The Master of Science in Engineering Science (MSES) 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.

The goal of the graduate program in the School of Engineering and Computer Science is threefold:

1. to advance student professional standing;
2. to extend the curiosity, intellectual capacities, and knowledge of its students;
3. and to stimulate and support the products of intellectual inquiry.

Students interested in eventually pursuing a PhD often build upon this training by engaging in research and completing a thesis. Other students interested in applied technology may prefer to enhance their studies with a graduate-level practicum experience in industry, or by taking additional coursework.

Mission

The mission of the School of Engineering and Computer Science is to provide a superior, student-centered learning environment that emphasizes close faculty-student interaction, experiential education, and distinctive research opportunities. Graduates will be prepared to excel as professionals, pursue advanced degrees, and possess the technical knowledge, critical thinking skills, creativity, and ethical values needed to lead the development and application of technology for bettering society and sustaining the world environment.

Accelerated Five Year Blended Program

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

Students would 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 that allows the bachelors and masters degrees to blend together. The two degrees are awarded on the same date.

Thesis and Non-thesis Options

The MSES program has two degree options: thesis and non-thesis plans, each requiring a minimum number of 30 units. The thesis plan requires students to perform independent research and culminates in the completion of a thesis based on the findings of the research. The thesis plan is intended for students who plan to pursue a career in research or plan to pursue a PhD. The non-thesis option allows students to complete a project, engage in directed experiential learning, or complete all their units through coursework.

Blended Program Admission Criteria

School of Engineering and Computer Science undergraduates who maintain a minimum institutional GPA of 3.0 and a major GPA of 3.0 upon reaching senior status are given priority consideration for admission to the Blended Program and if admitted may begin taking graduate level courses at that time that allows the BS and MS degrees to blend together. Students who choose to withdraw from the program prior to completing all the requirements may be awarded the Bachelor of Science degree alone, contingent upon having completed all of the respective program requirements, which includes the co-op experience.

Graduate Program Admission Criteria

Prospective students with earned bachelor’s degrees must submit the following materials to the Research and Graduate Studies Office at the University of the Pacific. A completed application includes:

1. The Graduate School application form
2. Three letters of references
3. Transcripts from the institution where the BS in engineering or computer science (or relevant degree) was granted
4. A personal statement on professional goals and objectives
5. Official scores on the GRE General Examination.
6. A 3.0/4.0 GPA on the last 60 units of undergraduate study
7. For students whose first language is not English, Test of English as a Foreign Language (TOEFL) is required. The minimum score for admission is 550 (paper) or 213 (computer) and the minimum score for a teaching assistantship award is 575 (paper) or 231 (computer)

General Academic Policies

Engineering and Computer Science Prerequisite Requirement

All MS in Engineering Science course prerequisites must be passed with a C or higher grade.

Courses Taken Pass/No Credit

All courses that count toward the MS in Engineering Science must be taken for a letter grade.

Graduate Independent Studies

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 consider enrolling in a graduate independent study. The qualified student should initiate 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 Individualized Study Form and submit it to the instructor and Office of the Registrar prior to the last day to add (see University Academic Calendar). 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. 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 should be informed of this decision.

Course Substitutions
A maximum of six units of approved advanced undergraduate courses (100 level) can count toward the MS in Engineering Science. The substitution of course(s) from the printed degree program is discouraged. When extenuating circumstances warrant consideration, the student should meet with his/her advisor, and the final decision must have the approval of the department chair. Consideration should be given to the source of the problem (school, student, etc.), severity of the hardship case, and what the department considers best for the individual.

Master of Science in Engineering Science Curriculum
All students who receive an MSES complete a set of core courses that cover the broader subjects of research and analysis. In addition, depending upon the option chosen, six units of thesis, project, directed experiential learning or coursework is required.

Core courses that cover the broader subjects of research and analysis:

<table>
<thead>
<tr>
<th>Category/Sub-category</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Techniques in Research</td>
<td>3</td>
</tr>
<tr>
<td>Math or Computational Science</td>
<td>3</td>
</tr>
<tr>
<td>Breadth Elective</td>
<td>3</td>
</tr>
<tr>
<td>Concentration Specified Courses</td>
<td>12-15</td>
</tr>
<tr>
<td>Thesis, Project, Directed Experiential Learning, or Coursework</td>
<td>6</td>
</tr>
</tbody>
</table>

Students must first choose whether they plan to complete the "Thesis Option" or the "Non-thesis Option."

A. Thesis Option
1. Students must complete a minimum of 30 units.
2. All students must perform independent research that must culminate in the completion of a thesis based on the findings of the research. For successful completion of the thesis course, students must submit a research proposal, conduct the research, write the thesis, and successfully complete a final oral defense. Students who choose the Thesis Option may not get credit for directed experiential learning at the graduate level.
3. All students complete six units of ENGR 299, Thesis Research.

B. Non-thesis Option
1. Students must complete a minimum of 30 units.
2. Students who choose the Non-thesis Option may choose to do a project, directed experiential learning, or they may satisfy all the unit requirements through coursework.
   a. For the directed experiential learning option, the SOECS assists students in securing engineering or computer science employment or a paid internship at a graduate engineer level. Students work with the Co-op Director, their faculty advisor, and their worksite supervisor to develop a research/design project along with a list of expected professional and technical learning objectives, with the experience culminating in the preparation of a report which documents the fulfillment of the project and these objectives.
   b. For the project option, students need to be employed in an engineering or computer science capacity. They come up with a special project in conjunction with their worksite supervisor and their faculty advisor. Upon completion of the project, the student submits a comprehensive report that outlines the project and documents its completion. The success of the project is judged by the faculty advisor, with input from the worksite supervisor.
   c. Students may elect to satisfy the entire degree through courses.

Master of Science in Engineering Science with a concentration in Civil Engineering
Within the Civil Engineering concentration, students can focus on the areas of environmental, management or structural. Students must complete a minimum of 30 units with a Pacific cumulative grade point average of 3.0 in order to earn the master of science in engineering science degree.

Core Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGR 201</td>
<td>Techniques in Research</td>
<td>3</td>
</tr>
<tr>
<td>Select one of the following Math or Computational Science Elective</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>ENGR 219</td>
<td>Numerical Methods for Engineering</td>
<td></td>
</tr>
<tr>
<td>ENGR 250</td>
<td>Probability and Statistics for Engineering and Computer Science</td>
<td></td>
</tr>
<tr>
<td>Breadth Elective (one from approved list for concentration)</td>
<td>3-4</td>
<td></td>
</tr>
<tr>
<td>Select one of the following options:</td>
<td>6-9</td>
<td></td>
</tr>
<tr>
<td>A) Thesis Option</td>
<td>ENGR 299 Thesis</td>
<td></td>
</tr>
<tr>
<td>B) Project Option</td>
<td>ENGR 291 Graduate Independent Study</td>
<td></td>
</tr>
<tr>
<td>C) Directed Experiential Learning Option</td>
<td>ENGR 297 Graduate Research</td>
<td></td>
</tr>
<tr>
<td>D) Course Work Option</td>
<td>ENGR 281 Directed Experiential Learning</td>
<td></td>
</tr>
<tr>
<td>Courses Approved by Advisor as Coherent Plan</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Concentration Requirements

Four Electives Approved by Advisor as Coherent Plan 12-15

Master of Science in Engineering Science with a concentration in Computer Engineering/Electrical Engineering/Computer Science
Students must complete a minimum of 30 units with a Pacific cumulative grade point average of 3.0 in order to earn the master of science in engineering science degree. Six of the 30 units may be upper division undergraduate courses approved by the advisor. A single course cannot fulfill requirements in both the MSES and BS degree.

Core Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGR 201</td>
<td>Techniques in Research</td>
<td>3</td>
</tr>
</tbody>
</table>
Select one of the following Math or Computational Science Elective:  

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
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<tbody>
<tr>
<td>ENGR 219</td>
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<td>ENGR 250</td>
<td>Probability and Statistics for Engineering and Computer Science</td>
</tr>
</tbody>
</table>

Breadth Elective (one from approved list for concentration) 3-4

Select one of the following options: 6-9

A) Thesis Option

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGR 299</td>
<td>Thesis</td>
</tr>
</tbody>
</table>

B) Project Option

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGR 291</td>
<td>Graduate Independent Study</td>
</tr>
<tr>
<td>ENGR 297</td>
<td>Graduate Research</td>
</tr>
</tbody>
</table>

C) Directed Experiential Learning Option

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGR 281</td>
<td>Directed Experiential Learning</td>
</tr>
</tbody>
</table>

D) Course Work Option

| Courses approved by advisor as coherent plan |

Concentration Requirements

Four electives approved by advisor as coherent plan * 15

* Minimum of 9 units of graduate ECPE or COMP courses for the concentration.

Master of Science in Engineering Science with a concentration in Mechanical Engineering

Students must complete a minimum of 30 units with a Pacific cumulative grade point average of 3.0 in order to earn the master of science in engineering science degree.

Core Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGR 201</td>
<td>Techniques in Research</td>
</tr>
</tbody>
</table>

Select one of the following Math or Computational Science Elective: 3

<table>
<thead>
<tr>
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<th>Title</th>
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<tbody>
<tr>
<td>ENGR 219</td>
<td>Numerical Methods for Engineering</td>
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<tr>
<td>ENGR 250</td>
<td>Probability and Statistics for Engineering and Computer Science</td>
</tr>
</tbody>
</table>

Breadth Elective (one from approved list for concentration) 3-4

Select one of the following options: 6-9

A) Thesis Option

<table>
<thead>
<tr>
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</tr>
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<tbody>
<tr>
<td>ENGR 299</td>
<td>Thesis</td>
</tr>
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</table>

B) Project Option

<table>
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</tr>
</thead>
<tbody>
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<td>Graduate Independent Study</td>
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<tr>
<td>ENGR 297</td>
<td>Graduate Research</td>
</tr>
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</table>

C) Directed Experiential Learning Option

<table>
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<tbody>
<tr>
<td>ENGR 281</td>
<td>Directed Experiential Learning</td>
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</tbody>
</table>

D) Course Work Option

| Courses approved by advisor as coherent plan |

Concentration Requirements

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGR 292</td>
<td>Managing Science Technology and Innovation</td>
</tr>
</tbody>
</table>

Three electives approved by advisor as coherent plan 9-12

School of Engineering and Computer Science Faculty

Steven Howell, Dean and Professor, 2013, BS, Mechanical Engineering, Southern Methodist University, 1976; MS, Mechanical Engineering, Southern Methodist University, 1977; PhD, Chemical Engineering, University of British Columbia, 1983.

Gary R. Martin, Assistant Dean of Administration and Professor of Cooperative Education, 1983, BA, University of California, Davis, 1981; MS, California State University, Hayward, 1982; EdD, University of the Pacific, 1987. Educational counseling and psychology, Pupil Personnel Services Credential.


Jennifer Ross, Associate Professor and Chair of Electrical and Computer Engineering, 1993, BS in Electrical Engineering, University of Illinois, 1988; MS in Electrical Engineering, University of California Berkeley, 1990, PhD in Electrical Engineering, University of California Berkeley, 1993; Solid state, short wavelength lasers, analog circuits and devices.

Camilla M. Saviz, Chair and Professor of Civil Engineering, 1999, BSME, Clarkson University, 1987; MSME, 1989; MBA, New York Institute of Technology, 1991; PhD, Civil and Environmental Engineering, University of California, Davis, 2003. Registered Professional Engineer. Environmental engineering, water resources, hydrodynamic and water quality modeling, fluid mechanics.

Jeffrey S. Burmeister, Program Director and Associate Professor of Bioengineering, 2002, BS, Mechanical Engineering, University of Delaware, 1988; PhD, Biomedical Engineering, Duke University, 1995, Biomaterials, cell adhesion.


Dr. Henghu (Henry) Sun, Professor and Director, Pacific Resources Research Center, School of Engineering and Computer Science, 2008, 2008 Professor, PCSP Program, TJKL Pharmacy School, University of the Pacific; 2002/2008, Professor, Tsinghua University; 1988, PhD China University of Mining and Technology.

Elizabeth Basha, Assistant Professor of Electrical and Computer Engineering, 2010, BS in Computer Engineering, University of the Pacific, 2003; SM in Electrical Engineering and Computer Science, Massachusetts Institute of Technology, 2005; PhD in Electrical Engineering and Computer Science, Massachusetts Institute of Technology, 2010. Sensor networks, autonomous robotics, international development.

Emma Bowring, Associate Professor of Computer Science, 2007, BS, University of Southern California, 2003; PhD, University of Southern California, 2007. Artificial Intelligence, multi-agent systems, computer science education.
Ashland O. Brown, Professor of Mechanical Engineering, 1991, BSME, Purdue University, 1966; MSME, University of Connecticut, 1968; PhD, 1974. Licensed Professional Engineer. Fluid mechanics, thermal sciences and finite element analysis.

Mary Kay Camarillo, Associate Professor of Civil Engineering, 2009, BS, University of Washington, 1996; MS, University of California, Davis, 2004; PhD, 2009; Registered Professional Engineer. Environmental engineering, physical and chemical treatment of water and wastewater.


Hector Estrada, Professor of Civil Engineering, 2006, BS, University of Illinois, 1993; MS, 1994; PhD, 1997. Registered Professional Engineer. Structural engineering and engineering mechanics.

Jinzhu Gao, Associate Professor of Computer Science, 2008, BS Computer Science and Engineering, Huazhong University of Science and Technology, 1995; MS Mechanical Engineering, Huazhong University of Science and Technology, 1998, PhD Computer and Information Science, Ohio State University, 2004. Scientific visualization, computer graphics, large scale data management, data analysis and visualization, data-intensive computing, remote visualization, web-based applications.

Shelly Gulati, Assistant Professor of Bioengineering, 2010, BS, Chemical Engineering, Johns Hopkins University, 2000; PhD, Bioengineering, University of California, Berkeley and San Francisco, 2006. Microfluidics, biological fluid flow.

Osvaldo Jimenez, Assistant Professor of Computer Science, 2013, BS Computer Science, Stanford University, 2002; MA Learning, Design, & Technology, Stanford University, 2003; PhD Learning Sciences & Technology Design, Stanford University, 2013. Educational games, video game development, software engineering, human-computer interaction, computer science education.


Scott Larwood, Assistant Professor of Mechanical Engineering, 2009, BS, Aeronautical Engineering, California Polytechnic State University, San Luis Obispo, 1988; MS, Aeronautics and Astronautics, Stanford University, 1993; PhD, Mechanical and Aeronautical Engineering, University of California at Davis, 2009. Licensed Professional Engineer. Wind energy, fluid mechanics, vibrations, dynamics.

Jiancheng Liu, Professor of Mechanical Engineering, 2006, BS, Taiyuan University of Technology (China), 1984; MS, 1987; PhD, Himeji Institute of Technology, now named University of Hyogo (Japan), 1996. Manufacturing, machine design.

Cherian Mathews, Professor of Electrical and Computer Engineering, 2002, MS, Electrical Engineering, Purdue University, 1989; PhD in Electrical Engineering, Purdue University, 1993; Statistical signal processing, Array signal processing, Real-time digital signal processing using DSP processors, Power Systems.

Jeffrey Shafer, Assistant Professor of Electrical and Computer Engineering, 2010, BS, Computer Engineering, University of Dayton, 2002; MS, Electrical Engineering, University of Dayton, 2004; PhD, Electrical and Computer Engineering, Rice University, 2010; Computer architecture, Network systems architecture, Data-intensive computing, Cloud computing, Virtualization.


Cynthia Wagner Weick, Professor, 1990, BS, Crop Physiology, Ohio State University, 1979; MS, Crop Physiology, 1980; PhD, Business Administration, University of Pennsylvania, 1986. International technology and innovation, strategic management in R&D based organizations.

Huihui Xu, Assistant Professor of Bioengineering, 2014, B.E., Biomedical Engineering, Zhejiang University, Hangzhou, Zhejiang, China, 2006; M.S., Applied Mathematics, Zhejiang University, Hangzhou, Zhejiang, China, 2002; Ph.D., Bioengineering, University of Illinois at Chicago, Chicago, IL., 2006; Biomedical Engineering, Biomedical Imaging, Bio-instrumentation.

**Bioengineering Courses**

**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 from the biological point of view. Prerequisites: Completion of all Fundamental Skills; ENGR 045; BIOL 061 or BENG 063 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. 4 Units.
This course is a lecture and lab-based study of the major organ systems in 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. Lectures also compare each system to abiotic models, and utilize basic principles of physics, math, and chemistry. Lab exercises demonstrate basic physiological processes and emphasize techniques of instrument-based data acquisition and data presentation. Students also create virtual instruments (VIs) that use the program LabVIEW and apply the VIs in a final independent lab project. Prerequisites: Completion of all Fundamental Skills; BIOL 051 or BENG 053; BIOL 061 or BENG 063; CHEM 025 all with a "C-" or better or permission of instructor.

BENG 124. Biomechanics. 4 Units.
This course focuses on the application of engineering mechanics to anatomy and medicine with emphasis on 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, ENGR 045 with a "C-" or better.

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 bioelectric 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; BIOL 061 or BENG 063; ECPE 041/ECPE 041L; MATH 055 all with a "C-" or better or permission of instructor.

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 195. Senior Project. 4 Units.
Students apply basic sciences, mathematics and engineering topics to meet a stated objective. Students also establish design objectives and criteria, and analyze solution alternatives, synthesize a problem, implement a solution, then evaluate design performance. Design documentation and demonstration are required. The course includes both written and oral reports and presentations. 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: MS in Engineering Science major and BENG 103 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: MS in Engineering Science major and BENG 103.

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

BENG 299. Thesis. 1-6 Units.
Minimum of six units is required for Thesis Option students. Prerequisites: MS in Engineering Science major and permission of the research advisor.

Civil Engineering Courses

CIVL 100. Introduction to Structural Engineering. 4 Units.
Introduction to the theory and applications of structural analysis and design. Topic include: determination of loads, analysis of beams, trusses and frames, influence line and indeterminate structures. Prerequisites: Completion of all Fundamental Skills, ENGR 019, 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. Introduction to 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, CIVL 060 with a "C-" or better.

CIVL 133. Water Resources Engineering. 4 Units.
Students examine hydraulic analysis and design that include pipe flow and open channel flow. Topics include elements of the hydrological cycle, deterministic and probabilistic analysis of rainfall-runoff data for estimation and design, and the application of computers in hydrologic and hydraulic design. Laboratory is included. Prerequisites: Completion of all Fundamental Skills, CIVL 015, CIVL 130 with a "C-" or better.
CIVL 134. Groundwater. 4 Units.
Students study groundwater hydraulics in confined and unconfined aquifers. Topics include the processes controlling that control the transport and fate of minerals and contaminants in subsurface environments, computer simulation of groundwater flow and contaminant movement, and strategies for removing and controlling contaminant plumes in aquifers. Prerequisites: Completion of all Fundamental Skills; CIVL 061, CIVL 130, MATH 057 all 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 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. Introduction to Geotechnical Engineering. 4 Units.
This introductory course covers the fundamentals of geotechnical engineering, that includes the characterization of soils and their behavior as an engineering material. Topics, include classification of soils, compaction, permeability, and consolidation. Also covered is design applications that 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, 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. Heavy Construction Methods. 4 Units.
An introduction to the areas of construction engineering and construction management. Construction engineering topics include construction processes and construction econometrics. Construction management topics include contracting, estimating, planning, bidding, and scheduling. Prerequisite: 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 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. Junior or Senior standing. (ENST)

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; EMST 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.
Upper division elective subject area based on expertise of faculty members.

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, MS in Engineering Science major 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: Master of Science in Engineering Science major 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, MS in Engineering Science major 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, microbiologically-mediated chemical reactions, kinetics, design of suspended growth and fixed-film treatment systems, and nutrient removal. Prerequisites: CIVL 132, MS in Engineering Science major 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: MS in Engineering Science major 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; MS in Engineering Science major; 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: MS in Engineering Science major or permission of the faculty member involved.

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: MS in Engineering Science major and CIVL 165 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 and MS in Engineering Science major 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: MS in Engineering Science major or permission of the faculty member involved.

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: MS in Engineering Science major 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.

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

CIVL 299. Thesis. 1-6 Units.
Minimum of six units are required for Thesis Option students. Prerequisites: MS in Engineering Science major and permission of the research advisor.

Computer Science Courses

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, odd years).

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, odd years).

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. (Spring, even years).

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, compilers architecture, programming paradigms, and comparison of programming languages and environments. Prerequisites: Completion of Fundamental Skills and COMP 053 with a "C-" or better. (Spring, every year).

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, intractability. Prerequisites: Completion of all Fundamental Skills; COMP 047 or ECPE 071 or MATH 074 with a "C-" or better. (Fall, every year).

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 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, every year).

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 use 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, every year).

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. (Fall, every year).

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 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 look 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, even years).

COMP 173. Operating Systems. 4 Units.
Students are introduced to the fundamental concepts of modern operating systems. Topics include an overview of the computer hardware that supports the operating system, 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 distributed systems. Prerequisites: Completion of all Fundamental Skills; COMP 053 and ECPE 170 with a "C-" or better or permission of instructor. (Fall, every year).

COMP 175. System Administration and Security. 3 Units.
Students are introduced to an operating system from an administrator’s standpoint. Topics include installation is considered with the proper allocation of disk resources, maintaining the operating system and various subsystems, security issues that include server hardening, host firewalls and network security issues. Students also study account administration in a networked environment, change management and intrusion detection. Prerequisites: Completion of all fundamental skills and familiarity with console-based operating systems commands. Junior standing. (Fall, every year).
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 7-layer OSI model and internet protocol stack, socket programming and client/server systems, wireless and security. The course includes a laboratory. 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 the pervasive security threats related to the Internet, data communications and networking. Topics include TCP/IP protocols, authentication, encryption, malware, cybercrime, and social engineering. Emphasis is on computer and network attack methods, their detection, prevention and analysis, and the integration of the tools and techniques employed in this effort. Includes lab. Prerequisites: Completion of all Fundamental Skills and ECPE 170 or COMP 175 with a "C-" or better. (Spring, every year).

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 188. Senior Project I. 2 Units.
Students establish design objectives and criteria, analyze solution alternatives and evaluate design performance for a medium scale software application. Results include analysis and design documents and a presentation of the system design. Prerequisite: Completion of all Fundamental Skills. Senior standing.

COMP 189. Senior Project II. 2 Units.
This course is a continuation of Senior Project I. Students implement, test, and evaluate their software application. Results include final design documents, test reports and a presentation and demonstration of the project. Prerequisite: Completion of all Fundamental Skills and COMP 188 with a "C-" or better.

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 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 241. Programming Language Semantics. 3 Units.
This course examines a variety of modern programming languages from a theoretical perspective. The focus is on languages designed to support particular novel or interesting concepts. Formal techniques for the specification of the semantics of languages are used to compare and contrast languages. Prerequisites: COMP 141 and MS in Engineering Science major.

COMP 251. Multi-Agent Systems. 3 Units.
An introduction to statistical machine learning that covers practical applications of machine learning as well as theoretical concepts like PAC learning and Occam's Razor. Topics include: decision tree learning, artificial neural networks, Bayesian learning, reinforcement learning, genetic algorithms, Markov decision processes and clustering. Prerequisites: COMP 053, MS in Engineering Science major 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 simulation, teaching and training. Students gain practical experience designing a virtual world. Prerequisites: COMP/ECPE 153 or MS in Engineering Science major.

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 includes analysis of published research, programming assignments and an original research project/investigation. Prerequisite: MS in Engineering Science major or permission of the instructor.

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

COMP 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: MS in Engineering Science major or permission of the instructor.

COMP 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: MS in Engineering Science major 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: MS in Engineering Science major and permission of the research advisor.

Electrical Computer Engr Courses
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. 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.

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. Prerequisites: Completion of all Fundamental Skills, MATH 055 with a "C-" or better.

ECPE 131. Electronics. 3 Units.
This course introduces students to semiconductor physics. Topics include modeling, analysis, and simulation of analog and digital circuits containing diodes, bipolar junction transistors, and MOSFETs. Other topics include analysis and design of single stage amplifiers, frequency response of amplifiers, gain, bandwidth, DC biasing, and small signal analysis of amplifiers. Prerequisites: Completion of all Fundamental Skills; ECPE 041, ECPE 041L, ECPE 071L, ECPE 071L; MATH 055, PHYS 055, completion of CHEM 024 or CHEM 025 or CHEM 027 or BIOL 051 or BIOL 061 or BENG 053 or BENG 063 with a "C-" or better. Prerequisite that may be taken concurrently: ECPE 071, ECPE 071L Corequisite: ECPE 131L.

ECPE 131L. Electronics Lab. 1 Unit.
Students examine the use of standard electronic test equipment and simulation tools to analyze, design, and test electronic circuits. Emphasis on analog circuits. Prerequisites: Completion of all Fundamental Skills. Corequisite: ECPE 131.

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 framework for understanding the behavior of a number of devices including Metal-Oxide-Semiconductor (MOS) and Hetero-junction Bipolar (HTBT) devices. On such a background, the course builds an understanding of the latest advances in the field. This course is cross listed with PHYS 170. Prerequisite: MATH 057, PHYS 055 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 and ECPE 131L with a "C-" or better. Prerequisite may be taken concurrently: ECPE 121 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. Prerequisites: Completion of all Fundamental Skills; ECPE 071, ECPE 071L, ECPE 131, ECPE 131L with a "C-" or better. (Spring odd years).

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. Prerequisites: Completion of all Fundamental Skills; PHYS 055, MATH 057, ECPE 041 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 and ECPE 121 with a "C-" or better.

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. 3 Units.
Students study electrical power generation and transmission, Three-phase systems, power system component models, per-unit system and single line diagrams, power flow analysis. Prerequisites: Completion of all Fundamental Skills and ECPE 041 with a "C-" or better. Junior standing.

ECPE 170. Computer Systems and Networks. 4 Units.
This course is a comprehensive and holistic examination of the modern computing environment. Students gain an understanding of the various hardware and software components that enable computers and networks to process information and execute applications. Students learn to apply this knowledge in the development of efficient and robust software applications. Prerequisites: Completion of all Fundamental Skills; ECPE 071, 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; ECPE 071 and ECPE 071L with a "C-" or better.

ECPE 173. Computer Organization and Arch. 3 Units.
The objective of this course is to give students an understanding of how a complete modern computer system operates. Students learn about design of control, datapath and arithmetic/logic units. Other topics include pipelining, memory hierarchy and assembly language programming. Prerequisites: Completion of all Fundamental Skills; ECPE 071, ECPE 071L, 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.
Students study computer networks and the Internet. Topics include LAN and WAN architectures, packet switched networks and routing, the 7-layer OSI model and Internet protocol stack, socket programming and client/server systems as well as wireless security. The course includes a laboratory. Also listed as COMP 177. Prerequisites: Completion of all Fundamental Skills; COMP 053 and ECPE 170 with a "C-" or better. Junior or Senior standing.

ECPE 178. Computer Network Security. 3 Units.
This course is an examination of the pervasive security threats related to the Internet, data communications and networking. Topics include TCP/IP protocols, authentication, encryption, malware, cybercrime, and social engineering. Emphasis is on computer and network attack methods, their detection, prevention and analysis, and the integration of the tools and techniques employed in this effort. Includes lab. 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 194. Core Assessment Exam (CAE). 0 Units.
Each student in the ECPE department is required to take the Core Assessment Exam (CAE). The CAE tests students knowledge of the material covered in the core courses and in basic math. Prerequisites: Completion of all Fundamental Skills; ECPE 041, ECPE 041L, ECPE 071, ECPE 071L, MATH 055, PHYS 055, COMP 051 with a "C-" or better.

ECPE 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 communications skills. Prerequisites: Completion of all Fundamental Skills; ECPE 071, ECPE 071L, ECPE 121, ECPE 131, ECPE 131L with a "C-" or better. Prerequisite, may be taken concurrently: ECPE 194 with a "C-" or better.

ECPE 196. Senior Project II. 2 Units.
This capstone design course integrates earlier studies, including ECPE 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. Prerequisites: Completion of all Fundamental Skills; ECPE 194 and 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 of 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 or equivalent and MS in Engineering Science major or permission of instructor.

ECPE 226. Computational Intelligence. 3 Units.
This course takes a mathematical approach to address the learning theory. Students will also learn the applications of computational intelligence by applying the techniques learned in the course to real world data sets. Topics include types of learning, theory of generalization, PAC model, growth function, break points, VC dimension, generalization trade-off, linear and logistic regression, non-linear transformation, fundamentals of neural networks, foundations of fuzzy approaches, support vector machines, and swarms. Familiarity with basics in linear algebra, probability, and analysis of algorithms recommended. Prerequisite: MS in Engineering Science major.

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, MS in Engineering Science major or permission of the instructor.

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, C programming experience (C++ or Java is acceptable, but students are expected to program in C), MS in Engineering Science major 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 MS in Engineering Science major.

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; MS in Engineering Science major; 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. 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: ECPE 170 with a "C-" or better and MS in Engineering Science major.

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

ECPE 297. Graduate Research. 1-4 Units.
ECPE 299. Thesis. 1-6 Units.
Minimum of six units is required for Thesis Option students. Prerequisites: MS in Engineering Science major and permission of the research advisor.

Engineering Management Courses
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 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 techniques 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 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, capital 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 039 and 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 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 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.
Prerequisites: MS in Engineering Science major and ENGR 250.

EMGT 262. Applied Analytics 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.

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

EMGT 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: MS in Engineering
Science major or permission of the instructor.

EMGT 297. Graduate Research. 1-4 Units.
Approval by the faculty supervisor and the department chairperson is
required. Prerequisite: MS in engineering Science major and permission
of instructor.

EMGT 299. Thesis. 1-6 Units.
Minimum of six units is required for Thesis Option students.
Prerequisites: MS in Engineering Science major and permission of the
research advisor.

General Engineering Courses

ENGR 110. Instrumentation and Experimental Methods. 3 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 and
ENGR 121 with a "C-" or better or permission of instructor.

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. 4 Units.
Students study concepts of stress, strain and deformation, and the
analysis and design of simple elements of structures and machines. The
course introduces the failure theory and energy methods. 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 and ideal gases. Students are also introduced to cycles for power
and refrigeration. Prerequisites: Completion of all Fundamental Skills;
CHEM 024 or CHEM 025 or CHEM 027; 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. 1-18 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 182. 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 183. 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 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 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: MS in Engineering Science major 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.

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 isses 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, some programming experience in any language and MS in Engineering Science major.

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 MS in Engineering Science major.

ENGR 281. Directed Experiential Learning. 1-6 Units.
Directed Experiential Learning (DEXL) credit recognizes student attainment of professional as well as technical learning objectives acquired through a Cooperative Education placement. Upon completing the Professional Practice Seminar (School-to-work learning objectives) as well as a minimum of six MSES graduate units, student may accept a Co-op assignment with specific technical learning objectives.

ENGR 282. Directed Experiential Learning. 1-6 Units.
Directed Experiential Learning (DEXL) credit recognizes student attainment of professional as well as technical learning objectives acquired through a Cooperative Education placement. Upon completing the Professional Practice Seminar (School-to-work learning objectives) as well as a minimum of six MSES graduate units, student may accept a Co-op assignment with specific technical learning objectives.

ENGR 283. Directed Experiential Learning. 1-6 Units.
Directed Experiential Learning (DEXL) credit recognizes student attainment of professional as well as technical learning objectives acquired through a Cooperative Education placement. Upon completing the Professional Practice Seminar (School-to-work learning objectives) as well as a minimum of six MSES graduate units, student may accept a Co-op assignment with specific technical learning objectives.

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: MS in Engineering Science major and EMGT 174.

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

ENGR 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: MS in Engineering Science major 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: MS in Engineering Science major.

ENGR 297. Graduate Research. 1-4 Units.
Approval by the faculty supervisor and the department chairperson is required. Prerequisite: MS in Engineering Science major or permission of instructor.
ENGR 299. Thesis. 1-6 Units.
Minimum of six units is required for Thesis Option students.
Prerequisites: MS in Engineering Science major and permission of research advisor.

Mechanical Engineering Courses

MECH 100. Manufacturing Processes. 4 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 with a "C-" or better.

MECH 104. Introduction to Mechatronics. 3 Units.
Students examine a broad understanding of the main components of mechatronic systems and understanding of the general principles involved in computer-controlled machinery. Topics include 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; ECPE 041, ENGR 120, ENGR 110 with a "C-" or better.

MECH 120. Machine Design and Analysis I. 3 Units.
This course builds on fundamental principles learned in statistics, 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 120, ENGR 121; MECH 015 with a "C-" or better. (Fall).

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: Completion of all Fundamental Skills; MATH 057, ENGR 019, ENGR 120 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, 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 121 and ENGR 122 with a "C-" or better. Prerequisite, may be taken concurrently: ENGR 110; 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. Parametric design techniques such as guided iteration, optimization, and Taguchi’s methods are used to complete the detailed design of a product or process that involves mechanical engineering. Manufacturing necessary to complete the product or process is a requirement. Weekly 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, 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 continue to examine of topics in Thermodynamics I which include availability, chemical reactions, combustion, and fuels. Students also study processes involving air and water mixtures relating that relate to heating, cooling and ventilating for human comfort. The course also introduces to the thermodynamics of the flow of ideal gases. 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. 4 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, ENGR 110, 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 197. Undergraduate Research. 2-4 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, MS in Engineering Science major 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 and MS in Engineering Science major 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 and MS in Engineering Science major 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: ENGR 122 and 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: MS in Engineering Science major 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: MS in Engineering Science major or permission of the instructor.

MECH 297. Graduate Research. 1-4 Units.
Prerequisite: MS in Engineering Science major 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: MS in Engineering Science major and permission of research advisor.