Degrees Offered
Bachelor of Science in Mechanical Engineering

Program Educational Objectives
Through their careers in Mechanical Engineering or a related profession, Pacific BSME graduates are expected to demonstrate one or more of the following within a few years of earning their BSME:

- Competence and/or leadership via promotion to positions of increasing responsibility, publications, and/or conference presentations;
- Adaptability to new developments in science and technology by successfully completing or pursuing graduate education in engineering and related fields, or participating in professional development and/or industrial training courses;
- Creativity and innovation in engineering and technology through participation in activities such as research, design, intellectual property development, and/or entrepreneurial endeavors;

Pacific BSME graduates are also expected to demonstrate an awareness of humanistic, societal, and environmental issues through application of these concerns within their professional activities.

Student Outcomes Required to Achieve M.E. Program Educational Objectives
1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Bachelor of Science in Mechanical Engineering
Students must complete a minimum of 120 units of academic work and a minimum of 32 units of Cooperative Education in order to earn the bachelor of science in mechanical engineering.

I. General Education Requirements

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>PACS 001</td>
<td>What is a Good Society</td>
<td>4</td>
</tr>
<tr>
<td>PACS 002</td>
<td>Topical Seminar on a Good Society</td>
<td>4</td>
</tr>
<tr>
<td>PACS 003</td>
<td>What is an Ethical Life?</td>
<td>3</td>
</tr>
</tbody>
</table>

Note: 1) Pacific Seminars cannot be taken for Pass/No Credit. 2) Transfer students with 28 or more transfer units complete 2 additional General Education elective courses from below in place of taking PACS 001 and PACS 002.

One course from each subdivision below:

Social and Behavioral Sciences
Two courses from the following:
- IA. Individual and Interpersonal Behavior
- IB. U.S. Studies
- IC. Global Studies

Arts and Humanities
- IIB. ENGR 030

One course from the following categories:
- IIA. Language and Literature
- IIC. Visual and Performing Arts

Note: 1) Only one course can come from each subcategory (A, B, or C) within each category. 2) No more than 2 courses from a single department are applied to meet the breadth program requirements, with the exception of certain 1-unit GE IIC courses.

II. Diversity Requirement
Students must complete one diversity course (3-4 units)

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
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<tbody>
<tr>
<td>ENGR 030</td>
<td>Engineering and Computing Ethics in Society</td>
<td>3</td>
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</tbody>
</table>

Note: 1) Transfer students with 28 units or more transfer units prior to fall 2011 are encouraged but not required to complete a designated diversity course prior to graduation. 2) Courses are also used to meet general education and/or major/minor requirements.

III. Fundamental Skills
Students must demonstrate competence in:

Writing
Quantitative analysis

Note: 1) Fundamental skills must be satisfied prior to enrolling in upper division courses.

IV. Major Requirements
Mathematics/Basic Science - Minimum 30 units that include:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>MATH 051</td>
<td>Calculus I</td>
<td>4</td>
</tr>
<tr>
<td>MATH 053</td>
<td>Calculus II</td>
<td>4</td>
</tr>
<tr>
<td>MATH 055</td>
<td>Calculus III</td>
<td>4</td>
</tr>
<tr>
<td>MATH 057</td>
<td>Applied Differential Equations I: ODEs</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 053</td>
<td>Principles of Physics I</td>
<td>5</td>
</tr>
<tr>
<td>PHYS 055</td>
<td>Principles of Physics II</td>
<td>5</td>
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</tbody>
</table>

Select one of the following for Chem Requirement: 4-5
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>CHEM 024</td>
<td>Fundamentals of Chem</td>
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<tr>
<td>CHEM 025</td>
<td>General Chemistry</td>
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<tr>
<td>CHEM 027</td>
<td>General Chemistry</td>
<td></td>
</tr>
<tr>
<td>MATH 037</td>
<td>Introduction to Statistics and Probability</td>
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<tr>
<td>MATH 072</td>
<td>Operations Research Models</td>
<td></td>
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<tr>
<td>MATH 075</td>
<td>Introduction to Linear Algebra</td>
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<tr>
<td>MATH 110</td>
<td>Numerical Analysis</td>
<td></td>
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<tr>
<td>MATH 131</td>
<td>Probability and Mathematical Statistics I</td>
<td></td>
</tr>
<tr>
<td>MATH 145</td>
<td>Applied Linear Algebra</td>
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<tr>
<td>MATH 152</td>
<td>Vector Analysis</td>
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<tr>
<td>MATH 157</td>
<td>Applied Differential Equations II</td>
<td></td>
</tr>
<tr>
<td>PHYS 057</td>
<td>Modern Physics</td>
<td></td>
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<tr>
<td>PHYS 101</td>
<td>Electricity and Magnetism</td>
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<tr>
<td>PHYS 105</td>
<td>Optics</td>
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<tr>
<td>PHYS 125</td>
<td>Molecular Nanotechnology</td>
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<tr>
<td>PHYS 127</td>
<td>Computational Physics</td>
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<tr>
<td>PHYS 170</td>
<td>Solid State Devices</td>
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<tr>
<td>PHYS 181</td>
<td>Classical Mechanics</td>
<td></td>
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<tr>
<td>PHYS 183</td>
<td>Quantum Mechanics</td>
<td></td>
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<tr>
<td>GESC 051</td>
<td>Dynamic Planet</td>
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<tr>
<td>GESC 053</td>
<td>Earth and Life Through Time</td>
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<tr>
<td>GESC 055</td>
<td>Physical Geography</td>
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<tr>
<td>GESC 057</td>
<td>Earth Systems Science</td>
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<tr>
<td>GESC 061</td>
<td>Geology of California</td>
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<tr>
<td>GESC 065</td>
<td>Regional Geology</td>
<td></td>
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<tr>
<td>BIOL 041</td>
<td>Introduction to Biology</td>
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<tr>
<td>BIOL 051</td>
<td>Principles of Biology</td>
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<tr>
<td>CIVL 130</td>
<td>Fluid Mechanics I</td>
<td>3</td>
</tr>
<tr>
<td>CIVL 130L</td>
<td>Fluid Mechanics I Lab</td>
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<tr>
<td>ENGR 010</td>
<td>Dean's Seminar</td>
<td>1</td>
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<tr>
<td>ENGR 019</td>
<td>Computer Applications in Engineering</td>
<td>3</td>
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<tr>
<td>ENGR 020</td>
<td>Engineering Mechanics I (Statics)</td>
<td>3</td>
</tr>
<tr>
<td>ENGR 025</td>
<td>Professional Practice Seminar</td>
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<tr>
<td>ECPE 041</td>
<td>Circuits</td>
<td>3</td>
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<tr>
<td>ECPE 041L</td>
<td>Circuits Laboratory</td>
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<tr>
<td>ENGR 045</td>
<td>Materials Engineering</td>
<td>4</td>
</tr>
<tr>
<td>ENGR 110</td>
<td>Instrumentation and Experimental Methods</td>
<td>3</td>
</tr>
<tr>
<td>ENGR 120</td>
<td>Engineering Mechanics II (Dynamics)</td>
<td>3</td>
</tr>
<tr>
<td>ENGR 121</td>
<td>Mechanics of Materials</td>
<td>4</td>
</tr>
<tr>
<td>ENGR 122</td>
<td>Thermodynamics I</td>
<td>3</td>
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</tbody>
</table>

**Engineering Electives:** A minimum of 9 units of Engineering Electives is required. Engineering Electives must be chosen from the list below. At least 6 units must be MECH Courses. (Some Electives are not offered every year)

**List of MECH Electives**

- MECH 104 Introduction to Mechatronics
- MECH 123 Kinematics and Dynamics of Machinery
- MECH 160 Fluid Dynamics
- MECH 178 Finite Element Methods
- MECH 151 Applied Heat Transfer
- MECH 155 Solar Energy Engineering
- MECH 158 Air Conditioning
- MECH 191 Independent Study

**MECH 193 Special Topics**

- MECH 197 Undergraduate Research
- MECH 200 Computer Aided Manufacturing
- MECH 202 Polymer and Composite Materials
- MECH 204 Advanced Mechatronics
- MECH 262 Combustion
- MECH 293 Special Topics

(200-level courses require instructor's permission)

**List of Engineering Electives**

- BENG 103 Biomaterials
- BENG 124 Biomechanics
- CIVL 132 Introduction to Environmental Engineering
- CIVL 133 Water Resources Engineering
- CIVL 171 Water and Environmental Policy
- CIVL 173 Sustainable Engineering
- ECPE 071 Digital Design
- ECPE 071L Digital Design Lab
- ECPE 121 Digital Signal Processing
- ECPE 131 Electronics
- ECPE 131L Electronics Lab
- ECPE 144 Applied Electromagnetics
- ECPE 163 Energy Conversion
- ECPE 165 Power System Analysis
- ECPE 170 Computer Systems and Networks
- EMGT 155 Computer Simulation
- EMGT 170 Project Decision Making
- EMGT 172 Engineering Economy
- EMGT 174 Engineering Project Management
- EMGT 176 Systems Engineering Management

**Cooperative Education - Minimum 32 units that include:**

- ENGR 181 Professional Practice
- ENGR 182 Professional Practice
- ENGR 183 Professional Practice
General Engineering Courses

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

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

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

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

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

ENGR 045. Materials Engineering. 4 Units.
Students examine the dependency of physical, chemical and mechanical properties on microscopic and macroscopic structure of materials. Laboratory experiments involve properties of materials such as metals, polymers, composites and ceramics. Prerequisites: CHEM 024 or CHEM 025 or CHEM 027; MATH 053 with a "C-" or better.

ENGR 110. Instrumentation and Experimental Methods. 3 Units.
Students study experimental techniques in the measurement of quantities such as biopotenials, force, pressure, sound, flow, temperature, strain and motion. Topics include statistical analysis and errors in measurement, data analysis and transmission. Students also use of instruments in the laboratory, and prepare a measurement project. Prerequisites: Completion of all Fundamental Skills; MATH 057; BENG 124 or ENGR 121 with a "C-" or better or permission of instructor.

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, including entropy and availability. Students are also introduced to the Carnot and ideal Rankine cycles. 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. 1-16 Units.
This course offers cooperative employment in a professional engineering environment. Students may register for a variable number of credits that depend upon the length of the work period. The course requires a satisfactory completion of the work assignment and a written report. Grading is on a Pass/Fail basis. Prerequisites: Completion of all Fundamental Skills.

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

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

ENGR 184. Professional Practice. 1-18 Units.
This course offers cooperative employment in a professional engineering environment. Students may register for a variable number of credits that depend upon the length of the work period. The course requires a satisfactory completion of the work assignment and a written report. Grading is on a Pass/Fail basis. Prerequisites: Completion of all Fundamental Skills.
ENGR 185. Professional Practice. 1-18 Units.
This course offers cooperative employment in a professional engineering environment. Students may register for a variable number of credits that depend upon the length of the work period. The course requires a satisfactory completion of the work assignment and a written report. Grading is on a Pass/Fail basis. Prerequisites: Completion of all Fundamental Skills.

ENGR 191. Independent Study. 1-4 Units.

Mechanical Engineering Courses

MECH 015. Mechanical Engineering Graphics. 3 Units.
This course covers the principles and applications of graphics in engineering design. Topics include pictorial and isometric sketching and orthographic projection, the use of auxiliary views and sections, drafting standards and conventions, dimensioning and tolerances, in addition to layout and assembly drawings, detail drawings and production drawings with SolidWorks and AutoCAD software. A laboratory is included. Prerequisite, may be taken concurrently: ENGR 010 with a "C-" or better.

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 dimensional 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 045, 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 examine the thermodynamics of cycles for power and refrigeration. Other topics include the thermodynamics of gas mixture, chemical reactions, combustion, fuels, and processes involving air and water mixtures relating to heating, cooling, and ventilating for human comfort. The course includes experimental activities and written laboratory reports. Prerequisites: Completion of all Fundamental Skills and ENGR 122 with a "C-" or better.

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

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

MECH 175. Systems Analysis and Control. 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.