. Prerequisites: CIVL 132 with a "C" or better and Graduate or blended students in the School of Engineering and Computer Science or permission of instructor.

CIVL 237. Biological Treatment Processes. 3 Units.
Biological processes occurring naturally and developed in engineered treatment systems. Includes applicable fundamentals of microbiology, microbially-mediated chemical reactions, kinetics, design of suspended growth and fixed-film treatment systems, and nutrient removal. Prerequisites: CIVL 132 with a "C" or better and Graduate or blended students in the School of Engineering and Computer Science or permission of instructor.

CIVL 238. Industrial and Hazardous Waste Management. 3 Units.
Industrial and Hazardous Waste Management and Treatment is an advanced level course on technical aspects concerning the management of chemical and radioactive wastes. The course addresses regulation, management and characterization of industrial wastes, especially hazardous wastes. Emphasis is placed on site characterization, investigation of pathways and transformations, and engineered treatment processes for toxic and reactive industrial materials. Prerequisite: Graduate or blended students in the School of Engineering and Computer Science or permission of instructor.

CIVL 259. Sensor Networks for Engineering Systems. 3 Units.
This course introduces sensor networks for infrastructure systems from sensor selection, system design, implementation, acquisition, and analysis. Examination of application across multiple engineering disciplines. Project based components with laboratory. Prerequisites: ECPE 131, ECPE 121; or ENGR 019, ENGR 121; or COMP 055, COMP 157 with a "C" or better; Graduate or blended students in the School of Engineering and Computer Science; or permission of instructor.

CIVL 263. Earthquake Engineering. 3 Units.
This course is an overview of seismology. Course content includes determination of loads on structures due to earthquakes, methods of estimating equivalent static lateral forces, response spectrum and time history analysis. Other topics include concepts of mass, damping and stiffness for typical structures, design for inelastic behavior. Numerical solutions and code requirements. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science and CIVL 100 with a "C" or better or permission of instructor.

CIVL 265. Advanced Structural Engineering. 3 Units.
Students examine the design of steel structural members that include composite beams, plate girders and connections following the AISC specifications in addition to economy evaluation of building design, and design of frame structures and second order effects. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science and CIVL 165 with a "C" or better or permission of instructor.

CIVL 266. Advanced Reinforced Concrete Design. 3 Units.
Students study the design and proportioning of structural systems to satisfy design criteria for reinforced concrete and pre-stress design in concrete. Topics include retaining walls, slabs, footing, and other structural members, Prerequisites: CIVL 166 with a "C" or better and Graduate or blended students in the School of Engineering and Computer Science or permission of instructor.

CIVL 267. Design of Timber Structures. 3 Units.
Students study the design and analysis of timber structures due to gravity, lateral and combined loadings. Both member and connection details are considered. The design procedures, material properties and allowable stress computations are based on UBC, and NDS and other governing standards. Prerequisite: Graduate or blended students in the School of Engineering and Computer Science, CIVL 100, MECH 120 with a "C" or better or permission of instructor.

CIVL 275. Microbiology of Engineered Systems. 3 Units.
An introduction to the concepts of environmental microbiology for upper division undergraduates and graduate students in engineering or environmental sciences who may not possess a strong background in the biological sciences. This course will emphasize the fundamental of microbiology and microbial ecology is described in the context of environmental engineering applications. Concepts relating to energy generation, metabolism and kinetics are emphasized. Prerequisite: Graduate or blended students in the School of Engineering and Computer Science or permission of the instructor.

CIVL 278. Ecological Engineering. 3 Units.
This course is a graduate-level introduction to the field of ecological engineering. Topics include the fundamental concepts of ecology and the application of ecological concepts to engineered systems. The course focuses on understanding large-scale biogeochemical cycles, investigating how these cycles have been disrupted in engineering systems, and evaluating tools and alternatives for restoring biogeochemical cycles within engineering systems. The students evaluate and apply the concepts developed in class to the resolution of ecological engineering challenges in example engineered landscapes. Prerequisite: Graduate or blended students in the School of Engineering and Computer Science.

CIVL 291. Graduate Independent Study. 1-4 Units.
Special individual projects are undertaken under the direction of one or more faculty. Prerequisite: Graduate or blended students in the School of Engineering and Computer Science or permission of instructor.

CIVL 293. Special Topics. 1-4 Units.
Special courses are organized and offered from time to time to meet the needs or interests of a group of students. Prerequisite: Graduate or blended students in the School of Engineering and Computer Science or permission of the instructor.

CIVL 297. Graduate Research. 1-4 Units.
Applied or basic research in engineering or computer science under faculty supervision. Approval by the faculty supervisor and the department chairperson is required. Prerequisite: Graduate or blended students in the School of Engineering and Computer Science or permission of instructor.

CIVL 299. Thesis. 1-6 Units.
Minimum of six units are required for Thesis Option students. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science and permission of the research advisor.

Computer Science Courses

COMP 025. Computers and Information Processing. 4 Units.
This introductory information technology course focuses on computer architecture, networking, internet technologies and the integration of productivity software. Lectures, readings, hands-on projects and lab assignments give a variety of learning experiences. Specific topics include computer architecture, digital data, networking, file management, spreadsheets, database systems and presentation applications. Students are exposed to JavaScript and Visual Basic scripting. Particular emphasis is placed on HTML programming and creating an interactive student website for homework and lab linking throughout the semester. Prerequisite: Fundamental Math Skills requirement. **(GE3B, GEQR)**

COMP 041. Great Ideas in Computing. 4 Units.
This course is a broad introduction to the field of computing. The concepts that are the foundation of computing are presented and placed in historical context. Discussion topics include the ways of thinking and working that make computing effective, and the future of the field. Example topics include number representation, architecture of computing systems, intelligent computing systems, and the use of computing in art and games. Prerequisite: Fundamental Math Skills requirement. **(GE3C, GEQR)**

COMP 047. Discrete Math for Computer Science. 4 Units.
This course is designed to develop skills in deductive reasoning and to apply concepts of discrete mathematics to computer science. Topics include logic, deductive reasoning, introduction to analysis of algorithms, mathematical induction, set theory, functions, recurrence relations, combinatorics and probability, graphs, and trees. Prerequisite: Fundamental Math Skills requirement. **(GE3B, GEQR)**

COMP 051. Introduction to Computer Science. 4 Units.
The course emphasizes program design and problem solving techniques that use a high-level programming language. The course introduces basic concepts such as assignment, control flow, iteration, and basic data structures in addition to a supervised lab. Credit for this course is not given if a student has credit for COMP 061. Prerequisite: Fundamental Math Skills requirement. **(GE3B, GEQR)**

COMP 053. Data Structures. 4 Units.
The course continues the development of program design and problem solving techniques. Topics include development of fundamental data structures and their associated algorithms as well as array-based algorithms, recursion, lists, generics, dynamic memory, binary trees, and associative structures. Prerequisite: COMP 051 or COMP 061 with a "C-" or better.

COMP 055. Application Development. 4 Units.
This course develops the skills and techniques required for the creation of contemporary software applications. Contemporary software applications are complex systems that involve the interaction of multiple subsystems that require teams of developers working together for extended periods of time. Topics include teamwork and communication skills, current development methodologies, analysis and design documentation and the use of libraries. This course is intended to prepare students to transition to upper division courses. Prerequisites: Completion of all Fundamental Skills and COMP 053 with a "C-" or better.

COMP 061. Introduction to Programming for Data Science. 4 Units.
This course introduces programming concepts and program design using topics in data science as examples. Basic concepts such as assignment, control flow, iteration, and simple as well as object-oriented data types and structures are developed. The course includes a supervised lab. Credit for this course is not given if student has credit for COMP 051. Prerequisite: Fundamental Math Skills requirement. **(GE3B, GEQR)**

COMP 093. Special Topics. 3 or 4 Units.

COMP 127. Web Applications. 4 Units.
The World-Wide Web consists of client-server applications operating over the Internet. This course introduces the skills and techniques for designing and developing web applications. Topics include: client-server architectures, web servers and web browsers, server-side programming, client-side programming, form processing, state management and multimedia. Prerequisites: Completion of all Fundamental Skills and COMP 053 with a "C-" or better or permission of instructor. (Fall, even years).

COMP 129. Software Engineering. 4 Units.
Students gain practical experience in dealing with medium to large scale software systems. Students learn how current analysis and design methodologies are used to develop the abstractions necessary to understand large systems. Students also learn how such methodologies and abstractions are used to communicate with coworkers and clients about the analysis and design. Because communication is an essential skill in large system development, students are expected to produce documents and presentations of professional quality and depth. Prerequisites: Completion of all Fundamental Skills and COMP 055 with a "C-" or better. (Spring, every year).

COMP 135. Human-Computer Interface Design. 3 Units.
Human-Computer Interface (HCI) Design focuses on the relationship between humans and computers or other physical devices. This course helps students develop an understanding of the common problems in designing these interfaces and presents a set of design techniques to ensure that designs are both useful and useable. Prerequisite: Completion of all Fundamental Skills. Junior standing. (Spring, every year).

COMP 137. Parallel Computing. 3 Units.
Parallel computing is a science which solves a large problem by giving small parts of the problem to many computers to solve and then combining the solutions for the parts into a solution for the problem. This course introduces architectures and implementation techniques to support parallel computation. Students are expected to design and implement an original parallel application as a term project. Prerequisite: Completion of all Fundamental Skills and COMP 053 with a "C-" or better. Corequisite: ECPE 170. (Spring, every year).

COMP 141. Programming Languages. 4 Units.
Topics in evaluation, design, and development of programming languages. Topics include type systems, variables and scope, functions, parameter passing, data hiding and abstractions, recursion, memory allocation, grammars and parsing, compiler architecture, programming paradigms, and comparison of programming languages and environments. Prerequisites: Completion of Fundamental Skills and COMP 053 with a "C-" or better.

COMP 147. Computing Theory. 4 Units.
Students study automata, formal languages and computability. Topics include finite state automata, regular languages, pushdown automata, context-free languages, Turing machines; decidability, reducibility, and time complexity that includes NP-completeness and intractability. Prerequisites: Completion of all Fundamental Skills; COMP 047 or ECPE 071 or MATH 074 with a "C-" or better.

COMP 151. Artificial Intelligence. 3 Units.
Students study fundamental concepts, techniques and tools used in Artificial Intelligence. Topics include knowledge representation, search techniques, machine learning and problem solving strategies. Also listed as ECPE 151. Prerequisites: Completion of all Fundamental Skills and COMP 053 with a “C-“ or better. (Fall, odd years).

COMP 152. Machine Learning. 3 Units.
This course provides an introduction to machine learning using Python, the open source, programming language extensively adopted by the machine learning community and industry. In this course, you will use Python to learn machine learning concepts, terms and methodology, and gain an intuitive understanding of the mathematics underlying it by building actual applications. The techniques you'll learn can be a starting point to build real-world applications such as search engines, image analysis, bioinformatics, industrial automation, speech recognition, and more. Prerequisites: Completion of all Fundamental Skills and COMP 053 with a “C-“ or better.

COMP 153. Computer Graphics. 3 Units.
An introduction to two and three dimensional computer graphics. Basic representations and mathematical concepts, object modeling, viewing, lighting and shading. Programming using OpenGL and other computer graphics applications. Also listed as ECPE 153. Prerequisites: Completion of all Fundamental Skills and COMP 053 with a "C-" or better. (Fall, even years).

COMP 155. Computer Simulation. 4 Units.
This course explores digital simulation, in which a model of a system is executed on a computer. The course focuses on modeling methodologies, mathematical techniques for implementing models, and statistical techniques for analyzing the results of simulations. Students develop simulations using both simulation development toolkits and general-purpose programming languages. Also listed as EMGT 155. Prerequisites: Completion of all Fundamental Skills; MATH 037 or MATH 039; MATH 045 or MATH 051, COMP 051 or ENGR 019 with a "C-" or better. (Fall, even years).

COMP 157. Design and Analysis of Algorithms. 4 Units.
Topics for this course include complexity analysis, algorithms for searching, sorting, pattern matching, combinatorial problems, optimization problems, backtracking, algorithms related to number theory, graph algorithms, and the limitations of algorithm power. Prerequisites: Completion of all Fundamental Skills; COMP 047 or MATH 074; COMP 053; MATH 045 or MATH 051 with a "C-" or better.

COMP 159. Computer Game Technologies. 4 Units.
This course surveys the technologies and processes used for modern video game development. Course topics include software engineering, media creation and management, hardware interfaces, user interaction, 3D mathematics and common algorithms and data structures to support graphics, physics and artificial intelligence. Prerequisite: Completion of all Fundamental Skills and COMP 055 with a "C-" or better. (Fall, odd years).

COMP 162. Data Analytics Programming. 4 Units.
This course develops programming skills for computational data analysis. The course emphasizes programming for statistical analysis, machine learning and predictive modeling. Other topics include programming packages for handling, preparation, and manipulation of data, as well as visualization tools for exploration and presentation of data and results. The course emphasizes hands-on data and analysis using a variety of real-world data sets and analytical objectives. Prerequisites: Completion of all Fundamental Skills; COMP 051 or COMP 061.

COMP 163. Database Management Systems. 4 Units.
A database management system (DBMS) is a computer application designed for the efficient and effective storage, access and update of large volumes of data. This course looks at such systems from two perspectives. The user-center perspective focuses on how a DBMS is used to build support for a data intensive application. This perspective includes examination of common data models, query languages and design techniques. The system implementation perspective focuses on the policies, algorithms and data structures used to design and implement a DBMS. Prerequisites: Completion of all Fundamental Skills and COMP 053 with a "C-" or better. Corequisite: COMP 047 or MATH 074. (Spring, every year).

COMP 173. Operating Systems. 4 Units.
Students are introduced to the fundamental concepts of modern operating systems. Topics include an overview of computer architecture and organization, process management, threads, and CPU scheduling. Students also study process synchronization that uses primitive and high-level languages, virtual memory management, file systems, system protection, and parallel and distributed computing. Prerequisites: Completion of all Fundamental Skills; COMP 053; COMP 175 or ECPE 170 with a "C-" or better or permission of instructor.

COMP 175. System Administration and Security. 3 Units.
This course provides an introduction to system administration of modern network servers and applications. Techniques to provide for data confidentiality, integrity, and availability are presented, both at the network security level and host security level, in order to resist common attacks and vulnerabilities. Topics include virtualization methods, resource provisioning in a cloud environment, command-line usage, installation and configuration of common network applications, containerized application deployment, password security and auditing, network configuration and firewalls, scripting, change management, and IT automation tools. Prerequisites: Completion of all fundamental skills and familiarity with console-based operating systems commands. Junior Standing.

COMP 177. Computer Networking. 4 Units.
Topics examined in this course include computer networks and the internet, LAN and WAN architectures, and packet switched networks and routing. Students learn about the internet protocol stack, socket programming and client/server systems, wireless networking and security. Also listed as ECPE 177. Prerequisites: Completion of all Fundamental Skills; COMP 053 and ECPE 170 with a "C-" or better. Junior or Senior standing. (Fall, every year).

COMP 178. Computer Network Security. 3 Units.
This course is an examination of computer security from a defensive and offensive perspective. Topics include attack methods used by threat actors (including scanning, exploits, privilege escalation, malware, and social engineering methods), their detection, and their prevention by network and host-based techniques. Additionally, cryptographic techniques are introduced in order to provide secure communications channels that guarantee message confidentiality, authenticity, and integrity. Prerequisites: Completion of all Fundamental Skills and ECPE 170 or COMP 175 with a “C-“ or better.

COMP 180. Fundamentals of Computer Science. 3 Units.
The course emphasizes program design and problem solving techniques that use a high-level programming language. The course introduces basic concepts of programming and then applies them to discrete math concepts and data structures through supervised labs. Credit will not be given for this course if a student has received credit for COMP 051, COMP 061, COMP 053, COMP 047, or ENGR 019.

COMP 187. Internship in Computer Science. 1-4 Units.
This internship course offers cooperative employment in a professional computer science environment. The internship requires satisfactory completion of the work assignment and written reports. Prerequisites: Completion of all Fundamental Skills; COMP 055 and ENGR 025 with a "C-" or better. Grading is Pass/No Credit only.

COMP 191. Independent Study. 1-4 Units.
Students create student-initiated projects that cover topics not available in regularly scheduled courses. A written proposal that outlines the project and norms for evaluation must be approved by the department chairperson.

COMP 193. Special Topics. 4 Units.

COMP 195. CS Senior Project. 4 Units.
In this course, students synthesize their cumulative computer science knowledge through the development of a computer application. Students will establish design objectives and criteria, analyze solution alternatives and evaluate design performance. Students will then implement, test and evaluate the system. Results will include analysis and design documents, the implemented system, test reports and a presentation and demonstration of the project. Prerequisites: Completion of all Fundamental Skills, Senior Standing, COMP 055 with a “C-“ or better.

COMP 197. Undergraduate Research. 1-4 Units.
Students conduct supervised research that contributes to current active topics in Computer Science. Topics may be selected by the student, related to faculty research, or provided by industrial sponsors. Permission of Undergraduate Research Coordinator.

COMP 227. Web Development. 3 Units.
This course is about the principles and techniques for designing and developing web applications. Topics include web application design, client-side web programming, and server-side web programming. Students are expected to read online resources and apply techniques to develop a website from scratch. Prerequisites: Programming Languages Core Skill.

COMP 229. Advanced Software Engineering. 3 Units.
Students gain practical experience in dealing with existing software systems. Students learn how existing software engineering practices are used to develop the abstractions necessary to understand and work with such systems. Students also learn how such methodologies and abstractions are used to communicate in a distributed environment with coworkers and clients surrounding the ideation, analysis, design and maintenance of systems. Because communication is an essential skill in large system development, students are expected to produce documents and presentations of professional quality and depth that can function in a remote working environment. Prerequisites: Programming Language Core Skill and Algorithms Core Skill and graduate students in the School of Engineering and Computer Science or instructor approval.

COMP 233. Software Engineering in Industry 4.0 Ecosystems. 3 Units.
In this course on Software Engineering within Industry 4.0 ecosystems, we will explore the integration and application of IoT and Cyber-Physical Systems (CPS). The course takes a dual perspective approach. First, we focus on user-centered aspects, examining how IoT and CPS are utilized to support and enhance data-driven applications, including discussions on models, communication protocols, and user interface design. The second perspective is system implementation, where we delve into the architecture, algorithms, and data structures fundamental to designing and deploying robust IoT and CPS. This comprehensive approach prepares students to meet the unique technological demands of Industry 4.0. Prerequisites: COMP 180 or COMP 053.

COMP 235. Interaction Design. 3 Units.
Interaction Design focuses on the relationship between humans and the use of interactive software applications and other physical devices. This course helps students develop an understanding of the common problems in designing interfaces for apps and devices and presents design and evaluation techniques to ensure that products are both useful and usable.

COMP 241. Programming Language Semantics. 3 Units.
This course studies the foundations of programming languages by exploring the static and dynamic language semantics from a theoretical perspective. Formal techniques are used to specify programming language semantics and the associated provable guarantees that these specifications provide. Prerequisites: Programming Language Core Skill and Computing Theory Core Skill and Graduate or blended students in the School of Engineering and Computer Science or instructor approval.

COMP 247. Computational Complexity. 3 Units.
This course provides a deep dive into the field of computational complexity, emphasizing the study of NP-completeness, the exploration of various complexity classes and the design and analysis of approximation algorithms. Students will explore the foundational theories that classify computational problems according to their inherent difficulty and investigate the limits of algorithmic efficiency. The course will cover classic approximation algorithms and randomized algorithms for a wide range of problems, including graph algorithms, scheduling, and partitioning, while also touching on recent advances and open problems in the field.

COMP 250. Computational Biology. 3 Units.
This course will provide an overview of the field of computational biology. Each week we will cover the biological background and computational details of a di#erent biological algorithm, including but not limited to: algorithms for phylogenetic tree estimation, protein folding, 3D structure prediction from DNA sequence, genome alignment algorithms, and reconstruction of gene regulatory networks. Students will gain experience using and implementing these algorithms. No previous programming experience or biological background is required.

COMP 251. Machine Learning. 3 Units.
This course introduces concepts of machine learning and statistical pattern recognition at the graduate level. The course covers topics such as linear and logistic regression, classification, clustering, model validation, support vector machines, neural networks, and decision trees. Data wrangling methods and dimensionality reduction are also examined. Prerequisites: Algorithms Core Skill and graduate students in the School of Engineering and Computer Science or instructor approval.

COMP 252. Natural Language Processing. 3 Units.
This course is an introduction to the topic of natural language processing (NLP) from a computational perspective. The course covers both formal and statistical approaches to NLP. Coursework includes programming, analysis and literature review assignments. Topics include: n-gram models, part-of-speech tagging, hidden Markov models, parsing, semantics, information extraction, question answering, dialogue agents and machine translation. Prerequisites: Algorithms Core Skill and Computing Theory Core Skill and Graduate or blended students in the School of Engineering and Computer Science or instructor approval.

COMP 253. Virtual Reality. 3 Units.
This course provides an overview of the field of virtual reality (VR). Topics include stereoscopic display, force feedback and haptic simulation, viewer tracking, virtual worlds, 3D user interface issues, augmented reality, and contemporary applications of VR in entertainment, teaching and training. Students gain practical experience designing and evaluating a virtual reality application. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science.

COMP 254. Advanced Graphics Programming. 3 Units.
This course provides a survey of advanced topics in computer graphics. Students will complete several Web-based 3D graphics programming projects, and explore a contemporary research topic related to computer graphics. Prerequisites: Programming Languages Core Skill, Algorithms Core Skill, and ENGR 201 with a "C" or better and graduate or blended students in the School of Engineering and Computer Science or instructor approval.

COMP 257. Advanced Algorithms. 3 Units.
This course will cover the fundamentals of algorithm design. We will discuss some basic paradigms for reasoning about algorithms and their asymptotic complexity and survey many of the techniques that apply broadly in the design of efficient algorithms. Prerequisites: Algorithms Core Skill and graduate or blended students in the School of Engineering and Computer Science or instructor approval.

COMP 258. Design/Assess of Serious Games. 3 Units.
This course develops the skills and techniques required for the creation of serious games. Serious games are games that have an additional purpose beyond simple entertainment. Topics include understanding and evaluating the current landscape of serious games, undergoing the research to design a serious game, and assessing the games created to see if they fulfill their goals as a serious game. This course is intended to prepare students to design, develop and assess multi-purpose software. Prerequisites: Algorithms Core Skill and Programming Languages Core Skill and graduate students in the School of Engineering and Computer Science or instructor approval.

COMP 259. Character Animation. 3 Units.
Investigation of algorithmic and data#driven techniques for directing the motion of computer generated characters, with a focus on human# like motion. Coursework will include analysis of published research, programming assignments and an original research project/investigation. Prerequisite: Graduate students in the School of Engineering and Computer Science or permission of the instructor.

COMP 261. Data Science. 3 Units.
This course is about the principles and methods for handling big data. Topics include data sources, data products, data analysis, and data visualization. Students are expected to read technical papers and apply techniques to solve real-world big data problems. Prerequisite: Algorithms Core Skill or EMGT 162 with a "C" or better and graduate students in the School of Engineering and Computer Science or instructor approval.

COMP 262. Advanced Data Analytics. 3 Units.
This course will cover advanced topics in computational data analysis with an emphasis on programming for deep learning and natural language processing. Students will learn to perform big data analysis on real-world data sets with Python and visualization tools. Prerequisites: Algorithms Core Skill or COMP 162 or EMGT 162 with a "C-" or instructor approval.

COMP 263. Database Management Systems II. 3 Units.
The course highlights the importance of learning how to manage large volumes of unstructured, offline, and continuously changing data in today's data-driven world. Given the evolving nature of data, the course places a strong emphasis on developing practical skills through hands-on labs, comprehensive projects, and direct engagement with real-world industry domains, including the Internet of Things (IoT) applications across sectors such as agriculture, automotive, retail, and healthcare. The course will critically contrast and evaluate these modern data management challenges against traditional SQL concepts, enabling students to understand the strengths and limitations of both paradigms and to apply the most appropriate solutions in different scenarios. Prerequisites: COMP 163 with a Minimum Grade of C-.

COMP 264. Storytelling and Visualization. 3 Units.
Current information professionals are faced with an overwhelming amount of information every day. The information is typically unstructured, abstract, large-scale, and needs a more efficient and intuitive way to represent the relationships, reveal the patterns, and/or discover potential opportunities. Information visualization has thus recently gained increasing attention and begun to be widely applied to scientific, engineering, and social disciplines to help people understand and present their information better. According to Gershon et al. (1998), visualization can provide "an interface between two powerful information processing systems—the human mind and the modern computer." A picture is worth a thousand words". We are all familiar with this expression. It especially applies when trying to explain the insights obtained from the analysis of increasingly large datasets. Data visualization plays an essential role in the representation of both small and large-scale data. Data visualization is the graphical representation of data in order to interactively and effectively convey insights to stakeholders general. With ever increasing volume of data, it is impossible to tell stories without visualization. Data visualization is an art of how to turn numbers in to useful knowledge. The growing availability of informative datasets and software tools has led to increased reliance on data visualizations across many areas. Data visualization provides a powerful way to communicate data-driven findings, motivate analyses, and detect flaws. The fact that it can be difficult or impossible to notice a mistake within a dataset makes data visualization particularly important. In this course, you will learn how to leverage a software tool to visualize data that will also enable you to extract information, better understand the data, and make more effective decisions. This course provides a practical approach to learning the theories and techniques of data visualization for data analysis. Python lets you learn the art of visualization by offering a set of inbuilt functions and libraries to build visualizations and present data. In this course you will learn functionality for visualization and basics of data visualization and exploratory data analysis using Matplotib and seaborn, a data visualization packages for the statistical programming language Python. The course will give you the skills you need to leverage data to reveal valuable insights and advance your career. You will study the application of primary drawing functions and advanced drawing functions and will focus on understanding the methods of data exploration by visualization. The ultimate goal of this course is to provide students with an alternative powerful tool to process information in the specific domain of their own interests.

COMP 265. ML Methods for Cybersecurity. 3 Units.
This course will cover basic machine and deep learning algorithms and explore their usage in cybersecurity research. Areas of research will include intrusion detection, malware analysis, user behavior modeling, anti-phishing, and threat identification. Students will have a chance to try out several of these models on practical problems.

COMP 270. Secure Software Systems. 3 Units.
In this course, students will study best practices for secure software development. Topics will include software security requirements, compliance requirements, misuse and abuse cases, security design principles, secure software architecture and design, secure coding practices, cryptography, code analysis for risks, software testing, lifecycle management, deployment, operations, and supply chain security. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science.

COMP 271. Vulnerabilities. 3 Units.
In this course, students will systematically study the fundamental principles of computer system security. Students will learn to identify vulnerabilities in computer systems and mitigate them. The course takes a practical approach to information security by focusing on real-world examples and hands-on lab activities. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science, and COMP 280 or ECPE 170 or COMP 173 with a "C" or better.

COMP 272. Software Reverse Engineering. 3 Units.
The objective of this course is to familiarize students with the practice of reverse engineering programs where the source code is unavailable. By this process, students can discover the specification for a given software program, thereby understanding its operation as well as any data it uses or communication protocols it employs. This knowledge is valuable for identifying and neutralizing malware on a system or discovering software vulnerabilities and patching them during the course of a security audit. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science, and COMP 280 or COMP 173 or ECPE 170 with a "C" or better.

COMP 274. Reliable Software Design. 3 Units.
With the technological advancements, critical systems (e.g., in the aerospace industry, healthcare industry, etc.) are being deployed and used in a widespread fashion. This trend, along with the increasing complexity of such systems, necessitate their software components to provide guaranteed reliability and assurance. This course introduces a mathematical foundation for rigorous analysis of computer programs by exploring the logical underpinnings and the tools that are used to reason about program correctness in order to develop high quality and robust software. In this course, students engage in developing programs that formally define system constructs, specifying the properties of interest, and proving the satisfaction of those properties in the system. Prerequisites: Programming Languages Core Skill and Computing Theory Core Skill and graduate or blended students in the School of Engineering and Computer Science or instructor approval.

COMP 275. Network Security and System Administration Essentials. 3 Units.
This course provides students with a comprehensive understanding of system administration and the technologies used to maintain confidentiality, integrity, and availability. Students will learn command-line usage, user management, database administration, fundamentals of network security, network security tools including firewalls and intrusion detection and prevention systems, and security analytics tools. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science.

COMP 276. Security Operations: Incident Response and Digital Forensics. 3 Units.
This course provides students with the tools and techniques to detect and respond to data breaches and cyberattacks. Topics include an overview of incident management, incident response plans, the lifecycle of an incident, the use of digital forensics to investigate and manage an incident, forensic analysis tools, and escalation management. The course includes case studies in incident response and digital forensics. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science.

COMP 277. Advanced Computer Networking. 3 Units.
The modern Internet is a communications system of global scale and high complexity. In this course, students will study the technological underpinnings that enable modern network communication, including routing, network, and application-layer protocols. Wired, wireless, and cellular networks will be examined. The course will include a laboratory, with emphasis placed on determining the current state of a network through network mapping, traffic analysis, and protocol analysis. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science, and COMP 280 or COMP 177 or ECPE 177 with a "C" or better.

COMP 278. Cyber Defense and Offense. 3 Units.
This course offers a comprehensive study of the principles and practices of computer system security including operating system security, network security, software security, and web security. Students will learn common threats and vulnerabilities, along with basic principles and techniques when designing a secure system. Hands-on labs will help students gain an understanding on how to think like an adversary, how modern cyber-attacks and defenses work in practice, and how to assess threats and protection mechanisms. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science, and COMP 280 or ECPE 170 or COMP 173 with a "C" or better.

COMP 279. Cybersecurity Advanced Topics. 3 Units.
This course covers elements of advanced topics in the field of cybersecurity, including tools and techniques for cyber offense, security information and event management, endpoint detection and security orchestration, cybersecurity analytics, API security, and development security and operations. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science.

COMP 280. Cybersecurity Bootcamp. 4 Units.
The Bootcamp course provides students with the hands-on technical skills and knowledge base to succeed in the Cybersecurity graduate program. Topics covered include computer networking (both network programming and network configuration), computer operating systems, virtualization, fundamentals of cybersecurity, and cybersecurity current events. Prerequisites: Graduate student in the Master of Science in Cybersecurity program, or permission of instructor.

COMP 282. Cybersecurity Capstone Project. 3 Units.
In this capstone design course, students synthesize their cumulative cybersecurity knowledge through the development of a computer application or system. Students will establish design objectives and criteria, analyze solution alternatives, and evaluate design performance and capabilities. Students will then implement, test and evaluate the resulting prototype system. Complete documentation is required, including oral presentations, written reports, and demonstration of the final working system. Prerequisites: Graduate student in the Master of Science in Cybersecurity program, and COMP 280 with a 'C' or better.

COMP 283. Vulnerability Management. 3 Units.
The process of vulnerability management is systematically studied in this course. Students will learn how to use management tools like scanners and ticketing systems, how to design, develop, and rollout systems to track the entire life cycle of vulnerabilities across an organization, and how to report and quantify vulnerabilities with metrics. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science.

COMP 284. Cybersecurity Governance, Risk and Compliance. 3 Units.
This course provides the students with a high-level overview of cybersecurity governance, risk, and compliance. Students will study risk management fundamentals including assessment, NIST processes, and risk management tools, as well as the overall place of risk management in the field of cybersecurity. Governance processes and techniques will also be explored, including business impact analysis, asset management and tools, alignment of cybersecurity and business objectives, SWOT and GAP analysis, and security process maturity assessment. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science.

COMP 285. Mobile and Cloud Security. 3 Units.
This course examines the architecture and security implications of cloud-based applications and mobile applications. For cloud computing, fundamental principles and common cloud-based architectures are studied, along with technical methods to secure both the cloud platform itself and data stored in cloud-based systems by applications. Fundamentals of popular industry cloud platforms such as AWS and Azure are also covered. For mobile applications, fundamental principles of mobile device and application security are studied, along with secure development for mobile applications, architectural layers of mobile device security, and testing and auditing. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science.

COMP 286. Cybersecurity and Privacy Management. 3 Units.
This course provides students with a fundamental background of security strategy, policy, standards and procedures. Management-focused topics include cybersecurity awareness and education, COBIT and ISO governance principles, security programs and project management fundamentals, security metrics, and security reporting at the operational, tactical, and CISCO level. Privacy-focused topics include an introduction to privacy and its principals, privacy focused regulations and security controls, and privacy impact assessments. Includes agile programming and applications to security. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science.

COMP 287. Graduate Internship. 1-4 Units.

COMP 287A. Graduate Internship. 1-4 Units.

COMP 287B. Graduate Internship. 1-4 Units.

COMP 291. Graduate Independent Study. 1-4 Units.
Special individual projects are undertaken under the direction of one or more faculty. Prerequisite: Graduate or blended students in the School of Engineering and Computer Science or permission of instructor.

COMP 293. Special Topics. 4 Units.
Special courses are organized and offered from time to time to meet the needs or interests of a group of students. Prerequisite: Graduate or blended students in the School of Engineering and Computer Science or permission of the instructor.

COMP 297. Graduate Research. 1-5 Units.
Applied or basic research in engineering or computer science under faculty supervision. Approval by the faculty supervisor and the department chairperson is required. Prerequisite: Graduate or blended students in the School of Engineering and Computer Science or permission of instructor.

COMP 297D. Graduate Research. 1-4 Units.

COMP 297E. Graduate Research. 1-4 Units.

COMP 297F. Graduate Research. 1-4 Units.

COMP 297G. Graduate Research. 1-4 Units.

COMP 299. Thesis. 1-6 Units.
Minimum of six units is required for Thesis Option students. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science and permission of the research advisor.

Electrcl Computer Engr Courses

ECPE 005. Introduction to Electrical and Computer Engineering. 1 Unit.
This course introduces students to various sub-disciplines of Electrical and Computer Engineering and to the tools, both hardware and software, that are used in Electrical & Computer Engineering. Prerequisite that may be taken concurrently: ENGR 010 with a "C-" or better.

ECPE 041. Circuits. 3 Units.
Students study concepts of voltage, current, power, energy. Topics include ideal circuit elements and their I/V characteristics, Kirchhoff's laws, circuit analysis using node voltage and mesh current methods Thevenin's and Norton's theorems, maximum power transfer, and operational amplifier circuits. The course examines step response of 1st order (RC, RL) and 2nd order (RLC) circuits, phasor analysis, impedance calculations, sinusoidal steady state response, instantaneous, average, and reactive power, frequency response, bandwidth of first order, and lowpass and highpass filters. Prerequisites: PHYS 055; MATH 055; COMP 061 or COMP 051 or ENGR 019 with a "C-" or better. Prerequisites that may be taken concurrently: PHYS 55, MATH 55.

ECPE 041L. Circuits Laboratory. 1 Unit.
Students study the use of standard test equipment to make DC and AC measurements and characterize electric circuits. Circuit simulation is taught with software tools, and data analysis is emphasized. Corequisite: ECPE 041.

ECPE 071. Digital Design. 3 Units.
Students study number systems, binary arithmetic, and Boolean logic. Topics include the analysis and synthesis of combinational and sequential circuits and the use of FPGA devices. Prerequisites: Fundamental Math Skills requirement, and Sophomore or Junior or Senior standing.

ECPE 071L. Digital Design Lab. 1 Unit.
This course involves laboratory treatment of the concepts discussed in ECPE 071. Corequisites: ECPE 071. Prerequisites: Fundamental Math Skills requirement; COMP 051 or COMP 061 or ENGR 019 with a "C-" or better.

ECPE 121. Digital Signal Processing. 4 Units.
Students analyze discrete-time signals and systems using z transforms and Fourier transforms, the fast Fourier transform and its applications, digital filters and their applications and implementation of DSP algorithms using Matlab and Simulink. Also listed as BENG 121. Prerequisites: ECPE 041 and MATH 057 with a "C-" or better.

ECPE 124. Digital Image Processing. 4 Units.
This course is the analysis and design of algorithms in digital image processing. Topics include: image formation, file format, pixel-based processing, object recognition, filtering and edge detection, image transforms, segmentation, stereo-vision, and motion tracking. Prerequisites: COMP 053, ECPE 121 with a "C-" or better. Prerequisite that may be taken concurrently: ECPE 121.

ECPE 127. Random Signals. 3 Units.
This course is an introduction to probability and statistics in engineering applications. Students will become familiar with discrete and continuous random variables and their probability models. Topics include counting methods, reliability problems, probability mass functions (PMF), probability density functions (PDF), cumulative distribution functions (CDF), conditional PDF's, expected value and variance, joint and marginal PDF's and CDF's, functions of two random variables, sampling distributions, population parameter estimation, hypothesis testing using statistical software. Prerequisites: Completion of all Fundamental Skills, MATH 055 with a "C-" or better.

ECPE 131. Electronics. 4 Units.
Introduction to semiconductor physics, devices, and their circuit models. Analysis, design, implementation, testing, and verification of practical analog and digital circuits containing diodes, bipolar junction transistors, and field effect transistors. Extensive use of computer-aided analysis and design software. The course includes a laboratory. Prerequisites: Completion of all Fundamental Skills; ECPE 041, ECPE 041L, ECPE 071, ECPE 071L, MATH 055, PHYS 055, with a "C-" or better; AP CHEM with score of 4 or higher, or IB CHEM Higher Level with score of 5 or higher, or one year of high school chemistry with a "B-" or better, or appropriate score on the Pacific Diagnostic Chemistry test or CHEM 023 with a "C-" or better. Prerequisite that may be taken concurrently: ECPE 071, ECPE 071L.

ECPE 133. Solid State Devices. 4 Units.
This course introduces concepts related to the crystal structure of semiconductors and electronic, optical, and magnetic properties of semiconductors. Dynamics of carriers under equilibrium and non-equilibrium conditions are presented as a frame work for understanding the behavior of a number of devices including Metal-Oxide-Semiconductor (MOS) and Hetero-junction Bipolar (HBT) devices. On such a background, the course builds an understanding of the latest advances in the field. This course is cross listed with EPHY 133 and PHYS 170. Prerequisite: PHYS 055 with a "C-" or better. Prerequisite that may be taken concurrently: MATH 057 with a "C-" or better.

ECPE 135. Power Electronics. 4 Units.
Switch-Mode DC-DC converters, Feedback control of converters, Rectifiers and power factor correction circuits, switch mode DC power supplies, applications to motor control and renewable energy integration to the grid. Includes laboratory. Prerequisites: Completion of all Fundamental Skills; ECPE 131 with a "C-" or better. Prerequisites that may be taken concurrently: ECPE 121 or ECPE 141 with a "C-" or better.

ECPE 136. VLSI Design. 4 Units.
Students examine issues in VLSI design. Topics include logic families, sizing, timing models, fabrication, layout, high speed and low power design tradeoffs, circuit simulation and device modeling. (Spring odd years). Prerequisites: Completion of all Fundamental Skills; ECPE 071, ECPE 071L, ECPE 131 with a "C-" or better.

ECPE 141. Advanced Circuits. 4 Units.
Analysis and design of circuits in the continuous time domain. Topics include: frequency response, Laplace transforms, Fourier transforms, stability and feedback. Applications include high-order filter design and controls. Prerequisites: ECPE 041, ECPE 041L, and MATH 057 with a "C-" or better.

ECPE 144. Applied Electromagnetics. 4 Units.
The purpose of this course is for students to gain an understanding of transmission lines and field theory as it applies to communication circuits and systems. Electromagnetic wave propagation, reflection, and transmission through common materials are examined. This course is cross listed with EPHY 144. Prerequisites: Completion of all Fundamental Skills; PHYS 055, MATH 057, with a "C-" or better.

ECPE 155. Autonomous Robotics. 4 Units.
This course is an overview of the design of autonomous robotics. Students study architectures for robot organization and control, configurations of fixed and mobile robots, sensors and actuators. Students also study the design of algorithms and knowledge representations. Prerequisites: Completion of all Fundamental Skills; COMP 053 and ECPE 172 with a "C-" or better or permission of instructor.

ECPE 161. Automatic Control Systems. 4 Units.
Students study component and system transfer functions, open and closed loop response; stability criteria; applications to engineering systems. this course include a laboratory. Prerequisites: Completion of all Fundamental Skills; Prerequisite that may be taken concurrently: ECPE 121 or ECPE 141.

ECPE 162. Communication Systems. 4 Units.
Students examine signal characterization in time and frequency domains. Topics include baseband communication, pulse code modulation, multiplexing, complex envelope representation of bandpass signals. AM, FM, and digital modulations. Students also examine applications to radio, television, telephone, and cellular phone systems. A laboratory is included. Prerequisites: Completion of all Fundamental Skills and ECPE 121 with a "C-" or better. (Spring).

ECPE 163. Energy Conversion. 4 Units.
Students study three phase power systems. Topics include magnetic circuits, transformers, rotating machines: DC, induction, and synchronous machines as well as equivalent circuits and characteristic curves of transformers and rotating machines, renewable energy sources and technologies. the course includes a laboratory. Prerequisites: Completion of all Fundamental Skills; ECPE 041 and ECPE 041L; PHYS 055 with a "C-" or better.

ECPE 165. Power System Analysis. 4 Units.
Students study electric power generation and transmission, three-phase systems, power system component models, per-unit system and single line diagrams, power flow analysis, unbalanced systems, symmetrical components, and fault studies. Prerequisites: Completion of all Fundamental Skills and ECPE 041 with a "C-" or better, Junior standing.

ECPE 170. Computer Systems and Networks. 4 Units.
The course investigates the operation of a modern computer system and its components. Students examine the processor data path and memory hierarchy by writing assembly programs and high-level simulations. The course also provides an introduction to computer networks and socket programming. Prerequisites: Completion of all Fundamental Skills; ECPE 071 or COMP 047 with a "C-" or better; COMP 053 with a "C-" or better.

ECPE 172. Microcontrollers. 4 Units.
Students study the design and implementation of digital monitoring and control systems that use micro-controllers. Topics include hardware and software development, interfacing input and output devices, assembly and C programming as well as representative applications. The course includes a laboratory. Prerequisites: Completion of all Fundamental Skills; COMP 053, ECPE 071, and ECPE 071L with a "C-" or better.

ECPE 173. Computer Organization and Architecture. 3 Units.
The objective of this course is to give students a deeper understanding of how a complete modern computer system operates. Students learn about design of a processing unit, pipelining, memory hierarchy, parallelism, and more advanced architecture topics. Prerequisites: Completion of all Fundamental Skills; ECPE 071L and ECPE 170 with a "C-" or better.

ECPE 174. Advanced Digital Design. 4 Units.
Students learn how to analysis, design, and implement synchronous state machines using programmable logic devices. Topics include CAD-based simulation and development that use schematic capture and hardware description languages, and representative applications. The course includes a laboratory. Prerequisites: Completion of all Fundamental Skills; ECPE 071 and ECPE 071L with a "C-" or better.

ECPE 177. Computer Networking. 4 Units.
Topics examined in this course include computer networks and the internet, LAN and WAN architectures, and packet switched networks and routing. Students learn about the internet protocol stack, socket programming and client/server systems, wireless networking and security. Also listed as COMP 177. Junior or Senior standing. Prerequisites: Completion of all Fundamental Skills; COMP 053 and ECPE 170 with a "C-" or better.

ECPE 178. Computer Network Security. 3 Units.
This course is an examination of computer security from a defensive and offensive perspective. Topics include attack methods used by threat actors (including scanning, exploits, privilege escalation, malware, and social engineering methods), their detection, and their prevention by network and host-based techniques. Additionally, cryptographic techniques are introduced in order to provide secure communications channels that guarantee message confidentiality, authenticity, and integrity. Prerequisites: Completion of all Fundamental Skills and ECPE 170 or COMP 175 with a “C-“ or better.

ECPE 191. Independent Study. 1-4 Units.
Special individual projects are undertaken under the direction of one or more faculty members knowledgeable in the particular field of study. Permission of department chairperson and faculty members involved.

ECPE 195. Senior Project I. 2 Units.
This first semester capstone design course instructs students in the application of design processes and interdisciplinary teamwork. Student teams select a project and develop requirements, test, and design documents. Projects incorporate consideration of engineering standards and realistic constraints such as economics, the environment, sustainability, manufacturability, or safety. Components are evaluated and selected. Feasibility is analyzed through prototyping or simulation and results are presented via oral and written reports. This course is cross listed with EPHY 195. Prerequisites: Completion of all Fundamental Skills; ECPE 131 with a "C-" or better.

ECPE 196. Senior Project II. 2 Units.
This second-semester capstone design course, interdisciplinary teams complete the design of their projects. Full implementation is completed, including iteration, optimization, and refinement; justifications for design decisions are analyzed. Testing is performed and results are evaluated to demonstrate satisfaction of specifications. Final oral and written reports, complete documentation, and a project demonstration are required. This course is cross listed with EPHY 196. Prerequisites: Completion of all Fundamental Skills; ECPE 195 with a "C-" or better.

ECPE 197. Undergraduate Research. 1-4 Units.
This course offers applied or basic research in electrical and/or computer engineering under faculty supervision. Permission of faculty supervisor and department chair. The student must be in good academic standing.

ECPE 225. Digital Signal Processing with Applications. 3 Units.
Topics include discrete time signals, systems, spectral analysis (DTFT), the Discrete Fourier Transform and the Fast Fourier Transform algorithm, decimation and interpolation, multi-rate signal procession, and filtering random signals. Additional course content is speech processing, speech models and characteristics, short time Fourier analysis, linear predictive coding. Image processing: 2D signals and systems, image coding, image enhancement is also addressed. Prerequisites: ECPE 121 with a "C" or better or equivalent and Graduate or blended students in the School of Engineering and Computer Science or permission of instructor.

ECPE 226. Computational Intelligence. 3 Units.
Computational intelligence is broadly defined as the concepts, models, and algorithms inspired by intelligent biological systems. Students will apply computational intelligence paradigms and techniques to real world data sets and optimization problems. Topics include types of learning, theory of generalization, linear and logistic regression, non-linear transformation, fundamentals of neural networks, evolutionary computation and optimization, fuzzy set theory and fuzzy logic, and other current topics in computational intelligence. Familiarity with basics in linear algebra, probability, and analysis of algorithms recommended. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science.

ECPE 233. Quantum and Nano Devices. 3 Units.
Students study advanced topics related to recent development of the emerging field of nanoelectronics where the feature lengths of the electron devices are of the order of several nanometers. They also study transport phenomenon in nano-structures that use a quantum atomistic transport approach. Topics include: quantum confined effects, nanofabrication, quantum wells, quantum wires, quantum dots, and quantum optoelectronic devices. The purpose of this course is to prepare the framework for analyzing, modeling, and designing of these non-scale electron devices. Prerequisites: familiarity with MATLAB, light familiarity with physics of semiconductor devices, light exposure to quantum physics, ability to solve second order differential equations, and an exposure to complex analysis, Graduate or blended students in the School of Engineering and Computer Science or permission of the instructor.

ECPE 251. High-Performance Computing. 3 Units.
This course investigates modern HPC systems and architectures including multiprocessor clusters, General-Purpose Graphical Processing Units (GP-GPUs), and Xeon Phi co-processors. Students develop effective parallel programs by applying parallel programming principles, parallelism models, and communication models. Topics include: taxonomy of parallel machines, supercomputer topology, shared memory systems, OpenMP, distributed systems, message passing interface, CPU architecture, compute unified device architecture, HPC performance modeling. Prerequisite: Graduate or blended student in the School of Engineering and Computer Science and ECPE 170 with a "C" or better.

ECPE 253. Advanced Computer Graphics. 3 Units.
Students study advanced topics in computer-generated graphics such as procedural modeling, surface simplification, shaders, texture synthesis and mapping, volume rendering, ray tracing, photon mapping, image-based rendering techniques, non-photorealistic rendering, 3D hardware/GPUs and animation. Course includes programming projects and presentation of research topics. Prerequisites: COMP 153 or ECPE 153 with a "C" or better, C programming experience (C++ or Java is acceptable, but students are expected to program in C), Graduate or blended students in the School of Engineering and Computer Science or permission of the instructor.

ECPE 255. Robotics. 3 Units.
This course explores high-level issues of autonomous robotics. The course will focus on theory, design, and implementation of making intelligent and autonomous robots. The course will examine these topics from the perspective of individual robots, swarm robots, and multi-agent robots. Students will learn both theory and practice through simulations and work on robot platforms. Prerequisites: ECPE 170 or ECPE 172 or MECH 104 with a “C“ or better and Graduate or blended students in the School of Engineering and Computer Science.

ECPE 259. Sensor Networks for Engineering Systems. 3 Units.
This course introduces sensor networks for infrastructure systems from sensor selection, system design, implementation, acquisition, and analysis. Examination of application across multiple engineering disciplines. Project based components with laboratory. Prerequisites: ECPE 131, ECPE 121; or ENGR 019, ENGR 121; or COMP 055, COMP 157 with a "C" or better; Graduate or blended students in the School of Engineering and Computer Science; or permission of instructor.

ECPE 263. Recent Topics in Renewable Energy. 3 Units.
Recent Trends in global warming and the rising cost of energy has resulted in significant interest in renewable energy sources that include solar thermal, solar photovoltaics, hydrogen fuel cells, biomass, geothermal, wind, hydraulic, and hybrid technologies. This course is a survey of these energy sources and covers the theory, economic feasibility, current level of technological development, renewability, abundance, and environmental impacts of the renewable sources and compares them to the non-renewable sources which include oil, gas, coal, nuclear, and other current energy technologies. The emphasis is given to research in these fields by the students' term papers and projects. Prerequisite: Graduate or blended students in the School of Engineering and Computer Science or permission of instructor.

ECPE 276. Cloud Computing. 3 Units.
Cloud computing has become mainstream in the field of information technology, providing highly scalable computing resources for applications with no up-front capital investment and operating costs proportional to the actual use. Students will study the technological underpinnings that enable modern cloud computing, including virtualization technology, datacenter networks, programming models, and middleware systems. This course will provide a survey of current research focused on improving the performance, security, fault-tolerance, and energy efficiency of cloud computing systems. Further, students will utilize these cloud computing technologies as application programmers to construct distributed large-scale data processing systems. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science and ECPE 170 with a "C" or better.

ECPE 287. Internship. 1-4 Units.

ECPE 291. Graduate Independent Study. 1-4 Units.
Special individual projects are undertaken under the direction of one or more faculty. Prerequisite: Graduate or blended students in the School of Engineering and Computer Science or permission of instructor.

ECPE 293. Special Topics. 1-4 Units.
Special courses are organized and offered from time to time to meet the needs or interests of a group of students. Prerequisite: Graduate or blended students in the School of Engineering and Computer Science or permission of the instructor.

ECPE 297. Graduate Research. 1-4 Units.

ECPE 297D. Graduate Research. 1-4 Units.

ECPE 299. Thesis. 1-6 Units.
Minimum of six units is required for Thesis Option students. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science and permission of the research advisor.

Engineering Management Courses

EMGT 115. Building Information Modeling. 4 Units.
This course provides the basics of design, modeling, scheduling, resource allocation, time/cost tradeoffs, task coordination, team-building, progress monitoring, and post project assessment while using the latest BIM technologies. Students study the lean construction and how to integrate BIM into the project delivery processes. Prerequisite: Completion of all fundamental skills.

EMGT 142. Design and Innovation. 3 Units.
This course brings buyers, sellers and end-users of design, prototyping and testing together in an educational and real problem environment. Students will learn how to identify innovation, and develop, design and market new product or service. Students will also learn the nature and importance of technological innovation in commercial organizations with particular reference to bringing a new product or service off the drawing board, through virtual development, and into a modern pre-sales promotional environment in weekly project deliverables. Prerequisite: Upper division standing in engineering.

EMGT 142L. Design and Innovation Lab. 1 Unit.
The laboratory component of EMGT 142, course provides the basics of Industrial Design techniques including drawing, graphical, presentation and design communication skills. Students learn how to design functional objects, sculpture and use a variety of 2D and 3D applications to produce those models as physical objects. A variety of rapid prototyping methods include: 3D Printing, Vacuum Forming, and Laser Cutting is used in weekly project deliverables. Prerequisite: Upper division. Corequisite: EMGT 142.

EMGT 145. Product Design & Additive Manufacturing. 3 Units.
In this course students learn the scientific principles of additive manufacturing (AM). The course covers, how to design and prototype to meet a specific need. Next, explore how AM can apply to the identified opportunity, from product planning and modeling to development and evolution. Prerequisites: Junior Standing, MECH 015 or CIVL 015.

EMGT 155. Computer Simulation. 4 Units.
This course explores digital simulation in which a model of a system is implemented and executed on a computer. The course focuses on modeling methodologies, mathematical techniques for implementing models, and statistical tecniques for analyzing the results of simulations. Students develop simulations that use both simulation development toolkits and general-purpose programming languages. Also listed as COMP 155. Prerequisites: Completion of all Fundamental Skills; MATH 037 or MATH 039; MATH 045 or MATH 051, COMP 051 or COMP 061 or ENGR 019 with a "C-" or better.

EMGT 162. Introduction to Data Analytics for Engineers and Computer Scientists. 3 Units.
This course introduces students to state-of-the-art topics involving large collection of data. Particular emphasis is made on data collection, data storage and processing, extracting structured data from unstructured data, analytics, visualization, and a number of specific applications. Students explore large amounts of complex, digital data and learn about the tools and skills they need to solve knowledge from voluminous data sets. Prerequisites: ENGR 019 or COMP 051; upper division standing.

EMGT 170. Project Decision Making. 4 Units.
Project decision-making based upon engineering economy studies. This area covers techniques for economic evaluation of alternatives including time value of money, risk costs, effects of inflation, compound interest calculation, minimum attractive rate of return, capital budgeting, break-even analysis, sensitivity analysis, and risk analysis. A second facet of the course covers the fundamental aspects of project management within an engineering context. This area covers the project procurement process, project management and project scheduling. (Summer, Fall).

EMGT 172. Engineering Economy. 3 Units.
This course examines decision-making based upon engineering economy studies. This course covers techniques for economic evaluation of alternatives that includes time, value of money, risk cost, effects of taxation, monetary inflation, compound interest calculations, minimum attractive rate of return, capitol budgeting, break-even analysis, sensitivity analysis and risk analysis. Prerequisite: Completion of all Fundamental Skills.

EMGT 174. Engineering Project Management. 3 Units.
Students study the fundamentals of project management that are used in estimating, planning, coordinating and controlling engineering projects. Topics include fundamentals of specifications and contracts, and the scheduling of projects. Prerequisites: Completion of all Fundamental Skills.

EMGT 176. Systems Engineering Management. 4 Units.
This course provides an introduction to the concepts and process of systems engineering. It uses interactive lectures, participatory class exercises and case studies to illustrate the framing and solution of problems through a systems engineering approach. The course stresses an understanding of the interdisciplinary aspects of systems development, operations and support. Prerequisites: Completion of all Fundamental Skills; MATH 055 with a “C-“ or better, or permission of instructor.

EMGT 191. Independent Study. 1-4 Units.
Special individual projects are undertaken under the direction of one or more faculty members knowledgeable in the particular field of study. Permission of faculty member involved. The student must be in good academic standing.

EMGT 192. Professional Practice. 8 Units.

EMGT 195. Engineering Management Synthesis. 4 Units.
The capstone course is for Engineering Management majors. Emphasis on integration and application of management concepts. including project proposal and design, with periodic reviews and written and oral reports. Prerequisites: Completion of all Fundamental Skills.

EMGT 197. Undergraduate Research. 1-4 Units.
This course offers applied or basic research in focused topics within Engineering Management under faculty supervision. Permission of faculty supervisor and department chair.

EMGT 215. Advanced Building Information Modeling. 3 Units.
Course provides advanced knowledge of design, modeling, scheduling, resource allocation, time/cost tradeoffs, task coordination, team-building, progress monitoring, and post project assessment while using the latest BIM technologies. Students study lean construction and how to integrate BIM into the project delivery processes. Prerequisite: Graduate or blended students in the School of Engineering and Computer Science.

EMGT 245. Advanced Product Design & Additive Manufacturing. 3 Units.
In this course students learn the scientific principles of additive manufacturing (AM). The course covers, how to design and prototype to meet a specific need. Next, explore how AM can apply to the identified opportunity, from product planning and modeling to development and evolution. Prerequisites: MSES standing or instructor approval.

EMGT 250. Decision Techniques in Engineering. 3 Units.
This course is designed to introduce fundamental and advanced decision techniques applicable to engineering and business processes. The techniques discussed are applicable to complex problems in both professional and personal situations. The tools and techniques address deterministic and stochastic problems, trade-offs, no-linear preferences and group decision making. Class discussions develop a theoretical framework as foundation for practical application within the organization. Prequisites: Graduate or blended students in the School of Engineering and Computer Science and ENGR 250 with a "C" or better.

EMGT 262. Applied Analytics for Decision Making. 3 Units.
This course examines concepts and methods central to analytics and decision making systems. The focus is on the application of management science and artificial intelligence techniques for prescriptive and predictive analytics. Case studies of existing systems are used to reinforce concepts discussed in class. A major component of the course is a project entailing the design, implementation, and evaluation of prototype systems for real world applications. Prerequisite: Graduate or blended students in the School of Engineering and Computer Science.

EMGT 276. Advanced Systems Engineering Management. 3 Units.
This course deepens understanding of the concepts and processes of system engineering. The course focuses on the interdisciplinary aspects of systems development, operations, and support. A systems engineering problem solving process is progressively developed starting with system requirements analysis and goal development, through the development of criteria for system evaluation, the system design requirements, the design review and evaluation, and the system engineering program planning. The course contents are structured into four principal areas: 1) system engineering fundamentals; 2) system analysis characteristics of design; 3) system engineering processes; 4) system planning, organizing, and managing. Prerequisites: Graduate standing.

EMGT 291. Graduate Independent Study. 1-4 Units.
Special individual projects are undertaken under the direction of one or more faculty. Prerequisite: Graduate or blended students in the School of Engineering and Computer Science or permission of instructor.

EMGT 293. Special Topics. 4 Units.
Special courses are organized and offered from time to time to meet the needs or interests of a group of students. Prerequisite: Graduate or blended students in the School of Engineering and Computer Science or permission of the instructor.

EMGT 297. Graduate Research. 1-4 Units.
Approval by the faculty supervisor and the department chairperson is required. Prerequisite: Graduate or blended students in the School of Engineering and Computer Science and permission of instructor.

EMGT 299. Thesis. 1-6 Units.
Minimum of six units is required for Thesis Option students. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science and permission of the research advisor.

General Engineering Courses

ENGR 010. Dean's Seminar. 1 Unit.
This course is a survey of the profession and practice of engineering and computer science. It is an overview of the programs and methodologies of the School of Engineering and Computer Science that includes educational requirements, professional and career opportunities, introduction to the history of engineering and computing, and entrepreneurship. Hands-on activities and guest lecturers are included to complement the discussion sessions. The course provides basic skills, tools, and techniques applied to problem solving, teamwork and communication necessary for academic and professional success. Students are required to complete a design project, write a basic technical report and present their results.

ENGR 019. Computer Applications in Engineering. 3 Units.
This course introduces students to binary arithmetic,; numerical methods applicable to engineering problems and their solution that use a programming language and computation tools. Topics include root finding, solving systems of equations, curve fitting and interpolation, numerical integration and differentiation, and numerical solution of ordinary differential equations. Students develop programming skills in a high level language and learn to use mathematical computation tools including and spreadsheets. Prerequisite may be taken concurrently: MATH 053 with a "C-" or better.

ENGR 020. Engineering Mechanics I (Statics). 3 Units.
Students study the fundamental principles of static equilibrium that results from the application of forces on particles and bodies. Prerequisites: MATH 053 and PHYS 053 with a "C-" or better.

ENGR 025. Professional Practice Seminar. 1 Unit.
This course is designed to prepare students for the Cooperative Education experience. Presentations are from representatives of industry, government, education and former Co-op students. Topics include engineering ethics, professionalism, time management and mock interviewing.

ENGR 030. Engineering and Computing Ethics in Society. 3 Units.
Major engineering achievements are explored with an emphasis on ethical principles and the global impact these achievements have on society and the environment. Topics include societal needs, personal rights, whistle blowing, conflicts of interest, professional autonomy, risk assessment, sustainable development and the application of engineering codes of ethics. Contemporary technological controversies are examined along with future developments that require engineers to stay current in their field. Student participation is expected in classroom discussions, oral presentations, and written analyses. Prerequisite: Fundamental Writing Skills requirement. **(DVSY, GE2B, GEDI, GEWE)**

ENGR 040. Engineering Design thinking. 3 Units.
In this course students learn engineering innovation and entrepreneurship practices. Students experience driving a process or product to launch using design thinking and lean startup approaches. **(GEAP)**

ENGR 045. Materials Engineering. 3 Units.
Students examine the dependency of physical, chemical and mechanical properties on microscopic and macroscopic structure of materials. Laboratory experiments involve properties of materials such as metals, polymers, composites and ceramics. Prerequisites: AP CHEM with score of 4 or 5, CHEM IB Higher Level (score of 5, 6, or 7), CHEM 024, CHEM 025, or CHEM 027 and MATH 53 with a "C-" or better. Co-Requisite: ENGR045L.

ENGR 045L. Materials Engineering Lab. 1 Unit.
Experimental analysis of concepts are discussed in ENGR045. Prerequisites: AP CHEM with score of 4 or 5, CHEM IB Higher Level (score of 5,6, or 7), CHEM 024, CHEM 025, or CHEM 027 and Math 53 with a "C-" or better. Co-Requisite: ENGR045.

ENGR 093. Introduction to Engineering. 1 Unit.

ENGR 110. Instrumentation and Experimental Methods. 2 Units.
Students study experimental techniques in the measurement of quantities such as biopotentials, force, pressure, sound, flow, temperature, strain and motion. Topics include statistical analysis and errors in measurement,; data analysis and transmission. Students also use of instruments in the laboratory, and prepare a measurement project. Prerequisites: Completion of all Fundamental Skills; MATH 057; BENG 124 or ENGR 121 with a "C-" or better or permission of instructor. Co-Requisite: ENGR 110L.

ENGR 110L. Instrumentation and Experimental Methods Lab. 1 Unit.
Experimental analysis of concepts are discussed in ENGR 110. Prerequisites: Completion of all Fundamental Skills; MATH 057; BENG 124 or ENGR 121 with a "C-" or better or permission of instructor. Co-Requisite: ENGR 110.

ENGR 120. Engineering Mechanics II (Dynamics). 3 Units.
Students examine the fundamental principles of particles and bodies in motion under the action of external forces. Prerequisites: Completion of all Fundamental Skills and ENGR 020 with a "C-" or better.

ENGR 121. Mechanics of Materials. 3 Units.
Students study concepts of stress, strain and deformation, analysis and design of simple elements of structures and machines. Prerequisites: Completion of all Fundamental Skills and ENGR 020 with a "C-" or better. Prerequisite, may be taken concurrently: MATH 057 with a "C-" or better.

ENGR 122. Thermodynamics I. 3 Units.
Students examine the first and second laws of thermodynamics for open and closed systems. Topics include properties of gases and liquids, including entropy and availability. Students are also introduced to the Carnot and ideal Rankine cycles. Prerequisites: Completion of all Fundamental Skills; AP Chem with score of 4 or 5, CHEM IB Higher Level (score of 5, 6, or 7), CHEM 024 or CHEM 025 or CHEM 027 and PHYS 053 with a "C-" or better.

ENGR 150. Engineering and Science-Based Entrepreneurship. 4 Units.
Entrepreneurial businesses are increasingly based on new products, processes and services derived from the realms of engineering and/or science. In this hands-on course a multidisciplinary team of students will develop a business plan around a prototype for an original product or service created by students and/or faculty in engineering or the sciences. The plan will focus on the market, technical, operational, financial and organization/administrative dimensions of the business. Prerequisite: Senior standing.

ENGR 181. Professional Practice. 1-16 Units.
This course offers cooperative employment in a professional engineering environment. Students may register for a variable number of credits that depend upon the length of the work period. The course requires a satisfactory completion of the work assignment and a written report. Grading is on a Pass/Fail basis. Prerequisites: Completion of all Fundamental Skills.

ENGR 182. Professional Practice. 1-16 Units.
This course offers cooperative employment in a professional engineering environment. Students may register for a variable number of credits that depend upon the length of the work period. The course requires a satisfactory completion of the work assignment and a written report. Grading is on a Pass/Fail basis. Prerequisites: Completion of all Fundamental Skills.

ENGR 183. Professional Practice. 1-16 Units.
This course offers cooperative employment in a professional engineering environment. Students may register for a variable number of credits that depend upon the length of the work period. The course requires a satisfactory completion of the work assignment and a written report. Grading is on a Pass/Fail basis. Prerequisites: Completion of all Fundamental Skills.

ENGR 184. Professional Practice. 1-18 Units.
This course offers cooperative employment in a professional engineering environment. Students may register for a variable number of credits that depend upon the length of the work period. The course requires a satisfactory completion of the work assignment and a written report. Grading is on a Pass/Fail basis. Prerequisites: Completion of all Fundamental Skills.

ENGR 185. Professional Practice. 1-18 Units.
This course offers cooperative employment in a professional engineering environment. Students may register for a variable number of credits that depend upon the length of the work period. The course requires a satisfactory completion of the work assignment and a written report. Grading is on a Pass/Fail basis. Prerequisites: Completion of all Fundamental Skills.

ENGR 191. Independent Study. 1-4 Units.

ENGR 192. Professional Practice. 8 Units.

ENGR 192P. Engineering Co-Op Placeholder. 12 Units.

ENGR 197. Undergraduate Research. 1-4 Units.

ENGR 201. Techniques in Research. 3 Units.
Students learn about research design, qualitative and quantitative research, and sources of data. The course will cover data collection procedures, measurement strategies, questionnaire design and content analysis, interviewing techniques, literature surveys; information data bases, probability testing, and inferential statistics. Students will prepare and present a research proposal as part of the course. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science or permission of the instructor.

ENGR 212. Technology Venturing. 3 Units.
Science and technology are increasingly driving new product, process and service development throughout the world. Turning a new idea into a useful innovation, however, is challenging. In this course, student teams invent an original technology-based product or process, and evaluate its feasibility from the standpoint of its market, intellectual property, technical, design, and financial potential. Teams also incorporate an international dimension into the feasibility study. At the conclusion of the course, teams present their findings to a panel, who will judge the potential of their new idea, and the team's ability to present their findings in a data based manner. Prerequisite: Graduate or blended students in the School of Engineering and Computer Science.

ENGR 219. Numerical Methods for Engineering. 3 Units.
The primary focus is algorithm implementation within the context of engineering applications. Course topics will include: sources of error and error propagation, eigenvalue/eigenvector computation, solution of linear systems via direct or iterative methods and issues of parallel implementation, least squares and approximation of lab/simulation data, solution of non-linear equations, spline interpolation in one and two dimensions, fast Fourier transforms, numerical differentiation and quadrature, and the numerical solution of ordinary and partial differential equations, including an introduction to finite element methods. Whenever appropriate, relevant aspects of parallel computation will be discussed. Prerequisites: MATH 057 or equivalent with a "C" or better, some programming experience in any language and Graduate or blended students in the School of Engineering and Computer Science.

ENGR 250. Probability and Statistics for Engineering and Computer Science. 3 Units.
Basic axioms of probability models, conditional probabilities and independence, discrete and continuous random variables, multiple random variables and their expected values and variances, models of stochastic processes, noise, stationarity and ergodicity, power spectral densities. Prerequisites: MATH 037 or MATH 039 or MATH 131 or ECPE 127 with a "C" or better and Graduate or blended students in the School of Engineering and Computer Science.

ENGR 275. Human/Brain Machine Interface. 3 Units.
Human/Brain Machine interface (HMI/BMI) is a direct communication pathway between human signals such as heart activity, electro dermal activity, and brain with an external device. Bioelectrical activity can be employed directly to provide information or predict the human alertness, stress level, health or control external devices such as an external keyboard and robotic arm. This topic includes the physiology of generation of human vital signals, designing interface device, and developing offline and real-time computational algorithms for controlling external devices. Prerequisites: ENGR 19 or COMP 51 or COMP 61 with a "C-" or better; Graduate or blended students in the School of Engineering and Computer Science or permission of the instructor.

ENGR 290. Engineering Project Management and Leadership. 3 Units.
This course is directed to the graduate student who has a basic knowledge of project management but seeks to explore the human side and strategic aspects of project management. The course introduces and describes the skills, qualities and attributes needed to successfully lead projects. Among the topics discussed are management styles, strategies, systems engineering, interpersonal competencies and other advanced topics not usually covered in a basic course on project management. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science.

ENGR 291. Graduate Independent Study. 1-4 Units.
Special individual projects are undertaken under the direction of one or more faculty. Prerequisite: Graduate or blended students in the School of Engineering and Computer Science or permission of instructor.

ENGR 292. Managing Science Technology and Innovation. 3 Units.
This course provides students with a fundamental understanding of research and development organizations and their categories, and elements needed for a productive research organization, organization effectiveness, managing conflicts in organizations, dealing with diversity in research and scientific organizations. Additional topics include strategic planning, motivation and leadership in research and innovation, the innovation process, technology transfer, and science policy and ethics in science and engineering. Ethics and the Impact of Technology on Society is also addressed. The course has two hours of lecture and one hour of discussion per week. Prerequisite: Graduate or blended students in the School of Engineering and Computer Science of permission of instructor.

ENGR 293. Special Topics. 4 Units.
Special courses are organized and offered from time to time to meet the needs or interests of a group of students. Prerequisite: Graduate or blended students in the School of Engineering and Computer Science or permission of the instructor.

ENGR 295. Graduate Seminar. 1 Unit.
This course is a graduate paper-reading seminar. Students are expected to read classic and current technical papers and actively participate in class discussion. Each student presents at least one paper per semester. Prerequisite: Graduate or blended students in the School of Engineering and Computer Science.

ENGR 297. Graduate Research. 1-4 Units.
Approval by the faculty supervisor and the department chairperson is required. Prerequisite: Graduate or blended students in the School of Engineering and Computer Science or permission of instructor.

ENGR 299. Thesis. 1-6 Units.
Minimum of six units is required for Thesis Option students. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science and permission of research advisor.

Engineering Physics Courses

EPHY 133. Solid State Devices. 4 Units.
This course introduces concepts related to the crystal structure of semiconductors and electronic, optical, and magnetic properties of semiconductors. Dynamics of carriers under equilibrium and non-equilibrium conditions are presented as a frame work for understanding the behavior of a number of devices including Metal-Oxide-Semiconductor (MOS) and Hetero-junction Bipolar (HBT) devices. On such a background, the course builds an understanding of the latest advances in the field including quantum and nano devices. This course is cross listed with ECPE 133 and PHYS 170. Pre-requisites: PHYS 055 with a "C-" or better. Prerequisite that may be taken concurrently: MATH 057 with a "C-" or better.

EPHY 144. Applied Electromagnetics. 4 Units.
The purpose of this course is for students to gain an understanding of transmission lines and field theory as it applies to communication circuits and systems. Electromagnetic wave propagation, reflection, and transmission through common materials are examined. This course is cross listed with ECPE 144. Prerequisites: MATH 057; PHYS 055 with a "C-" or better.

EPHY 195. Senior Project I. 2 Units.
This course instructs students in the application of design processes and teamwork. Topics include multiple interdisciplinary team design experiences of increasing complexity. Projects incorporate consideration of engineering standards and realistic constraints such as economics, the environment, sustainability, manufacturability, and safety. Students are given instruction and practice in documentation and as well as oral and written communication skills. This course is cross listed with ECPE 195. Prerequisites: Completion of all Fundamental Skills; ECPE 131 with a "C-" or better.

EPHY 196. Senior Project II. 2 Units.
This capstone design course integrates earlier studies, including EPHY 195, to perform interdisciplinary team design projects. Student design teams define a requirements document, a test document, and a design document for a prescribed product, then design, build and test a prototype. Complete documentation is expected. Final oral and written reports and project demonstrations are required. This course is cross listed with ECPE 196. Prerequisites: EPHY 195 or ECPE 195 with a "C-" or better.

Interd Design Entrep Courses

IDEA 010. Interdisciplinary Design and Success. 2 Units.
The first course in the Interdisciplinary Design and Entrepreneurship in Action (IDEA) series that aims at providing students with a unified cohort experience and skills for college success. The students are exposed to various SOECS disciplines via multidisciplinary design projects where they apply computational and mathematical concepts for problem solving. Students actively participate in their curriculum planning, explore techniques for college and career success, and implement strategies for continuous improvement.

IDEA 020. Interdisciplinary Design and Innovation. 2 Units.
The second course in the Interdisciplinary Design and Entrepreneurship in Action (IDEA) series aims at providing students with a unified cohort experience and skills for college and professional success. The students delve into engineering and computer science disciplines via multidisciplinary design projects where they apply engineering design processes, mathematical modeling, and engineering/computational tools to address real-life problems. Throughout the course, students reflect on their skills, abilities, interests, and opportunities for growth and how those align with their chosen major. Prerequisites: IDEA 010 with a "D" or better.

IDEA 040. Engineering Design Thinking. 3 Units.
In this course students learn engineering innovation and entrepreneurship practices. Students experience driving a process or product to launch using design thinking and lean startup approaches. Prerequisites: Sophomore standing. **(GEAP)**

IDEA 093. Special Topics. 4 Units.

IDEA 130. Introduction to Mobile Robotics. 4 Units.
This course is an overview of mobile robotics and introduces fundamentals of robot modeling and design of wheeled mobile robots including locomotion and kinematics with constraints. It includes several examples of robot sensing such as ultrasonic, IR, Lidar, IMU, or vision sensors. Includes laboratory. The lab provides students relevant experiential learning to strengthen theoretical aspects of robotics and robotics-related algorithms such as line tracking, obstacle avoidance, object following, distance control with encoders, basic analog/digital circuits, electronics, microcontrollers, motor controls, and robot programming. Prerequisites: Completion of all Fundamental Skills; COMP 053 or ENGR 019 with a "C-" or better.

IDEA 131. Autonomous Mobile Robotics. 4 Units.
This course emphasizes the design of autonomous robots. Students study architectures for robot organization and mechanisms for mobile robots, actuators, sensors to develop localization, perception, cognition, mapping, navigation, and control utilizing sensing technologies. The course covers multi-agent systems, human-robots interaction, and heterogeneous systems including ground robots and drones. Students also study the design of algorithms, knowledge representations, and decision-making with a single board computer. Includes laboratory. The lab provides students relevant experiential learning to strengthen theoretical aspects of robotics and the development of algorithms. Prerequisites: Completion of all Fundamental Skills; IDEA 130 with a "C-" or better or Junior or Senior standing with COMP 53 or ENGR 019 with a "C-" or better.

IDEA 132. Robotics, Telematics and AI Seminar. 1 Unit.
This interdisciplinary seminar is open to undergraduate and graduate students, especially students majoring in engineering and computer science. The course studies current research in the areas of robotics, telematics (data acquisition, tracking, communications, and informatics), and artificial intelligence in a seminar format led by both the instructor and students. Prerequisites: Completion of all Fundamental Skills; COMP 053 or ENGR 019 with a "C-" or better.

IDEA 193. Special Topics. 1-4 Units.

IDEA 197. Undergraduate Research. 1-4 Units.

IDEA 230. Industrial Robotics. 3 Units.
The course provides an overview of industrial robotics as robot manipulators (or robotic arms) consisting of multiple links, joints, actuators, sensing technologies, and computing. Students learn the design of various types of robots. Topics include robot modeling using DH conventions, fundamentals of robot motion in a 2D or 3D workspace, forward kinematics and inverse kinematics, robot programming, generating path or tracking robot trajectories based on waypoints or velocity profiles, and dynamics with forces and moments. The course also introduces real-world industrial robots (FANUC, Mitsubishi, RAZOR, etc.) used for tasks such as material handling, machine tending, drilling, palletizing, or painting along with automated processing systems connected with CNC or an automated conveyor belt system with sensors. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science or permission of the instructor.

IDEA 231. Modern Robotics and Control. 3 Units.
The course covers modern robotics and their controls from industrial robotics to mobile manipulators, drones, submarines, vessels, or collaborative robots. Students learn robot structures and modeling, statics, kinematics and dynamics, motion planning (based on waypoints or velocity profiles), grasping objects, and robot controls for manipulating or tracking. The course also introduces general robots (Cobot, FANUC, Mitsubishi, etc.) used for machine tending or material handling. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science or permission of the instructor.

IDEA 232. Robotics, Telematics and AI Seminar. 1 Unit.
This interdisciplinary seminar is open to undergraduate and graduate students, especially students majoring in engineering and computer science. The course studies current research in the areas of robotics, telematics (data acquisition, tracking, communications, and informatics), and artificial intelligence in a seminar format led by both the instructor and students. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science or permission of the instructor.

IDEA 293. Special Topics. 4 Units.

Mechanical Engineering Courses

MECH 010. Introduction to Mechanical Engineering. 3 Units.
Students will be introduced to the many subdisciplines of Mechanical Engineering, future career paths, and what essential skill sets are needed for each subdiscipline. Students will learn how to work collaboratively and equitably in diverse groups. The ethics of working in groups in a mechanical engineering context will be discussed as students learn how to perform experimentation, technical writing skills, data analysis, statistics, and are trained on common instrumentation/apparatuses used by Mechanical Engineers.

MECH 015. Mechanical Engineering Graphics. 3 Units.
This course covers the principles and applications of graphics in engineering design. Topics include pictorial and isometric sketching and orthographic projection, the use of auxiliary views and sections, drafting standards and conventions, dimensioning and tolerances, in addition to layout and assembly drawings, detail drawings and production drawings with SolidWorks.

MECH 100. Manufacturing Processes. 3 Units.
This course is a study of traditional manufacturing processes such as formatting, cutting, joining, casting, and heat treating as well as advanced processing methods; manufacturing with polymers, composites, and ceramics in addition to metals, tribology, nondestructive evaluation, and quality control. Laboratory projects involve manufacturing skills, reverse engineering, automated machines, geometric dimensioning and tolerancing, and statistical process control. Prerequisites: Completion of all Fundamental Skills; MECH 015; and ENGR 045 or PDEP 046 with a "C-" or better. Corequisite: MECH 100L.

MECH 100L. Manufacturing Process Lab. 1 Unit.
Experimental analysis of concepts are discussed in MECH 100. Prerequisites: Completion of all Fundamental Skills; MECH 015; and ENGR 045 or PDEP 046 with a "C-" or better.

MECH 104. Introduction to Mechatronics. 3 Units.
A broad understanding of the main components of mechatronic systems; Understanding of the general principles involved in computer controlled machinery, including sensing, actuation and control; Practical knowledge of the development of simple embedded computer programs; Understanding of the practical application of mechatronic systems in applications such as manufacturing, automobile systems and robotics. Prerequisites: Completion of all Fundamental Skills and ENGR 019 with a "C-" or better.

MECH 120. Machine Design and Analysis I. 3 Units.
This course builds on fundamental principles learned in statics, dynamics, and mechanics of materials, and applies them to the design and analysis of machines. Methods for performing load and stress analysis are learned along with analytical methods for solving deflection and stability problems. Static, impact, and fatigue failure theories for machines are also studied. Statistical methods for solving machine design problems are presented, and engineering design practices are integrated throughout the course. Prerequisites: Completion of all Fundamental Skills; ENGR 045, ENGR 120, ENGR 121; MECH 015 with a "C-" or better.

MECH 123. Kinematics and Dynamics of Machinery. 3 Units.
Students learn how to design, analyze and prepare a simulation of complex mechanisms with emphasis on high speed and precision applications. Topics include kinematics and dynamics of planar and three dimensional mechanisms; gyroscopic forces in machines and balancing, and applications to robotics. Prerequisites: Completion of all Fundamental Skills; ENGR 120 and ENGR 121 with a "C-" or better.

MECH 125. Machine Design and Analysis II. 3 Units.
Students learn how to design, analyze, and incorporate a variety of standard parts and devices into machines. These parts and devices include fasteners, gear systems, belt drives, chain drives, shafts, couplings, bearings, springs, clutches, and brakes. Principles of tribology (friction, wear, and lubrication) are introduced and applied to the design of machines. Engineering design practices are integrated throughout the course. Prerequisites: Completion of all Fundamental Skills and MECH 120 with a "C-" or better.

MECH 129. Vibrations. 3 Units.
Students study models of physical systems with lumped and distributed parameters. The studies include free and forced vibrations of machines and structures as well as excitation and response of single degree of freedom systems. The course introduces multiple degrees of freedom systems, finite element formulations and mode superposition techniques. Prerequisites: ENGR 120, MATH 057, ENGR 019 with a "C-" or better.

MECH 140. Engineering Design/Senior Project I. 3 Units.
This course discusses methods of initiating, planning, conceptualizing, and configuring engineering designs. The student uses these methods to develop an engineering design for a product or process that involves mechanical engineering. Product realization methods, project management, materials selection, design thinking, rapid prototyping, manufacturing for designers, guided iteration, communication skills, economics, ethics, liability, and safety issues are put into practice through class activities. Prerequisites: Completion of all Fundamental Skills; ENGR 122 with a "C-" or better; and Prerequisite that may be taken concurrently: MECH 120 or MECH 150 with a "C-" or better.

MECH 141. Engineering Design/Senior Project II. 3 Units.
The student completes the design phase of their project. Guided iteration and optimization are used to complete the detailed design of a product or process involving mechanical engineering. Manufacturing and rapid prototyping are used to complete the fabrication of a product or process. Failure modes and effects analysis, safety, and liability are considered. Regular oral and written progress reports are required along with final comprehensive oral and written reports. Prerequisites: Completion of all Fundamental Skills; MECH 100 and MECH 140 with a "C-" or better.

MECH 150. Heat Transfer. 3 Units.
Students study heat transfer by conduction in one, two and three dimensions in transient and steady state and heat transfer in extended surfaces. Topics include solutions by numerical methods and simulation techniques, convection in external and internal flow, free convection, and radiation. Prerequisites: Completion of all Fundamental Skills; ENGR 122 and MATH 057 with a "C-" or better.

MECH 151. Applied Heat Transfer. 3 Units.
Applications and extensions of the topics in MECH 150. Multimode heat transfer; heat exchangers. Heat transfer with phase change. Prerequisites: Completion of all Fundamental Skills and MECH 150 with a "C-" or better.

MECH 155. Solar Energy Engineering. 3 Units.
This course introduces students to solar energy, sun-earth geometry, radiation measurement, insulation on surfaces, principles of solar collectors, applications such as space heating and solar ovens, and photovoltaics. Laboratory experiments are included. Prerequisites: Completion of all Fundamental Skills and ENGR 122 with a "C-" or better.

MECH 157. Thermodynamics II. 3 Units.
Students examine the thermodynamics of cycles for power and refrigeration. Other topics include the thermodynamics of gas mixtures, chemical reactions, chemical equilibrium, combustion, fuels, and processes involving air and water mixtures relating to heating, cooling, and ventilating for human comfort. The course includes experimental activities and written laboratory reports. Prerequisites: Completion of all Fundamental Skills and ENGR 122 with a "C-" or better.

MECH 158. Air Conditioning. 3 Units.
Students are introduced to air conditioning purpose, terminology and typical systems. Students study the analysis and design of air conditioning as applied to residential and small commercial buildings, and they learn the codes and standards applicable to this field. Prerequisites: Completion of all Fundamental Skills; ENGR 122 with a "C-" or better.

MECH 160. Fluid Dynamics. 3 Units.
Students study equations of continuity, energy, and momentum as applied to fluid flow. Topics include one dimensional compressible flow, and the introduction to more advanced topics, such as turbomachinery, viscous flow and potential flow. Prerequisites: Completion of all Fundamental Skills; CIVL 130 and ENGR 122 with a "C-" or better.

MECH 175. Systems Analysis and Control. 3 Units.
Students study dynamic analysis and control of systems composed of mechanical, electrical, hydraulic and thermal components. Students use of system modeling and simulation techniques to predict transient and steady state response, lumped parameter approximations and linearization. Students also use feedback to enhance system performance and stability and they study design of linear control systems in the time and frequency domains. Prerequisites: Completion of all Fundamental Skills; ECPE 041, ECPE 041L, MECH 129 with a “C-“ or better.

MECH 178. Finite Element Methods. 3 Units.
This course introduces the finite element method for engineering problems. Topics include matrix formulation of finite element models for problems in solid mechanics, heat transfer and fluid flow as well as solution of finite element equilibrium equations. Students study the development of computer algorithms and applications that use commercial finite element computer programs. Some familiarity with matrix methods is desirable. Prerequisites: Completion of all Fundamental Skills; ENGR 121 and ENGR 122 with a "C-" or better. Prerequisite, may be taken concurrently: CIVL 130 with a "C-" or better.

MECH 191. Independent Study. 1-4 Units.
Special individual projects are undertaken under the direction of one or more faculty members knowledgeable in the particular field of study. Permission of department chairperson and faculty members involved.

MECH 193. Special Topics. 1-4 Units.

MECH 197. Undergraduate Research. 1-4 Units.
This course includes applied or basic research in mechanical engineering under faculty supervision. Projects may be experimental, mathematical or computational in nature. Permission of faculty supervisor and department chairperson. Student must be in good academic standing.

MECH 200. Computer Aided Manufacturing. 3 Units.
Develop students' competence and self-confidence as mechanical engineers. Computer aided design, analysis and manufacturing are emphasized. Course subject depends on active learning via several major design-and-build projects. Lecture focuses on the underlying theory of parametric 3-D solid modeling and representation, transformation techniques, machining strategy, and CNC manufacturing technology. Prerequisites: ENGR 121, MECH 100 with a "C" or better, Graduate or blended students in the School of Engineering and Computer Science or permission of the instructor.

MECH 202. Polymer and Composite Materials. 3 Units.
Fundamental characteristics of polymers, fibers, and polymer-based composite materials are studied. Advanced mechanics of materials are used to develop tools to predict the mechanical behavior of composite laminates. Experimental and analytical methods for characterizing the mechanical and thermal behavior of polymers are studied, and laboratory-based experiences are used to enhance the learning process. Design methods for using these advanced materials in engineering applications are discussed. Prerequisites: ENGR 045, ENGR 121 with a "C" or better and Graduate or blended students in the School of Engineering and Computer Science or permission of instructor.

MECH 204. Advanced Mechatronics. 3 Units.
Students study the design of mechatronic systems that integrate mechanical, electrical, and control systems engineering. Laboratories form the core of the course. They cover topics such as mechanism design, motors and sensors, interfacing and programming microprocessors, mechanical prototyping, and creativity in the design process. Project topics vary from year to year. Prerequisites: MECH 104 with a "C" or better and Graduate or blended students in the School of Engineering and Computer Science or permission of instructor.

MECH 262. Combustion. 3 Units.
This course introduces students to combustion processes and systems. Students study the conservation equations for reacting flows, chemical kinetics, conserved scalars, premixed flames, diffusion flames and droplet burning. Primary applications studied are internal combustion engines and gas turbine combustors. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science and ENGR 122 with a "C" or better or permission of instructor.

MECH 291. Graduate Independent Study. 1-4 Units.
Special individual projects are undertaken under the direction of one or more faculty. Prerequisite: Graduate or blended students in the School of Engineering and Computer Science or permission of instructor.

MECH 293. Special Topics. 1-4 Units.
Special courses are organized and offered from time to time to meet the needs or interests of a group of students. Prerequisite: Graduate or blended students in the School of Engineering and Computer Science or permission of the instructor.

MECH 297. Graduate Research. 1-4 Units.
Prerequisite: Graduate or blended students in the School of Engineering and Computer Science or permission of instructor. Permission of faculty supervisor and department chair.

MECH 299. Thesis. 1-6 Units.
Minimum of six units is required for Thesis Option students. Prerequisites: Graduate or blended students in the School of Engineering and Computer Science and permission of research advisor.