Materials Science and Engineering/Mechanical Engineering Joint Major

Bachelor of Science (BS)
The joint major programs are designed for students who wish to undertake study in two areas of engineering in order to qualify for employment in either field or for positions in which competence in two fields is required. These curricula include the core courses in each of the major fields. While they require slightly increased course loads, they can be completed in four years.

Students interested in the mechanical behavior of materials have the option of pursuing a joint major in Materials Science and Engineering and Mechanical Engineering. The curriculum addresses key fundamentals of both disciplines, preparing students in materials selection and design for structural and functional applications. Students completing this joint major enter professional positions in the aerospace, automotive, energy, and manufacturing industries, along with many others.

Admission to the Joint Major
Admission directly to a joint major is closed to freshmen and junior transfer applicants. Students interested in a joint program may apply to change majors during specific times in their academic progress. Please see the College of Engineering joint majors website (http://engineering.berkeley.edu/academics/majors-minors/joint-majors) for complete details.

In addition to the University, campus, and college requirements, students must fulfill the below requirements specific to their major program.

General Guidelines
1. All technical courses taken in satisfaction of major requirements must be taken for a letter grade.
2. No more than one upper division course may be used to simultaneously fulfill requirements for a student’s major and minor programs.
3. A minimum overall grade point average (GPA) of 2.0 is required for all work undertaken at UC Berkeley.
4. A minimum GPA of 2.0 is required for all technical courses taken in satisfaction of major requirements.

For information regarding residence requirements and unit requirements, please see the College Requirements tab.

For a detailed plan of study by year and semester, please see the plan of study tab.

Lower Division Requirements

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 1A</td>
<td>Calculus</td>
<td>4</td>
</tr>
<tr>
<td>MATH 1B</td>
<td>Calculus</td>
<td>4</td>
</tr>
<tr>
<td>MATH 53</td>
<td>Multivariable Calculus</td>
<td>4</td>
</tr>
<tr>
<td>MATH 54</td>
<td>Linear Algebra and Differential Equations</td>
<td>4</td>
</tr>
</tbody>
</table>

Upper Division Requirements

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 1A &amp; 1AL</td>
<td>General Chemistry and General Chemistry Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>or CHEM 4A</td>
<td>General Chemistry and Quantitative Analysis</td>
<td>4</td>
</tr>
<tr>
<td>PHYSICS 7A</td>
<td>Physics for Scientists and Engineers</td>
<td>4</td>
</tr>
<tr>
<td>PHYSICS 7B</td>
<td>Physics for Scientists and Engineers</td>
<td>4</td>
</tr>
<tr>
<td>ENGIN 7</td>
<td>Introduction to Computer Programming for Scientists and Engineers</td>
<td>4</td>
</tr>
<tr>
<td>ENGIN 25</td>
<td>Visualization for Design</td>
<td>2</td>
</tr>
<tr>
<td>ENGIN 26</td>
<td>Three-Dimensional Modeling for Design</td>
<td>2</td>
</tr>
<tr>
<td>ENGIN 27</td>
<td>Introduction to Manufacturing and Tolerancing</td>
<td>2</td>
</tr>
<tr>
<td>MAT SCI 45</td>
<td>Properties of Materials</td>
<td>3</td>
</tr>
<tr>
<td>MAT SCI 45L</td>
<td>Properties of Materials Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>MEC ENG 40</td>
<td>Thermodynamics</td>
<td>3</td>
</tr>
<tr>
<td>MEC ENG C85</td>
<td>Introduction to Solid Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>EL ENG 49</td>
<td>Electronics for the Internet of Things</td>
<td>3-4</td>
</tr>
<tr>
<td>or PHYSICS 111</td>
<td>Instrumentation Laboratory</td>
<td>3-4</td>
</tr>
</tbody>
</table>

1 CHEM 4A is intended for students majoring in chemistry or a closely related field.

Students in the College of Engineering must complete no fewer than 120 semester units with the following provisions:

1. Completion of the requirements of one engineering major program (http://engineering.berkeley.edu/academics/undergraduate-programs) study.
2. A minimum overall grade point average of 2.00 (C average) and a minimum 2.00 grade point average in upper division technical coursework required of the major.

3. The final 30 units and two semesters must be completed in residence in the College of Engineering on the Berkeley campus.

4. All technical courses (math, science and engineering) that can fulfill requirements for the student’s major must be taken on a letter graded basis (unless they are only offered P/NP).

5. Entering freshmen are allowed a maximum of eight semesters to complete their degree requirements. Entering junior transfers are allowed a maximum of four semesters to complete their degree requirements. (Note: junior transfers admitted missing three or more courses from the lower division curriculum are allowed five semesters.) Summer terms are optional and do not count toward the maximum. Students are responsible for planning and satisfactorily completing all graduation requirements within the maximum allowable semesters.

6. Adhere to all college policies and procedures (http://engineering.berkeley.edu/academics/undergraduate-guide) as they complete degree requirements.

7. Complete the lower division program before enrolling in upper division engineering courses.

**Humanities and Social Sciences (H/SS) Requirement**

To promote a rich and varied educational experience outside of the technical requirements for each major, the College of Engineering has a six-course Humanities and Social Sciences breadth requirement (http://engineering.berkeley.edu/student-services/degree-requirements/humanities-and-social-sciences), which must be completed to graduate. This requirement, built into all the engineering programs of study, includes two reading and composition courses (R&C), and four additional courses within which a number of specific conditions must be satisfied. Follow these guidelines to fulfill this requirement:

1. Complete a minimum of six courses from the approved Humanities/Social Sciences (H/SS) lists (http://engineering.berkeley.edu/hssreq).
2. Courses must be a minimum of 3 semester units (or 4 quarter units).
3. Two of the six courses must fulfill the college’s Reading and Composition (R&C) requirement. These courses must be taken for a letter grade (C- or better required) and must be completed by no later than the end of the sophomore year (fourth semester of enrollment). The first half of R&C, the “A” course, must be completed by the end of the freshman year; the second half of R&C, the “B” course, must be completed by no later than the end of the sophomore year. Use the Class Schedule (http://classes.berkeley.edu) to view R&C courses offered in a given semester. View the list of exams (http://engineering.berkeley.edu/academics/undergraduate-guide/exams) that can be applied toward the first half of the R&C requirement. Note: Only the first half of R&C can be fulfilled with an AP or IB exam score. Test scores do not fulfill the second half of the R&C requirement for College of Engineering students.
4. The four additional courses must be chosen within College of Engineering guidelines from the H/SS lists (see below). These courses may be taken on a Pass/Not Passed basis (P/NP).
5. Two of the six courses must be upper division (courses numbered 100-196).
6. One of the six courses must satisfy the campus American Cultures requirement. For detailed lists of courses that fulfill American Cultures requirements, visit the American Cultures (http://guide.berkeley.edu/engineering/american-cultures-requirement) site.
7. A maximum of two exams (Advanced Placement, International Baccalaureate, or A-Level) may be used toward completion of the H/SS requirement. View the list of exams (http://engineering.berkeley.edu/academics/undergraduate-guide/exams) that can be applied toward H/SS requirements.
8. Courses may fulfill multiple categories. For example, CY PLAN 118AC (http://guide.berkeley.edu/search/?P=CY%20PLAN%20118AC) satisfies both the American Cultures requirement and one upper division H/SS requirement.
9. No courses offered by any engineering department other than BIO ENG 100 (http://guide.berkeley.edu/search/?P=BIO%20ENG%20100), COMPSCI C79 (http://guide.berkeley.edu/search/?P=COMPSCI%20C79), ENGIN 125 (http://guide.berkeley.edu/search/?P=ENGIN%20125), ENGIN 157AC (http://guide.berkeley.edu/search/?P=ENGIN%20157AC), and MEC ENG 191K (http://guide.berkeley.edu/search/?P=MEC%20ENG%20191K) may be used to complete H/SS requirements.
10. Foreign language courses may be used to complete H/SS requirements. View the list of language options (http://guide.berkeley.edu/undergraduate/colleges-schools/engineering/approved-foreign-language-courses).
11. Courses numbered 97, 98, 99, or above 196 may not be used to complete any H/SS requirement.
12. The College of Engineering uses modified versions of five of the College of Letters and Science (L&S) breadth requirements lists to provide options to our students for completing the H/SS requirement. The five areas are:
   - Arts and Literature
   - Historical Studies
   - International Studies
   - Philosophy and Values
   - Social and Behavioral Sciences

   Within the guidelines above, choose courses from any of the Breadth areas listed above. (Please note that you cannot use courses on the Biological Science or Physical Science Breadth list to complete the H/SS requirement.) To find course options, go to the Class Schedule (http://classes.berkeley.edu), (http://classes.berkeley.edu/search/class) select the term of interest, and use the Breadth Requirements (https://ls.berkeley.edu/sites/default/files/breadth_search_annotation_in_guide.png) filter.

**Class Schedule Requirements**

- Minimum units per semester: 12.0
- Maximum units per semester: 20.5
- Minimum technical courses: College of Engineering undergraduates must enroll each semester in no fewer than two technical courses (of a minimum of 3 units each) required of the major program of study in which the student is officially declared. (Note: For most majors, normal progress will require enrolling in 3-4 technical courses each semester).
- All technical courses (math, science, engineering) that satisfy requirements for the major must be taken on a letter-graded basis (unless only offered as P/NP).
Minimum Academic (Grade) Requirements

- A minimum overall and semester grade point average of 2.00 (C average) is required of engineering undergraduates. Students will be subject to dismissal from the University if during any fall or spring semester their overall UC GPA falls below a 2.00, or their semester GPA is less than 2.00.
- Students must achieve a minimum grade point average of 2.00 (C average) in upper division technical courses required for the major curriculum each semester.
- A minimum overall grade point average of 2.00, and a minimum 2.00 grade point average in upper division technical course work required for the major is needed to earn a Bachelor of Science in Engineering.

Unit Requirements

To earn a Bachelor of Science in Engineering, students must complete at least 120 semester units of courses subject to certain guidelines:

- Completion of the requirements of one engineering major program (https://engineering.berkeley.edu/academics/undergraduate-guide/degree-requirements/major-programs) of study.
- A maximum of 16 units of special studies coursework (courses numbered 97, 98, 99, 197, 198, or 199) is allowed towards the 120 units.
- A maximum of 4 units of physical education from any school attended will count towards the 120 units.
- Students may receive unit credit for courses graded P (including P/ NP units taken through EAP) up to a limit of one-third of the total units taken and passed on the Berkeley campus at the time of graduation.

Normal Progress

Students in the College of Engineering must enroll in a full-time program and make normal progress each semester toward the bachelor's degree. The continued enrollment of students who fail to achieve minimum academic progress shall be subject to the approval of the dean. (Note: Students with official accommodations established by the Disabled Students' Program, with health or family issues, or with other reasons deemed appropriate by the dean may petition for an exception to normal progress rules.)

University of California Requirements

Entry Level Writing (http://guide.berkeley.edu/undergraduate/colleges-schools/natural-resources/entry-level-writing-requirement)

All students who will enter the University of California as freshmen must demonstrate their command of the English language by fulfilling the Entry Level Writing Requirement. Satisfaction of this requirement is also a prerequisite to enrollment in all reading and composition courses at UC Berkeley.

American History and American Institutions (http://guide.berkeley.edu/undergraduate/colleges-schools/natural-resources/american-history-institutions-requirement)

The American History and Institutions requirements are based on the principle that a U.S. resident graduated from an American university should have an understanding of the history and governmental institutions of the United States.

Campus Requirement

American Cultures (http://guide.berkeley.edu/undergraduate/colleges-schools/natural-resources/american-cultures-requirement)

American Cultures (AC) is the one requirement that all undergraduate students at UC Berkeley need to take and pass in order to graduate. The requirement offers an exciting intellectual environment centered on the study of race, ethnicity, and culture in the United States. AC courses offer students opportunities to be part of research-led, highly accomplished teaching environments, grappling with the complexity of American Culture.

For more detailed information regarding the courses listed below (e.g., elective information, GPA requirements, etc.), please see the College Requirements and Major Requirements tabs.

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Freshman Fall</th>
<th>Units</th>
<th>Freshman Spring</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 4A or 1A and 1AL</td>
<td>4 MATH 1B</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATH 1A</td>
<td>4 PHYSICS 7A</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENGIN 25</td>
<td>2 ENGIN 7</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reading &amp; Composition course from List A</td>
<td>4 Reading &amp; Composition course from List B</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Optional Freshman Seminar or ENGIN 92</td>
<td>0-1 Optional Freshman Seminar</td>
<td>0-1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total Units: 119-127
CHEM 4A is intended for students majoring in chemistry or a closely-related field.

A total of 9 upper-division technical elective units are required. These must include 6 units of upper-division Mechanical Engineering courses, one of which must be from the following list: ENGIN 128, MEC ENG 101, MEC ENG 110, MEC ENG C117, MEC ENG 119, MEC ENG 130, MEC ENG 135, MEC ENG 146, MEC ENG 165, MEC ENG C176, MEC ENG C178. In addition, 3 units must be from the MAT SCI 120 series. Students may receive up to 3 units of technical elective credit for work on a research project in MEC ENG H194 or MEC ENG 196. Other letter-graded research courses may be approved by petition.

Technical Electives cannot include any course taken on a Pass/No Pass basis or MEC ENG 191K.

**Materials Science**

**MEASURED CURRICULAR OUTCOMES**

The program is designed around a set of curricular outcomes.

1. Be able to apply general math, science and engineering skills to the solution of engineering problems.
2. Be aware of the social, safety and environmental consequences of their work, and be able to engage in public debate regarding these issues.
3. Be able to apply core concepts in materials science to solve engineering problems.
4. Be knowledgeable of contemporary issues relevant to materials science and engineering.
5. Be able to select materials for design and construction.
6. Understand the importance of life-long learning.
7. Be able to design and conduct experiments, and to analyze data.
8. Understand the professional and ethical responsibilities of a materials scientist and engineer.
9. Be able to work both independently and as part of a team.
10. Be able to communicate effectively while speaking, employing graphics, and writing.
11. Possess the skills and techniques necessary for modern materials engineering practice.

**EDUCATIONAL OBJECTIVES FOR GRADUATES**

Stated succinctly, graduates from the program will have the following skills:

1. Know the fundamental science and engineering principles relevant to materials.
2. Understand the relationship between nano/microstructure, characterization, properties and processing, and design of materials.
3. Have the experimental and computational skills for a professional career or graduate study in materials.
4. Possess a knowledge of the significance of research, the value of continued learning, and environmental/social issues surrounding materials.
5. Be able to communicate effectively, to work in teams and to assume positions as leaders.
6. Be able to communicate effectively, to work in teams and to assume positions as leaders.

**Mechanical Engineering**

**Learning Goals**

The objectives of the Mechanical Engineering undergraduate program are to produce graduates who do the following:

1. Vigorously engage in post-baccalaureate endeavors, whether in engineering graduate study, in engineering practice, or in the pursuit of other fields such as science, law, medicine, business or public policy.
2. Apply their mechanical engineering education to address the full range of technical and societal problems with creativity, imagination, confidence and responsibility.
3. Actively seek out positions of leadership within their profession and their community.
4. Serve as ambassadors for engineering by exhibiting the highest ethical and professional standards, and by communicating the importance and excitement of this dynamic field.
5. Retain the intellectual curiosity that motivates lifelong learning and allows for a flexible response to the rapidly evolving challenges of the 21st century.

**Skills**

Mechanical Engineering graduates have the following:

1. An ability to apply knowledge of mathematics, science, and engineering.
2. An ability to design and conduct experiments as well as to analyze and interpret data.
3. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
4. An ability to function on multi-disciplinary teams.
5. An ability to identify, formulate, and solve engineering problems.
6. An understanding of professional and ethical responsibility.
7. An ability to communicate effectively.
8. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
9. A recognition of the need for and an ability to engage in life-long learning.
10. A knowledge of contemporary issues.
11. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

- Materials Science and Engineering (p. )
- Mechanical Engineering (p. )

**Materials Science and Engineering**

Expand all course descriptions [+ ]

Collapse all course descriptions [- ]
MAT SCI 24 Freshman Seminar 1 Unit
Terms offered: Spring 2019, Spring 2018, Spring 2017
The Freshman Seminar Program has been designed to provide new students with the opportunity to explore an intellectual topic with a faculty member in a small seminar setting. Freshman seminars are offered in all campus departments, and topics vary from department to department and semester to semester. Enrollment limited to 20 freshmen.
Freshman Seminar: Read More [+]

Hours & Format
Fall and/or spring: 15 weeks - 1 hour of lecture per week

Additional Details
Subject/Course Level: Materials Science and Engineering/ Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final exam required.

Freshman Seminar: Read Less [-]

MAT SCI 45 Properties of Materials 3 Units
Terms offered: Spring 2019, Fall 2018, Spring 2018
Application of basic principles of physics and chemistry to the engineering properties of materials. Special emphasis devoted to relation between microstructure and the mechanical properties of metals, concrete, polymers, and ceramics, and the electrical properties of semiconducting materials. Sponsoring Department: Materials Science and Engineering
Properties of Materials: Read More [+]

Rules & Requirements

Prerequisites: Physics 7A (may be taken concurrently)

Credit Restrictions: Students will receive no credit for MSE 45 after taking E45

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Materials Science and Engineering/ Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructors: Martin, Messersmith

Properties of Materials: Read Less [-]

MAT SCI 45L Properties of Materials Laboratory 1 Unit
Terms offered: Spring 2019, Fall 2018, Spring 2018
This course presents laboratory applications of the basic principles introduced in the lecture-based course MSE45 – Properties of Materials.
Properties of Materials Laboratory: Read More [+]

Rules & Requirements

Credit Restrictions: Students will receive no credit for MSE 45L after taking E45L

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of laboratory per week

Additional Details
Subject/Course Level: Materials Science and Engineering/ Undergraduate

Grading/Final exam status: Letter grade. Final exam not required.

Instructors: Martin, Messersmith

Properties of Materials Laboratory: Read Less [-]

MAT SCI 102 Bonding, Crystallography, and Crystal Defects 3 Units
Terms offered: Fall 2018, Fall 2017, Fall 2016
Bonding in solids; classification of metals, semiconductors, and insulators; crystal systems; point, line, and planar defects in crystals; examples of crystallographic and defect analysis in engineering materials; relationship to physical and mechanical properties.
Bonding, Crystallography, and Crystal Defects: Read More [+]

Rules & Requirements

Prerequisites: Engineering 45

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Materials Science and Engineering/ Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Chrzan

Bonding, Crystallography, and Crystal Defects: Read Less [-]
MAT SCI 103 Phase Transformations and Kinetics 3 Units
Terms offered: Spring 2019, Spring 2018, Spring 2017
The nature, mechanisms, and kinetics of phase transformations and microstructural changes in the solid state. Atom diffusion in solids. Phase transformations through the nucleation and growth of new matrix or precipitate phases. Martensitic transformations, spinodal decomposition. The use of phase transformations to control microstructure.
Phase Transformations and Kinetics: Read More [+]

Rules & Requirements
Prerequisites: 102 and Engineering 115

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Materials Science and Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Phase Transformations and Kinetics: Read Less [-]

MAT SCI 104 Materials Characterization 4 Units
Terms offered: Spring 2019, Spring 2018, Spring 2017
Materials Characterization: Read More [+]

Rules & Requirements
Prerequisites: 102

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 3 hours of laboratory per week

Additional Details
Subject/Course Level: Materials Science and Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Gronsky
Materials Characterization: Read Less [-]

MAT SCI 111 Properties of Electronic Materials 4 Units
Terms offered: Spring 2019, Spring 2018, Spring 2017
Introduction to the physical principles underlying the electric properties of modern solids with emphasis on semiconductors; control of defects and impurities through physical purification, bulk and thin film crystal growth and doping processes, materials basis of electronic and optoelectronic devices (diodes, transistors, semiconductor lasers) and optical fibers; properties of metal and oxide superconductors and their applications.
Properties of Electronic Materials: Read More [+]

Rules & Requirements
Prerequisites: Physics 7A-7B-7C or Physics 7A-7B and consent of instructor

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details
Subject/Course Level: Materials Science and Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructors: Dubon, Wu, Yao
Properties of Electronic Materials: Read Less [-]

MAT SCI 112 Corrosion (Chemical Properties) 3 Units
Terms offered: Spring 2019, Spring 2018, Spring 2017
Corrosion (Chemical Properties): Read More [+]

Rules & Requirements
Prerequisites: Engineering 45 and Engineering 115

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Materials Science and Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Devine
Corrosion (Chemical Properties): Read Less [-]
**MAT SCI 113 Mechanical Behavior of Engineering Materials 3 Units**

Terms offered: Fall 2018, Fall 2017, Fall 2016

This course covers elastic and plastic deformation under static and dynamic loads. Prediction and prevention of failure by yielding, fracture, fatigue, wear and environmental factors are addressed. Design issues pertaining to materials selection for load bearing applications are discussed. Case studies of engineering failures are presented. Topics include engineering materials, structure-property relationships, materials selection for design, mechanical behavior of polymers and design of plastic components, complex states of stress and strain, elastic deformation and multiaxial loading, plastic deformation and yield criteria, dislocation plasticity and strengthening mechanisms, creep, effects of stress concentrations, fracture, fatigue, and contact stresses.

**Rules & Requirements**

**Prerequisites:** C30/Mechanical Engineering C85 and Engineering 45

**Credit Restrictions:** Students will receive no credit for 113 after taking C113 or Mechanical Engineering C124. Deficiency in C113 or Mechanical Engineering C124 maybe removed by taking 113.

**Hours & Format**

Fall and/or spring: 15 weeks - 3 hours of lecture per week

**Additional Details**

**Subject/Course Level:** Materials Science and Engineering/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Instructor:** Ritchie

**Mechanical Behavior of Engineering Materials: Read Less [-]**

**MAT SCI 117 Properties of Dielectric and Magnetic Materials 3 Units**

Terms offered: Spring 2017, Spring 2011, Fall 2010

Introduction to the physical principles underlying the dielectric and magnetic properties of solids. Processing-microstructure-property relationships of dielectric materials, including piezoelectric, pyroelectric, and ferroelectric oxides, and of magnetic materials, including hard- and soft ferromagnets, ferrites and magneto-optic and -resistive materials. The course also covers the properties of grain boundary devices (including varistors) as well as ion-conducting and mixed conducting materials for applications in various devices such as sensors, fuel cells, and electric batteries.

**Rules & Requirements**

**Prerequisites:** Physics 7A-7B-7C or Physics 7A-7B and consent of instructor; 111 is recommended

**Hours & Format**

Fall and/or spring: 15 weeks - 3 hours of lecture per week

**Additional Details**

**Subject/Course Level:** Materials Science and Engineering/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Properties of Dielectric and Magnetic Materials: Read Less [-]**
MAT SCI C118 Biological Performance of Materials 4 Units
Terms offered: Fall 2018, Fall 2017, Fall 2015
This course is intended to give students the opportunity to expand their knowledge of topics related to biomedical materials selection and design. Structure-property relationships of biomedical materials and their interaction with biological systems will be addressed. Applications of the concepts developed include blood-materials compatibility, biomimetic materials, hard and soft tissue-materials interactions, drug delivery, tissue engineering, and biotechnology.

Objectives Outcomes

Course Objectives: The course is separated into four parts spanning the principles of synthetic materials and surfaces, principles of biological materials, biological performance of materials and devices, and state-of-the-art materials design. Students are required to attend class and master the material therein. In addition, readings from the clinical, life and materials science literature are assigned. Students are encouraged to seek out additional reference material to complement the readings assigned. A mid-term examination is given on basic principles (parts 1 and 2 of the outline). A comprehensive final examination is given as well. The purpose of this course is to introduce students to problems associated with the selection and function of biomaterials. Through class lectures and readings in both the physical and life science literature, students will gain broad knowledge of the criteria used to select biomaterials, especially in devices where the material-tissue or material-solution interface dominates performance. Materials used in devices for medicine, dentistry, tissue engineering, drug delivery, and the biotechnology industry will be addressed.

This course also has a significant design component (~35%). Students will form small teams (five or less) and undertake a semester-long design project related to the subject matter of the course. The project includes the preparation of a paper and a 20 minute oral presentation critically analyzing a current material-tissue or material-solution problem. Students will be expected to design improvements to materials and devices to overcome the problems identified in class with existing materials.

Student Learning Outcomes: Apply math, science & engineering principles to the understanding of soft materials, surface chemistry, DLVO theory, protein adsorption kinetics, viscoelasticity, mass diffusion, and molecular (i.e., drug) delivery kinetics.

- Design experiments and analyze data from the literature in the context of the class design project.
Applies core concepts in materials science to solve engineering problems related to the selection biomaterials, especially in devices where the material-tissue or material-solution interface dominates performance. Develop an understanding of the social, safety and medical consequences of biomaterial use and regulatory issues associated with the selection of biomaterials in the context of the silicone breast implant controversy and subsequent biomaterials crisis.
Work independently and function on a team, and develop solid communication skills (oral, graphic & written) through the class design project.

- Understanding of the origin of surface forces and interfacial free energy, and how they contribute to the development of the biomaterial interface and ultimately biomaterial performance.

Rules & Requirements

Prerequisites: Engin 45; BioE 103 or equivalent; BioE 102 and BioE 104 recommended

MAT SCI 120 Materials Production 3 Units
Terms offered: Fall 2018, Fall 2017, Fall 2016

Materials Production: Read More [+]

Rules & Requirements

Prerequisites: Engineering 115, Mechanical Engineering 40, Chemical Engineering 141, Chemistry 120B or equivalent thermodynamics course

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Materials Science and Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Materials Production: Read Less [-]

MAT SCI 121 Metals Processing 3 Units
Terms offered: Spring 2019, Spring 2015, Spring 2014
The principles of metals processing with emphasis on the use of processing to establish microstructures which impart desirable engineering properties. The techniques discussed include solidification, thermal and mechanical processing, powder processing, welding and joining, and surface treatments.

Metals Processing: Read More [+]

Rules & Requirements

Prerequisites: Engineering 45

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Materials Science and Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Gronsky

Metals Processing: Read Less [-]
MAT SCI 122 Ceramic Processing 3 Units
Terms offered: Fall 2012, Fall 2011, Fall 2010
Powder fabrication by grinding and chemical methods, rheological behavior of powder-fluid suspensions, forming methods, drying, sintering, and grain growth. Relation of processing steps to microstructure development.
Ceramic Processing: Read More [+]

Rules & Requirements
Prerequisites: Engineering 45, 115

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Materials Science and Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.

MAT SCI 123 ELECTRONIC MATERIALS PROCESSING 4 Units
Terms offered: Spring 2019, Fall 2018, Fall 2017
This 4-unit course starts with a brief review of the fundamentals of solid-state physics including bands and defects in semiconductors and oxides, and then moves to bulk semiconductor crystals growth and processing including doping, diffusion and implantation, and then to thin film deposition and processing methods, and finishes with a discussion of materials analysis and characterization. Recent advances in nanomaterials research will also be introduced.

Objectives Outcomes
Course Objectives:
To prepare students a) for work in semiconductor processing facilities and b) for graduate studies related to thin film processing and relevant materials science topics.
To present the relevant materials science issues in semiconductor and oxide processing
To provide an introduction into the principles of thin film processing and related technologies.

Student Learning Outcomes:
Basic knowledge of gas kinetics and vacuum technology, including ideal gas, gas transport theory, definition, creation and measurement of vacuum.
Knowledge of electrical and optical properties of thin films.
Knowledge of the formation of p-n junction to explain the diode operation and its I-V characteristics. Understanding of the mechanisms of Hall Effect, transport, and C-V measurements, so that can calculate carrier concentration, mobility and conductivity given raw experimental data.
The ability to describe major growth techniques of bulk, thin film, and nanostructured semiconductors, with particular emphasis on thin film deposition technologies, including evaporation, sputtering, chemical vapor deposition and epitaxial growths.
To have basic knowledge of doping, purification, oxidation, gettering, diffusion, implantation, metallization, lithography and etching in semiconductor processing.
To have basic knowledge of electronic material characterization methods: x-ray diffraction, SEM and TEM, EDX, Auger, STM and AFM, Rutherford Back Scattering and SIMS, as well as optical methods including photoluminescence, absorption and Raman scattering.
To understand the concepts of bands, bandgap, to distinguish direct and indirect bandgap semiconductors. Understanding of free electron and hole doping of semiconductors to determine Fermi level position.
To understand the effect of defects in semiconductors, so that can describe their electronic and optical behaviors, and the methods to eliminate and control them in semiconductors.

Rules & Requirements
Prerequisites: MSE 111 or Physics 7C or consent of instructor

Hours & Format
Fall and/or spring: 15 weeks - 4 hours of lecture per week

Additional Details
Subject/Course Level: Materials Science and Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructors: Wu, Yao
**MAT SCI 125 Thin-Film Materials Science**

3 Units

Terms offered: Spring 2016, Spring 2015, Fall 2014


Instructor: Dubon

** Rules & Requirements

**Prerequisites:** Upper division or graduate standing in engineering, physics, chemistry, and chemical engineering; Engineering 45 required; 111 or Physics 141A recommended

**Hours & Format**

Fall and/or spring: 15 weeks - 3 hours of lecture per week

**Additional Details**

**Subject/Course Level:** Materials Science and Engineering/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**MAT SCI 130 Experimental Materials Science and Design**

3 Units

Terms offered: Fall 2018, Fall 2017, Fall 2016

This course provides a culminating experience for students approaching completion of the materials science and engineering curriculum. Laboratory experiments are undertaken in a variety of areas from the investigations on semiconductor materials to corrosion science and elucidate the relationships among structure, processing, properties, and performance. The principles of materials selection in engineering design are reviewed.

Instructor: Dubon

**Rules & Requirements**

**Prerequisites:** Senior standing or consent of instructor

**Hours & Format**

Fall and/or spring: 15 weeks - 2 hours of lecture and 3 hours of laboratory per week

**Additional Details**

**Subject/Course Level:** Materials Science and Engineering/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**MAT SCI 136 Materials in Energy Technologies**

4 Units

Terms offered: Fall 2017, Fall 2015, Fall 2011

In many, if not all, technologies, it is materials that play a crucial, enabling role. This course examines potentially sustainable technologies, and the materials properties that enable them. The science at the basis of selected energy technologies are examined and considered in case studies.

Instructor: Minor

**Rules & Requirements**

**Prerequisites:** Junior or above standing in Materials Science and Engineering or related field

**Hours & Format**

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

**Additional Details**

**Subject/Course Level:** Materials Science and Engineering/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Formerly known as:** Materials Science and Engineering 126

**MAT SCI 140 Nanomaterials for Scientists and Engineers**

3 Units

Terms offered: Spring 2015, Spring 2013, Spring 2012

This course introduces the fundamental principles needed to understand the behavior of materials at the nanometer length scale and the different classes of nanomaterials with applications ranging from information technology to biotechnology. Topics include introduction to different classes of nanomaterials, synthesis and characterization of nanomaterials, and the electronic, magnetic, optical, and mechanical properties of nanomaterials.

Instructor: Minor

**Rules & Requirements**

**Prerequisites:** 102 or equivalent recommended; Physics 7C and Engineering 45 required

**Hours & Format**

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

**Additional Details**

**Subject/Course Level:** Materials Science and Engineering/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Nanomaterials for Scientists and Engineers: Read Less [-]**
MAT SCI C150 Introduction to Materials Chemistry 3 Units
The application of basic chemical principles to problems in materials discovery, design, and characterization will be discussed. Topics covered will include inorganic solids, nanoscale materials, polymers, and biological materials, with specific focus on the ways in which atomic-level interactions dictate the bulk properties of matter.
Introduction to Materials Chemistry: Read More [+] Rules & Requirements
Prerequisites: 104A; 104B is recommended
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week
Additional Details
Subject/Course Level: Materials Science and Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Also listed as: CHEM C150
Introduction to Materials Chemistry: Read Less [-]

MAT SCI 151 Polymeric Materials 3 Units
Terms offered: Spring 2019, Spring 2018, Spring 2017
This course is designed for upper division undergraduate and graduate students to gain a fundamental understanding of the science of polymeric materials. Beginning with a treatment of ideal polymeric chain conformations, it develops the thermodynamics of polymer blends and solutions, the modeling of polymer networks and gelations, the dynamics of polymer chains, and the morphologies of thin films and other dimensionally-restricted structures relevant to nanotechnology.
Polymeric Materials: Read More [+] Rules & Requirements
Prerequisites: Chemistry 1A or Engineering 5. 103 is recommended
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week
Additional Details
Subject/Course Level: Materials Science and Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Xu
Polymeric Materials: Read Less [-]

MAT SCI H194 Honors Undergraduate Research 1 - 4 Units
Terms offered: Spring 2019, Fall 2016, Spring 2016
Students who have completed a satisfactory number of advanced courses with a grade-point average of 3.3 or higher may pursue original research under the direction of one of the members of the staff. A maximum of 3 units of H194 may be used to fulfill technical elective requirements in the Materials Science and Engineering program or double majors (unlike 198 or 199, which do not satisfy technical elective requirements). Final report required.
Honors Undergraduate Research: Read More [+] Rules & Requirements
Prerequisites: Upper division technical GPA of 3.3 or higher and consent of instructor and adviser
Repeat rules: Course may be repeated for credit without restriction.
Hours & Format
Fall and/or spring: 15 weeks - 1-4 hours of independent study per week
Summer: 8 weeks - 1.5-7.5 hours of independent study per week
Additional Details
Subject/Course Level: Materials Science and Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam not required.
Honors Undergraduate Research: Read Less [-]

MAT SCI 195 Special Topics for Advanced Undergraduates 1 Unit
Terms offered: Spring 2012, Spring 2011, Spring 2010
Group study of special topics in materials science and engineering. Selection of topics for further study of underlying concepts and relevant literature, in consultation with appropriate faculty members.
Special Topics for Advanced Undergraduates: Read More [+] Rules & Requirements
Prerequisites: Upper division standing and good academic standing. (2.0 gpa and above)
Hours & Format
Fall and/or spring: 15 weeks - 1 hour of directed group study per week
Additional Details
Subject/Course Level: Materials Science and Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Special Topics for Advanced Undergraduates: Read Less [-]
MAT SCI 198 Directed Group Studies for Advanced Undergraduates 1 - 4 Units
Terms offered: Fall 2018, Spring 2016, Fall 2015
Group studies of selected topics.
Directed Group Studies for Advanced Undergraduates: Read More [+]

Rules & Requirements

Prerequisites: Upper division standing in Engineering

Hours & Format
Fall and/or spring: 15 weeks - 1-4 hours of directed group study per week

Additional Details
Subject/Course Level: Materials Science and Engineering/ Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

Directed Group Studies for Advanced Undergraduates: Read Less [-]

MAT SCI 199 Supervised Independent Study 1 - 4 Units
Terms offered: Spring 2019, Fall 2016, Spring 2016
Supervised independent study. Enrollment restrictions apply; see the Introduction to Courses and Curricula section of this catalog.
Supervised Independent Study: Read More [+]

Rules & Requirements

Prerequisites: Consent of instructor and major adviser

Credit Restrictions: Course may be repeated for a maximum of four units per semester.

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format
Fall and/or spring: 15 weeks - 1-4 hours of independent study per week
Summer: 6 weeks - 1-5 hours of independent study per week
8 weeks - 1-4 hours of independent study per week

Additional Details
Subject/Course Level: Materials Science and Engineering/ Undergraduate

Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

Supervised Independent Study: Read Less [-]

Mechanical Engineering Courses
Expand all course descriptions [+]Collapse all course descriptions [-]
MEC ENG C85 Introduction to Solid Mechanics 3 Units
Terms offered: Spring 2019, Fall 2018, Spring 2018
Introduction to Solid Mechanics: Read More [+]

Rules & Requirements
Prerequisites: Mathematics 53 and 54 (may be taken concurrently); Physics 7A

Credit Restrictions: Students will receive no credit for Mechanical Engineering C85/Civil and Environmental Engineering C30 after completing Mechanical Engineering W85. A deficient grade in Mechanical Engineering W85 may be removed by taking Mechanical Engineering C85/Civil and Environmental Engineering C30.

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week
Summer:
6 weeks - 7.5 hours of lecture and 2.5 hours of discussion per week
10 weeks - 4.5 hours of lecture and 1.5 hours of discussion per week

Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructors: Armero, Papadopoulos, Zohdi, Johnson

Also listed as: CIV ENG C30

Introduction to Solid Mechanics: Read Less [-]

MEC ENG W85 Introduction to Solid Mechanics 3 Units
Terms offered: Summer 2019 8 Week Session, Summer 2018 8 Week Session, Summer 2016, Summer 2016 10 Week Session
Introduction to Solid Mechanics: Read More [+]

Objectives Outcomes
Course Objectives: To learn statics and mechanics of materials
Student Learning Outcomes: - Correctly draw free-body
- Apply the equations of equilibrium to two and three-dimensional solids
- Understand the concepts of stress and strain
- Ability to calculate deflections in engineered systems
- Solve simple boundary value problems in linear elastostatics (tension, torsion, beam bending)

Rules & Requirements
Prerequisites: Mathematics 53 and 54 (may be taken concurrently); Physics 7A

Credit Restrictions: Students will receive no credit for Mechanical Engineering W85/Civil and Environmental Engineering W30 after completing Mechanical Engineering C85/C Civil and Environmental Engineering C30. A deficient grade in Mechanical Engineering C85/C Civil and Environmental Engineering C30 may be removed by taking Mechanical Engineering W85/Civil and Environmental Engineering W30.

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of web-based lecture and 1 hour of web-based discussion per week
Summer:
6 weeks - 7.5 hours of web-based lecture and 2.5 hours of web-based discussion per week
8 weeks - 6 hours of web-based lecture and 2 hours of web-based discussion per week
10 weeks - 4.5 hours of web-based lecture and 1.5 hours of web-based discussion per week

Online: This is an online course.

Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Govindjee

Also listed as: CIV ENG W30

Introduction to Solid Mechanics: Read Less [-]
MEC ENG 98 Supervised Independent Group Studies 1 - 4 Units
Terms offered: Fall 2016, Summer 2016 10 Week Session, Spring 2016
Organized group study on various topics under the sponsorship and direction of a member of the Mechanical Engineering faculty.
Supervised Independent Group Studies: Read More [+]

Rules & Requirements
Prerequisites: Consent of instructor
Repeat rules: Course may be repeated for credit without restriction.

Hours & Format
Fall and/or spring: 15 weeks - 1-4 hours of directed group study per week
Summer: 10 weeks - 1.5-6 hours of directed group study per week

Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.
Supervised Independent Group Studies: Read Less [-]

MEC ENG 100 Electronics for the Internet of Things 4 Units
Terms offered: Not yet offered
Electronics and Electrical Engineering has become pervasive in our lives as a powerful technology with applications in a wide range of fields including healthcare, environmental monitoring, robotics, or entertainment. This course offers a broad survey of Electrical Engineering ideas to non-majors. In the laboratory students will learn in-depth how to design and build systems that exchange information with or are controlled from the cloud. Examples include solar harvesters, robots, and smart home devices. In the course project, the students will integrate what they have learned and build an Internet-of-Things application of their choice. The course has a mandatory lab fee.
Electronics for the Internet of Things: Read More [+]

Objectives Outcomes
Course Objectives: Electronics has become a powerful and ubiquitous technology supporting solutions to a wide range of applications in fields ranging from science, engineering, healthcare, environmental monitoring, transportation, to entertainment. This course teaches students majoring in these and related subjects how to use electronic devices to solve problems in their areas of expertise. Through the lecture and laboratory, students gain insight into the possibilities and limitations of the technology and how to use electronics to help solve problems. Students learn to use electronics to interact with the environment through sound, light, temperature, motion using sensors and actuators, and how to use electronic computation to orchestrate the interactions and exchange information wirelessly over the internet.
The course has two objectives: (a) to teach students how to build electronic circuits that interact with the environment through sensors and actuators and how to communicate wirelessly with the internet to cooperate with other devices and with humans, and (b) to offer a broad survey of modern Electrical Engineering including analog electronics: analysis of RLC circuits, filtering, diodes and rectifiers, op-amps, A2D and D2A converters; digital electronics: combinatorial and sequential logic, flip-flops, counters, memory; applications: communication systems, signal processing, computer architecture; basics of manufacturing of integrated circuits.

Student Learning Outcomes: an ability to communicate effectively an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability an ability to identify, formulate, and solve engineering problems an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Rules & Requirements
Prerequisites: Engineering 7, Computer Science 10, Computer Science 61a, Computer Science C8 or equivalent background in computer programming, Math 1A or equivalent background in Calculus, Physics 7A or equivalent background in Physics
Credit Restrictions: Student will not receive credit for this course if they have taken EE49

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture, 2 hours of discussion, and 3 hours of laboratory per week

Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Alternative to final exam.
MEC ENG 101 Introduction to Lean Manufacturing Systems 3 Units
Terms offered: Spring 2019, Spring 2018, Spring 2017
Fundamentals of lean manufacturing systems including manufacturing fundamentals, unit operations and manufacturing line considerations for work in process (WIP), manufacturing lead time (MLT), economics, quality monitoring; high mix/low volume (HMLV) systems fundamentals including just-in-time (JIT), kanban, buffers and line balancing; class project/case studies for design and analysis of competitive manufacturing systems.
Introduction to Lean Manufacturing Systems: Read More [+]

Objectives Outcomes
Course Objectives: This course will enable students to analyze manufacturing lines in order to understand the production process and improve production efficiency. The course provides practical knowledge and skills that can be applied in industry, covering the complete manufacturing system from production planning to quality control. Students are given a chance to practice and implement what they learn during lectures by conducting projects with local or global manufacturing companies.

Student Learning Outcomes: Students will understand the whole scope of manufacturing systems from production planning to quality control, which can be helpful to set up manufacturing lines for various products. Students will be capable of identifying sources of manufacturing problems by analyzing the production line and produce multi-level solutions to optimize manufacturing efficiency.

Rules & Requirements
Prerequisites: Completion of all lower division requirements for an engineering major, or consent of instructor

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week
Summer: 6 weeks - 7.5 hours of lecture and 3 hours of discussion per week

Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructors: Dornfeld, McMains

Introduction to Lean Manufacturing Systems: Read Less [-]

MEC ENG 102A Introduction to Mechanical Systems for Mechatronics 4 Units
Terms offered: Fall 2017, Spring 2017, Fall 2016
The objectives of this course are to introduce students to modern experimental techniques for mechanical engineering, and to improve students' written and oral communication skills. Students will be provided exposure to, and experience with, a variety of sensors used in mechatronic systems including sensors to measure temperature, displacement, velocity, acceleration and strain. The role of error and uncertainty in measurements and analysis will be examined. Students will also be provided exposure to, and experience with, using commercial software for data acquisition and analysis. The role and limitations of spectral analysis of digital data will be discussed.
Introduction to Mechanical Systems for Mechatronics: Read More [+]

Objectives Outcomes
Course Objectives: Introduce students to modern experimental techniques for mechanical engineering; provide exposure to and experience with a variety of sensors used in mechatronic systems, including sensors to measure temperature, displacement, velocity, acceleration and strain; examine the role of error and uncertainty in measurements and analysis; exposure to and experience in using commercial software for data acquisition and analysis; discuss the role and limitations of spectral analysis of digital data; provide experience in working in a team in all aspects of the laboratory exercises, including set-up, data collection, analysis and report writing.

Student Learning Outcomes: By the end of this course, students should: Know how to use, what can be measured with, and what the limitations are of the basic instruments found in the laboratory: oscilloscope, multimeter, counter/timer, analog-to-digital converter; know how to write a summary laboratory report; understand the relevance of uncertainty in measurements, and the propagation of uncertainty in calculations involving measurements; understand the physics behind the instruments and systems used in the laboratory; know how to program effectively using LabVIEW for data acquisition and analysis; understand the use of spectral analysis for characterizing the dynamic response of an instrument or of a system.

Rules & Requirements
Prerequisites: Engineering 26 (waived for Junior Transfers), Mechanical Engineering C85, ME 104, ME 132 (can be taken as a co-requisite if the course schedule allows) Electrical Engineering 16A or 40. Reading and Composition courses completed

Hours & Format
Fall and/or spring: 15 weeks - 2 hours of lecture and 3 hours of laboratory per week

Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam not required.

Introduction to Mechanical Systems for Mechatronics: Read Less [-]
MEC ENG 102B Mechatronics Design 4 Units
Terms offered: Spring 2019, Fall 2018, Spring 2018
Introduction to design and realization of mechatronics systems. Microcomputer architectures. Basic computer IO devices. Embedded microprocessor systems and control, IO programming such as analogue to digital converters, PWM, serial and parallel outputs. Electrical components such as power supplies, operational amplifiers, transformers and filters. Shielding and grounding. Design of electric, hydraulic and pneumatic actuators. Design of sensors. Design of power transmission systems. Kinematics and dynamics of robotics devices. Basic feedback design to create robustness and performance.

Course Objectives: Introduce students to design and design techniques of mechatronics systems; provide guidelines to and experience with design of variety of sensors and actuators; design experience in programming microcomputers and various IO devices; exposure to and design experience in synthesis of mechanical power transfer components; understanding the role of dynamics and kinematics of robotic devices in design of mechatronics systems; exposure to and design experience in synthesis of feedback systems; provide experience in working in a team to design a prototype mechatronics device.

Student Learning Outcomes: By the end of this course, students should: Know how to set up micro computers and interface them with various devices; know how to understand the microcomputers architectures, IO devices and be able to program them effectively; understand the design of actuators and sensors; know how to do shielding and grounding for various mechatronics projects, know how to create feedback systems, know the role of dynamics and kinematics of robotic devices in design and control of mechatronics systems; know how to design mechanical components such as transmissions, bearings, shafts, and fasteners.

Rules & Requirements
Prerequisites: E 25, E 26 (junior transfers students are exempt from this requirement), E 27, as well as EE 16A or EE 40

Hours & Format
Fall and/or spring: 15 weeks - 2 hours of lecture and 3 hours of laboratory per week

MEC ENG 103 Experimentation and Measurements 4 Units
Terms offered: Spring 2019, Fall 2018
This course introduces students to modern experimental techniques for mechanical engineering, and improves students' teamwork and communication skills. Students will work in a laboratory setting on systems ranging in complexity from desktop experiments with only a few instruments up to systems such as an internal combustion engine with a wide variety of sensors. State-of-the-art software for data acquisition and analysis will be introduced and used throughout the course. The role of error and uncertainty, and uncertainty propagation, in measurements and analysis will be examined. Design of experiments will be addressed through examples and homework. The role and limitations of spectral analysis of digital data will be discussed.

Course Objectives: Introduce students to modern experimental techniques for mechanical engineering; provide exposure to and experience with a variety of sensors, including those to measure temperature, displacement, velocity, acceleration and strain; examine the role of error and uncertainty in measurements and analysis; exposure to and experience in using commercial software for data acquisition and analysis; discuss the role and limitations of spectral analysis of digital data; provide experience in working in a team in all aspects of the laboratory exercises, including set-up, data collection, analysis, technical report writing and oral presentation.

Student Learning Outcomes: (a) an ability to apply knowledge of mathematics, science, and engineering (b) an ability to design and conduct experiments, as well as to analyze and interpret data (c) an ability to function on multi-disciplinary teams (d) an ability to identify, formulate, and solve engineering problems (e) an understanding of professional and ethical responsibility (f) an ability to communicate effectively (g) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context (h) a recognition of the need for, and an ability to engage in life-long learning (i) a knowledge of contemporary issues (j) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Rules & Requirements
Prerequisites: MEC85, ME40, EE 100/EE 49, and ME 109

Credit Restrictions: Students will not receive credit for this course if they have taken both ME 102A and ME 107.

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 3 hours of laboratory per week
MEC ENG 104 Engineering Mechanics II 3 Units
Terms offered: Summer 2019 10 Week Session, Spring 2019, Fall 2018
This course is an introduction to the dynamics of particles and rigid bodies. The material, based on a Newtonian formulation of the governing equations, is illustrated with numerous examples ranging from one-dimensional motion of a single particle to planar motions of rigid bodies and systems of rigid bodies.

Rules & Requirements
Prerequisites: C85 and Engineering 7

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week
Summer: 10 weeks - 4.5 hours of lecture and 1.5 hours of discussion per week

Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.

Engineering Mechanics II: Read More [+]

MEC ENG 106 Fluid Mechanics 3 Units
Terms offered: Summer 2019 10 Week Session, Spring 2019, Fall 2018
This course introduces the fundamentals and techniques of fluid mechanics with the aim of describing and controlling engineering flows.

Rules & Requirements
Prerequisites: C85 and 104 (104 may be taken concurrently)

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week
Summer: 10 weeks - 4.5 hours of lecture and 1.5 hours of discussion per week

Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.

Fluid Mechanics: Read More [+]

MEC ENG 107 Mechanical Engineering Laboratory 3 Units
Terms offered: Spring 2018, Fall 2017, Spring 2017
Experimental investigation of engineering systems and of phenomena of interest to mechanical engineers. Design and planning of experiments. Analysis of data and reporting of experimental results.

Objectives Outcomes
Course Objectives: Through a series of three experiments from a number of experiments students design, perform, analyze, and report on complex prototypical engineering systems as a group.

Student Learning Outcomes: (a) an ability to apply knowledge of mathematics, science, and engineering (b) an ability to design and conduct experiments, as well as to analyze and interpret data (e) an ability to identify, formulate, and solve engineering problems (g) an ability to communicate effectively (i) a recognition of the need for, and ability to engage in lifelong learning (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Rules & Requirements
Prerequisites: 102A; senior standing

Hours & Format
Fall and/or spring: 15 weeks - 2-2 hours of lecture, 0-1 hours of discussion, and 3-3 hours of laboratory per week

Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam not required.

Mechanical Engineering Laboratory: Read Less [-]
MEC ENG 108 Mechanical Behavior of Engineering Materials 4 Units
Terms offered: Spring 2019, Fall 2018, Spring 2018
This course covers elastic and plastic deformation under static and dynamic loads. Failure by yielding, fracture, fatigue, wear, and environmental factors are also examined. Topics include engineering materials, heat treatment, structure-property relationships, elastic deformation and multiaxial loading, plastic deformation and yield criteria, dislocation plasticity and strengthening mechanisms, creep, stress concentration effects, fracture, fatigue, and contact deformation.

Objectives Outcomes
Course Objectives: The central theme of this course is the mechanical behavior of engineering materials, such as metals, ceramics, polymers, and composites, subjected to different types of loading. The main objectives are to provide students with basic understanding of phase transformation by heat treating and stress-induced hardening, linear and nonlinear elastic behavior, deformation under multiaxial loading, plastic deformation and yield criteria, dislocation plasticity and strengthening mechanisms, creep, stress concentration effects, brittle versus ductile fracture, fracture mechanisms at different scales, fatigue, contact deformation, and wear.

Student Learning Outcomes: (a) an ability to apply knowledge of mathematics, science, and engineering (b) an ability to design and conduct experiments, as well as to analyze and interpret data (c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability (e) an ability to identify, formulate, and solve engineering problems (i) a recognition of the need for, and an ability to engage in life-long learning (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Rules & Requirements
Prerequisites: C85

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture, 1 hour of discussion, and 2 hours of laboratory per week
Summer: 10 weeks - 4.5 hours of lecture, 1.5 hours of discussion, and 3 hours of laboratory per week

Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.

MEC ENG 109 Heat Transfer 3 Units
Terms offered: Summer 2019 10 Week Session, Spring 2019, Fall 2018
This course covers transport processes of mass, momentum, and energy from a macroscopic view with emphasis both on understanding why matter behaves as it does and on developing practical problem solving skills. The course is divided into four parts: introduction, conduction, convection, and radiation.

Rules & Requirements
Prerequisites: 40 and 106

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week
Summer: 8 weeks - 5.5 hours of lecture and 1.5 hours of discussion per week
10 weeks - 4.5 hours of lecture and 1.5 hours of discussion per week

Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.

MEC ENG 110 Introduction to Product Development 3 Units
Terms offered: Summer 2019 10 Week Session, Spring 2019, Summer 2018 10 Week Session
The course provides project-based learning experience in innovative new product development, with a focus on mechanical engineering systems. Design concepts and techniques are introduced, and the student's design ability is developed in a design or feasibility study chosen to emphasize ingenuity and provide wide coverage of engineering topics. Relevant software will be integrated into studio sessions, including solid modeling and environmental life cycle analysis. Design optimization and social, economic, and political implications are included.

Rules & Requirements
Prerequisites: Junior or higher standing

Hours & Format
Fall and/or spring: 15 weeks - 3-3 hours of lecture and 0-1 hours of voluntary per week
Summer: 10 weeks - 4.5-4.5 hours of lecture and 0-1 hours of voluntary per week

Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam not required.
MEC ENG C115 Molecular Biomechanics and Mechanobiology of the Cell 4 Units
Terms offered: Spring 2019, Spring 2016, Spring 2015
This course applies methods of statistical continuum mechanics to subcellular biomechanical phenomena ranging from nanoscale (molecular) to microscale (whole cell and cell population) biological processes at the interface of mechanics, biology, and chemistry.
Molecular Biomechanics and Mechanobiology of the Cell: Read More [+]

Objectives Outcomes

Course Objectives: This course, which is open to senior undergraduate students or graduate students in diverse disciplines ranging from engineering to biology to chemistry and physics, is aimed at exposing students to subcellular biomechanical phenomena spanning scales from molecules to the whole cell.

Student Learning Outcomes: The students will develop tools and skills to (1) understand and analyze subcellular biomechanics and transport phenomena, and (2) ultimately apply these skills to novel biological and biomedical applications

Rules & Requirements

Prerequisites: Math 54; Physics 7A; BioE102 or MEC85 or instructor's consent

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Mechanical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Alternative to final exam.

Instructor: Mofrad

Also listed as: BIO ENG C112

Molecular Biomechanics and Mechanobiology of the Cell: Read Less [-]

MEC ENG C117 Structural Aspects of Biomaterials 4 Units
Terms offered: Spring 2019, Spring 2018, Spring 2016
This course covers the structure and mechanical functions of load bearing tissues and their replacements. Natural and synthetic load-bearing biomaterials for clinical applications are reviewed. Biocompatibility of biomaterials and host response to structural implants are examined. Quantitative treatment of biomechanical issues and constitutive relationships of tissues are covered in order to design biomaterial replacements for structural function. Material selection for load bearing applications including reconstructive surgery, orthopedics, dentistry, and cardiology are addressed. Mechanical design for longevity including topics of fatigue, wear, and fracture are reviewed. Case studies that examine failures of devices are presented.

Structural Aspects of Biomaterials: Read More [+]

Rules & Requirements

Prerequisites: Biology 1A, Engineering 45, Civil and Environmental Engineering 130 or 130N or Bioengineering 102, and Engineering 190

Credit Restrictions: Students will receive no credit for Mechanical Engineering C117 after completing Mechanical Engineering C215/ Bioengineering C222.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Mechanical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam not required.

Instructor: Pruitt

Also listed as: BIO ENG C117

Structural Aspects of Biomaterials: Read Less [-]
MEC ENG 118 Introduction to Nanotechnology and Nanoscience 3 Units
Terms offered: Spring 2017, Spring 2015, Spring 2013
This course introduces engineering students (juniors and seniors) to the field of nanotechnology and nanoscience. The course has two components: (1) Formal lectures. Students receive a set of formal lectures introducing them to the field of nanotechnology and nanoscience. The material covered includes nanofabrication technology (how one achieves the nanometer length scale, from “bottom up” to “top down” technologies), the interdisciplinary nature of nanotechnology and nanoscience (including areas of chemistry, material science, physics, and molecular biology), examples of nanoscience phenomena (the crossover from bulk to quantum mechanical properties), and applications (from integrated circuits, quantum computing, MEMS, and bioengineering). (2) Projects. Students are asked to read and present a variety of current journal papers to the class and lead a discussion on the various works.

MEC ENG 119 Introduction to MEMS (Microelectromechanical Systems) 3 Units
Terms offered: Fall 2017, Fall 2015, Fall 2013
Fundamentals of microelectromechanical systems including design, fabrication of microstructures; surface-micromachining, bulk-micromachining, LIGA, and other micro machining processes; fabrication principles of integrated circuit device and their applications for making MEMS devices; high-aspect-ratio microstructures; scaling issues in the micro scale (heat transfer, fluid mechanics and solid mechanics); device design, analysis, and mask layout.

MEC ENG 120 Computational Biomechanics Across Multiple Scales 3 Units
Terms offered: Fall 2016, Spring 2015, Spring 2014
This course applies the methods of computational modeling and continuum mechanics to biomedical phenomena spanning various length scales ranging from molecular to cellular to tissue and organ levels. The course is intended for upper level undergraduate students who have been exposed to undergraduate continuum mechanics (statics and strength of materials.)

MEC ENG 122 Processing of Materials in Manufacturing 3 Units
Terms offered: Spring 2019, Spring 2018, Spring 2017
Fundamentals of manufacturing processes (metal forming, forging, metal cutting, welding, joining, and casting); selection of metals, plastics, and other materials relative to the design and choice of manufacturing processes; geometric dimensioning and tolerancing of all processes.

MEC ENG 119 Introduction to MEMS (Microelectromechanical Systems) 3 Units
Terms offered: Fall 2017, Fall 2015, Fall 2013
Fundamentals of microelectromechanical systems including design, fabrication of microstructures; surface-micromachining, bulk-micromachining, LIGA, and other micro machining processes; fabrication principles of integrated circuit device and their applications for making MEMS devices; high-aspect-ratio microstructures; scaling issues in the micro scale (heat transfer, fluid mechanics and solid mechanics); device design, analysis, and mask layout.

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Terms offered: Fall 2017, Fall 2015, Fall 2013
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MEC ENG 122 Processing of Materials in Manufacturing 3 Units
Terms offered: Spring 2019, Spring 2018, Spring 2017
Fundamentals of manufacturing processes (metal forming, forging, metal cutting, welding, joining, and casting); selection of metals, plastics, and other materials relative to the design and choice of manufacturing processes; geometric dimensioning and tolerancing of all processes.
MEC ENG 125 Industry-Associated Capstones in Mechanical Engineering (iACME) 4 Units

Terms offered: Spring 2018

iACME provide opportunities for Mechanical Engineering undergraduates to tackle real-world engineering problems. Student teams, consisting of no more than four students, will apply to work on specific industry-initiated projects. Teams will be selected based on prior experience in research/internships, scholastic achievements in ME courses, and most importantly, proposed initial approaches toward tackling the specific project. ME faculty, alumni of the Mechanical Engineering Department, and industry participants will mentor selected teams. Projects fall within a wide range of mechanical engineering disciplines, e.g. biomedical, automotive/transportation, energy, design, etc.

Industry-Associated Capstones in Mechanical Engineering (iACME):
Read More [+]

Objectives & Outcomes

Course Objectives: The purpose of this course is to:
• learn the fundamental concepts of approaching practical engineering problems;
• enhance skills in communication with clients and other engineers;
• enhance skills in design, prototyping, testing, and analysis.

Student Learning Outcomes: (a) an ability to apply knowledge of mathematics, science, and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(d) an ability to function on multi-disciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Rules & Requirements

Prerequisites: Senior standing and a minimum GPA of 3.0

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Alternate method of final assessment during regularly scheduled final exam group (e.g., presentation, final project, etc.).

Instructor: O'Connell, Sohn

Industry-Associated Capstones in Mechanical Engineering (iACME):
Read Less [-]

MEC ENG 130 Design of Planar Machinery 3 Units

Terms offered: Fall 2018, Fall 2017, Fall 2016

Synthesis, analysis, and design of planar machines. Kinematic structure, graphical, analytical, and numerical analysis and synthesis. Linkages, cams, reciprocating engines, gear trains, and flywheels.

Design of Planar Machinery: Read More [+]

Rules & Requirements

Prerequisites: 104

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of laboratory per week

Additional Details

Subject/Course Level: Mechanical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Youssefi

Design of Planar Machinery: Read Less [-]
MEC ENG 131 Vehicle Dynamics and Control
4 Units
Terms offered: Spring 2019, Spring 2018, Spring 2016
Physical understanding of automotive vehicle dynamics including simple lateral, longitudinal and ride quality models. An overview of active safety systems will be introduced including the basic concepts and terminology, the state-of-the-art development, and basic principles of systems such as ABS, traction control, dynamic stability control, and roll stability control. Passive, semi-active and active suspension systems will be analyzed. Concepts of autonomous vehicle technology including drive-by-wire and steer-by-wire systems, adaptive cruise control and lane keeping systems. Design of software control systems for an actual 1/10 scale race vehicle.

Objectives Outcomes

Course Objectives: At the end of the course the students should be able to:

a. Formulate simple but accurate dynamic models for automotive longitudinal, lateral and ride quality analysis.

b. Assess the stability of dynamic systems using differential equation theory, apply frequency-response methods to assess system response to external disturbances, sensor noise and parameter variations.

c. Have a basic understanding of modern automotive safety systems including ABS, traction control, dynamic stability control and roll control.

d. Follow the literature on these subjects and perform independent design, research and development work in this field.

e. Expected to design feedback control systems for an actual 1/010 scaled vehicle platform which will be distributed to every group of two students in the class.

Student Learning Outcomes: (a) an ability to apply knowledge of mathematics, science, and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(d) an ability to function on multi-disciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(g) an ability to communicate effectively
(i) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Rules & Requirements

Prerequisites: Math 53, 54, Physics 7A-7B

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Mechanical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Borrelli

Vehicle Dynamics and Control: Read More [+]

MEC ENG 132 Dynamic Systems and Feedback
3 Units
Terms offered: Summer 2019 10 Week Session, Spring 2019, Fall 2018

Objectives Outcomes

Rules & Requirements

Prerequisites: Math 53, 54, Physics 7A-7B

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of laboratory per week

Summer: 10 weeks - 4.5 hours of lecture and 1.5 hours of laboratory per week

Additional Details

Subject/Course Level: Mechanical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Borrelli

Dynamic Systems and Feedback: Read Less [-]

Vehicle Dynamics and Control: Read Less [-]
Mechanical Vibrations: 3 Units
Terms offered: Spring 2019, Fall 2016, Spring 2014
An introduction to the theory of mechanical vibrations including topics of harmonic motion, resonance, transient and random excitation, applications of Fourier analysis and convolution methods. Multidegree of freedom discrete systems including principal mode, principal coordinates and Rayleigh’s principle.

Objectives
Course Objectives: Introduce basic aspects of vibrational analysis, considering both single and multi-degree-of-freedom systems. Discuss the use of exact and approximate methods in the analysis of complex systems. Familiarize students with the use of MATLAB as directed toward vibration problems.

Student Learning Outcomes: (a) an ability to apply knowledge of mathematics, science, and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Upon completion of the course students shall be able to: Derive the equations of motion for vibratory systems. Linearize nonlinear systems so as to allow a linear vibrational analysis. Compute the natural frequency (or frequencies) of vibratory systems and determine the system’s modal response. Determine the overall response based upon the initial conditions and/or steady forcing input. Design a passive vibration absorber to ameliorate vibrations in a forced system.

Rules & Requirements
Prerequisites: 104

Feedback Control Systems: 4 Units
Terms offered: Spring 2019, Fall 2018, Spring 2018
Analysis and synthesis of linear feedback control systems in transform and time domains. Control system design by root locus, frequency response, and state space methods. Applications to electro-mechanical and mechatronics systems.

Rules & Requirements
Prerequisites: EE 16A and either ME 132 or EE 120

Design of Microprocessor-Based Mechanical Systems: 4 Units
Terms offered: Spring 2019, Spring 2018, Spring 2017
This course provides preparation for the conceptual design and prototyping of mechanical systems that use microprocessors to control machine activities, acquire and analyze data, and interact with operators. The architecture of microprocessors is related to problems in mechanical systems through study of systems, including electro-mechanical components, thermal components and a variety of instruments. Laboratory exercises lead through studies of different levels of software.

Rules & Requirements
Prerequisites: Engineering 7
MEC ENG 136 Introduction to Control of Unmanned Aerial Vehicles 3 Units

Terms offered: Fall 2018, Fall 2017, Fall 1998

This course introduces students to the control of unmanned aerial vehicles (UAVs). The course will cover modeling and dynamics of aerial vehicles, and common control strategies. Laboratory exercises allow students to apply knowledge on a real system, by programming a microcontroller to control a UAV.

Introduction to Control of Unmanned Aerial Vehicles: Read More [+]

Objectives Outcomes

Course Objectives: Introduce the students to analysis, modeling, and control of unmanned aerial vehicles. Lectures will cover:

- Principle forces acting on a UAV, including aerodynamics of propellers
- The kinematics and dynamics of rotations, and 3D modeling of vehicle dynamics
- Typical sensors, and their modeling
- Typical control strategies, and their pitfalls
- Programming a microcontroller

During the laboratory sessions, students will apply these skills to create a model-based controller for a UAV.

Student Learning Outcomes: (a) an ability to apply knowledge of mathematics, science, and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(g) an ability to communicate effectively
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Rules & Requirements

Prerequisites: Mechanical Engineering 132 (or equivalent, taken simultaneously). Recommended: Mechanical Engineering 104 (or equivalent)

Credit Restrictions: Student will not receive credit for this course if they have taken Mechanical Engineering 236U.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Mechanical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructor: Mueller

Introduction to Control of Unmanned Aerial Vehicles: Read Less [-]

MEC ENG 138 Introduction to Micro/Nano Mechanical Systems Laboratory 3 Units

Terms offered: Spring 2018, Spring 2015, Spring 2013

This hands-on laboratory course focuses on the mechanical engineering principles that underlie the design, fabrication, and operation of micro/nanoscale mechanical systems, including devices made by nanowire/nanotube syntheses; photolithography/soft lithography; and molding processes. Each laboratory will have different focuses for basic understanding of MEMS/NEMS systems from prototype constructions to experimental testings using mechanical, electrical, or optical techniques.

Introduction to Micro/Nano Mechanical Systems Laboratory: Read More [+]

Rules & Requirements

Prerequisites: EE 16A or 40, Physics 7B, ME 106, (ME119 or ME118 are highly recommended but not mandatory)

Credit Restrictions: Students will receive no credit for Mechanical Engineering 238 after taking Mechanical Engineering 138.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of lecture and 3 hours of laboratory per week

Additional Details

Subject/Course Level: Mechanical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam not required.

Introduction to Micro/Nano Mechanical Systems Laboratory: Read Less [-]

MEC ENG 140 Combustion Processes 3 Units

Terms offered: Fall 2018, Fall 2016, Fall 2015

Fundamentals of combustion, flame structure, flame speed, flammability, ignition, stirred reaction, kinetics and nonequilibrium processes, pollutant formation. Application to engines, energy production and fire safety.

Combustion Processes: Read More [+]

Rules & Requirements

Prerequisites: 40, 106, and 109 (106 and 109 may be taken concurrently)

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of laboratory per week

Additional Details

Subject/Course Level: Mechanical Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.

Instructors: Fernandez-Pello, Chen

Combustion Processes: Read Less [-]
MEC ENG 146 Energy Conversion Principles
3 Units
Terms offered: Fall 2018, Spring 2018, Fall 2016
This course covers the fundamental principles of energy conversion processes, followed by development of theoretical and computational tools that can be used to analyze energy conversion processes. The course also introduces the use of modern computational methods to model energy conversion performance characteristics of devices and systems. Performance features, sources of inefficiencies, and optimal design strategies are explored for a variety of applications, which may include conventional combustion based and Rankine power systems, energy systems for space applications, solar, wind, wave, thermoelectric, and geothermal energy systems.

Rules & Requirements
- Prerequisites: 40, 106, and 109 (106 and 109 may be taken concurrently)

Hours & Format
- Fall and/or spring: 15 weeks - 3-3 hours of lecture and 0-1 hours of discussion per week

Additional Details
- Subject/Course Level: Mechanical Engineering/Undergraduate
- Grading/Final exam status: Letter grade. Final exam required.
- Instructor: Carey

Energy Conversion Principles: Read Less [-]

MEC ENG 150A Solar-Powered Vehicles: Analysis, Design and Fabrication
3 Units
Terms offered: Summer 2015 10 Week Session, Summer 2014 10 Week Session, Spring 2014
This course addresses all aspects of design, analysis, construction and economics of solar-powered vehicles. It begins with an examination of the fundamentals of photovoltaic solar power generation, and the capabilities and limitations that exist when using this form of renewable energy. The efficiency of energy conversion and storage will be evaluated across an entire system, from the solar energy that is available to the mechanical power that is ultimately produced. The structural and dynamic stability, as well as the aerodynamics, of vehicles will be studied. Safety and economic concerns will also be considered. Students will work in teams to design, build and test a functioning single-person vehicle capable of street use.

Objectives Outcomes
- Course Objectives: This course provides a structured environment within which students can participate in a substantial engineering project from start to finish. It provides the opportunity for students to engage deeply in the analysis, design and construction of a functioning vehicle powered by a renewable source. Through participation in this course, students should strengthen their understanding of how their engineering education can be used to address the multidisciplinary problems with creativity, imagination, confidence and responsibility. Students will recognize the importance of effective communication in effectively addressing such problems.

- Student Learning Outcomes: This course will strengthen students’ abilities: to apply knowledge of mathematics, science, and engineering to real projects; to design a component or process that is part of a larger system; to function on multi-disciplinary teams; to identify, formulate, and solve engineering problems; to communicate effectively; to understand the impact of engineering solutions in a context beyond the classroom; to appreciate the importance of engaging in life-long learning and understanding contemporary issues; and to recognize and use the techniques, skills, and modern engineering tools necessary for successful project completion.

Rules & Requirements
- Prerequisites: Math 54, Physics 7A; Upper division status in engineering

Hours & Format
- Fall and/or spring: 15 weeks - 2 hours of lecture and 3 hours of laboratory per week
- Summer: 10 weeks - 3 hours of lecture and 4.5 hours of laboratory per week

Additional Details
- Subject/Course Level: Mechanical Engineering/Undergraduate
- Grading/Final exam status: Letter grade. Alternative to final exam.

Solar-Powered Vehicles: Analysis, Design and Fabrication: Read Less [-]
MEC ENG 151 Advanced Heat Transfer 3 Units
Terms offered: Spring 2017, Spring 2014, Spring 2008
Basic principles of heat transfer and their application. Subject areas include steady-state and transient system analyses for conduction, free and forced convection, boiling, condensation and thermal radiation.

Rules & Requirements
Prerequisites: 40, 106, and 109 (106 and 109 may be taken concurrently)

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.

MEC ENG 151A Conductive and Radiative Transport 3 Units
Terms offered: Fall 2018

Course Objectives: The course will provide students with knowledge of the physics of conductive transport in solids, the analysis of steady and transient heat conduction by both analytical and numerical methods and the treatment of phase change problems. Furthermore, the course will provide students with knowledge of radiative properties, the mechanisms of radiative transfer and will present theory and methods of solution of radiative transfer problems in participating and nonparticipating media.

Student Learning Outcomes: Students will gain knowledge of the mechanisms of conductive transfer and will develop the ability to quantify steady and transient temperature in important engineering problems often encountered (e.g. manufacturing, materials processing, bio-thermal treatment and electronics cooling) by applying analytical methods and by constructing numerical algorithms. Students will also gain knowledge of the fundamental radiative properties and the mechanisms of radiative transport in enclosures, absorbing, emitting and scattering media as well as the interaction of thermal radiation with other modes of heat transfer.

Rules & Requirements
Prerequisites: Undergraduate courses in engineering thermodynamics, fluid dynamics and heat transfer (Mechanical Engineering 40, Mechanical Engineering 106 and Mechanical Engineering 109 or equivalent). Each student must have access to a PC, Macintosh or workstation machine with scientific programming capabilities for use in homework and projects.

Credit Restrictions: Students who have taken ME 151 or ME 250A will not receive credit.

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Alternative to final exam.
Instructor: Grigoropoulos

Conductive and Radiative Transport: Read Less [-]
MEC ENG 151B Convective Transport and Computational Methods 3 Units
Terms offered: Spring 2019
The transport of heat and mass in fluids in motion; free and forced convection in laminar and turbulent flow over surfaces and within ducts. Fundamentals of computational methods used for solving the governing transport equations will also be covered.
Convective Transport and Computational Methods: Read More [+]

Objectives Outcomes

Course Objectives: This course will provide students with knowledge of the physics of convective transport and an introduction to computational tools that can model convective processes in important applications such as electronics cooling, aerospace thermal management. The course also teaches students to construct computational models of natural and forced convection processes in boundary layers near surfaces, in enclosures and in ducts or pipes that can be used to design heat exchangers and thermal management equipment for applications.

Student Learning Outcomes:
(a) an ability to apply knowledge of mathematics, science, and engineering
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(d) an ability to function on multi-disciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(g) an ability to communicate effectively
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Students will gain a knowledge of the mechanisms of convective heat and mass transfer for flow over surfaces and within ducts, and will develop the ability to construct computer programs that implement computation methods that predict the flow and temperature fields and heat transfer performance for convective flows of interest in engineering applications.

Rules & Requirements

Prerequisites: Undergraduate courses in engineering thermodynamics, fluid dynamics and heat transfer (Mechanical Engineering 40, Mechanical Engineering 106 and Mechanical Engineering 109 or equivalent). Each student must have access to a PC, Macintosh or workstation machine with scientific programming capabilities for use in homework and projects

Credit Restrictions: Students should not receive credit for this course if they have taken ME 252 or ME 250B.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Alternative to final exam.
Instructor: Carey

Convective Transport and Computational Methods: Read Less [-]

MEC ENG 154 Thermophysics for Applications 3 Units
Terms offered: Spring 2019
Development of classical thermodynamics from statistical treatment of microscale molecular behavior; Boltzmann distribution; partition functions; statistical-mechanical evaluation of thermodynamic properties; equilibrium; chemical equilibrium; phase transitions; molecular collisions; Maxwell-Boltzmann distribution; collision theory; elementary kinetic theory; molecular dynamics simulation of molecular collisions; kinetic Monte Carlo simulations of gas-phase and gas-surface reactions. Implications are explored for a variety of applications, which may include advanced combustion systems, renewable power systems, microscale transport in high heat flux electronics cooling, aerospace thermal management, and advanced materials processing.
Thermophysics for Applications: Read More [+]

Objectives Outcomes

Course Objectives: To introduce students to the statistical foundation of thermodynamics and provide skills to perform advanced calculations for analysis of advanced energy conversion processes and devices.

Student Learning Outcomes:
(a) a knowledge of contemporary issues
(b) an ability to apply knowledge of mathematics, science, and engineering
(c) an ability to communicate effectively
(e) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(g) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Students will gain a knowledge of the mechanisms of convective heat and mass transfer for flow over surfaces and within ducts, and will develop the ability to construct computer programs that implement computation methods that predict the flow and temperature fields and heat transfer performance for convective flows of interest in engineering applications.

Rules & Requirements

Prerequisites: Mechanical Engineering 40

Credit Restrictions: Student will not receive credit for this course if they have taken ME 254.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructors: Frenklach, Carey

Thermophysics for Applications: Read Less [-]
MEC ENG 160 Ocean Engineering Seminar 2
Units
Terms offered: Spring 2019
Lectures on new developments in ocean, offshore, and arctic engineering.
Ocean Engineering Seminar: Read More [+]
Objectives Outcomes
Course Objectives: To provide exposure of the field of ocean engineering, arctic engineering and related subject areas to students with the intention to show the broad and interdisciplinary nature of this field, particularly recent or new developments.
Student Learning Outcomes: (f) an understanding of professional and ethical responsibility (h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context (i) a recognition of the need for, and an ability to engage in life-long learning (j) a knowledge of contemporary issues Students will learn of new developments in ocean, offshore, and arctic engineering, connecting much of what is learned in other courses to practical applications and active research topics.
Rules & Requirements
Repeat rules: Course may be repeated for credit with instructor consent.
Hours & Format
Fall and/or spring: 15 weeks - 2 hours of seminar per week
Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Offered for pass/not pass grade only. Alternative to final exam.
Instructors: Makiharju, Alam
Ocean Engineering Seminar: Read Less [-]

MEC ENG 163 Engineering Aerodynamics 3
Units
Terms offered: Fall 2018, Fall 2016, Fall 2014
Introduction to the lift, drag, and moment of two-dimensional airfoils, three-dimensional wings, and the complete airplane. Calculations of the performance and stability of airplanes in subsonic flight.
Engineering Aerodynamics: Read More [+]
Rules & Requirements
Prerequisites: 106
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week
Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Savas
Engineering Aerodynamics: Read Less [-]

MEC ENG 164 Marine Statics and Structures 3 Units
Terms offered: Fall 2012, Fall 2011, Fall 2009
Terminology and definition of hull forms, conditions of static equilibrium and stability of floating submerged bodies. Effects of damage on stability. Structural loads and response. Box girder theory. Isotropic and orthotropic plate bending and bucking.
Marine Statics and Structures: Read More [+]
Rules & Requirements
Prerequisites: Civil and Environmental Engineering 130 or 130N or consent of instructor
Credit Restrictions: Students will receive no credit for 164 after taking C164/Ocean Engineering C164; 2 units after taking 151.
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week
Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Mansour
Formerly known as: C164
Marine Statics and Structures: Read Less [-]
MEC ENG 165 Ocean-Environment Mechanics 3 Units
Terms offered: Spring 2018, Spring 2017, Fall 2015
Ocean-Environment Mechanics: Read More [+]
Rules & Requirements
Prerequisites: 106 or Civil and Environmental Engineering 100
Credit Restrictions: Students will receive no credit for 165 after taking C165/Ocean Engineering C165.
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week
Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Yeung
Formerly known as: C165
Ocean-Environment Mechanics: Read Less [-]

MEC ENG 167 Microscale Fluid Mechanics 3 Units
Terms offered: Spring 2019, Spring 2018, Spring 2016
Phenomena of physical, technological, and biological significance in flows of gases and liquids at the microscale. The course begins with familiar equations of Newtonian fluid mechanics, then proceeds to the study of essentially 1-D flows in confined geometries with the lubrication equations. Next is a study of the flow of thin films spreading under gravity or surface tension gradients. Lubrication theory of compressible gases leads to consideration of air bearings. Two- and 3-D flows are treated with Stokes' equations. Less familiar physical phenomena of significance and utility at the microscale are then considered: intermolecular forces in liquids, slip, diffusion and bubbles as active agents. A review of relevant aspects of electricity and magnetism precedes a study of electrowetting and electrokinetically driven liquid flows.
Microscale Fluid Mechanics: Read More [+]
Rules & Requirements
Prerequisites: 40, 106, 109, (106 and 109 may be taken concurrently) Physics 7B or equivalent
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week
Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructors: Morris, Szeri
Microscale Fluid Mechanics: Read Less [-]
MEC ENG 168 Mechanics of Offshore Systems 3 Units
Terms offered: Spring 2019, Fall 2017, Fall 2015
This course covers major aspects of offshore engineering including ocean environment, loads on offshore structures, cables and mooring, underwater acoustics and arctic operations.
Mechanics of Offshore Systems: Read More [+]
Objectives Outcomes
Course Objectives: To provide a basic to intermediate level of treatment of engineering systems that operate in coastal, offshore, and arctic environment. Students will acquire an understanding of the unique and essential character of the marine fields and the analysis tools to handle the engineering aspects of them.
Student Learning Outcomes: (a) an ability to apply knowledge of mathematics, science, and engineering (c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability (d) an ability to function on multi-disciplinary teams (e) an ability to identify, formulate, and solve engineering problems (j) a knowledge of contemporary issues (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
Rules & Requirements
Prerequisites: Mechanical Engineering 106 and Mechanical Engineering C85 (or Civil Engineering C30). Mechanical Engineering 165 is recommended
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week
Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Alam
MEC ENG 170 Engineering Mechanics III 3 Units
Terms offered: Spring 2019, Spring 2018, Spring 2017
This course builds upon material learned in 104, examining the dynamics of particles and rigid bodies moving in three dimensions. Topics include non-fixed axis rotations of rigid bodies, Euler angles and parameters, kinematics of rigid bodies, and the Newton-Euler equations of motion for rigid bodies. The course material will be illustrated with real-world examples such as gyroscopes, spinning tops, vehicles, and satellites. Applications of the material range from vehicle navigation to celestial mechanics, numerical simulations, and animations.
Engineering Mechanics III: Read More [+]
Rules & Requirements
Prerequisites: 104 or consent of instructor
Hours & Format
Fall and/or spring: 15 weeks - 3-3 hours of lecture and 0-1 hours of discussion per week
Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructors: O'Reilly, Casey
Engineering Mechanics III: Read Less [-]
MEC ENG 173 Fundamentals of Acoustics 3 Units
Terms offered: Spring 2019, Spring 2017, Spring 2013
Fundamentals of Acoustics: Read More [+]
Rules & Requirements
Prerequisites: 104
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week
Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Johnson
Fundamentals of Acoustics: Read Less [-]
MEC ENG 175 Intermediate Dynamics 3 Units
Terms offered: Fall 2018, Fall 2017, Fall 2016
This course introduces and investigates Lagrange's equations of motion for particles and rigid bodies. The subject matter is particularly relevant to applications comprised of interconnected and constrained discrete mechanical components. The material is illustrated with numerous examples. These range from one-dimensional motion of a single particle to three-dimensional motions of rigid bodies and systems of rigid bodies.

Rules & Requirements
Prerequisites: 104 or equivalent

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Intermediate Dynamics: Read Less [-]

MEC ENG C176 Orthopedic Biomechanics 4 Units
Terms offered: Spring 2019, Fall 2017, Fall 2016
Statics, dynamics, optimization theory, composite beam theory, beam-on-elastic foundation theory, Hertz contact theory, and materials behavior. Forces and moments acting on human joints; composition and mechanical behavior of orthopedic biomaterials; design/analysis of artificial joint, spine, and fracture fixation prostheses; musculoskeletal tissues including bone, cartilage, tendon, ligament, and muscle; osteoporosis and fracture-risk predication of bones; and bone adaptation. MATLAB-based project to integrate the course material.

Orthopedic Biomechanics: Read More [+]

Rules & Requirements
Prerequisites: Mechanical Engineering C85, Civil Engineering C30, or Bioengineering 102, or equivalent; concurrent enrollment OK. Proficiency in MatLab or equivalent. Prior knowledge of biology or anatomy is not assumed

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of laboratory per week

Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Keaveny
Also listed as: BIO ENG C119
Orthopedic Biomechanics: Read Less [-]

MEC ENG C178 Designing for the Human Body 4 Units
Terms offered: Fall 2018, Fall 2017
The course provides project-based learning experience in understanding product design, with a focus on the human body as a mechanical machine. Students will learn the design of external devices used to aid or protect the body. Topics will include forces acting on internal materials (e.g., muscles and total replacement devices), forces acting on external materials (e.g., protheses and crash pads), design/analysis of devices aimed to improve or fix the human body, muscle adaptation, and soft tissue injury. Weekly laboratory projects will incorporate EMG sensing, force plate analysis, and interpretation of data collection (e.g., MATLAB analysis) to integrate course material to better understand contemporary design/analysis/problems.

Designing for the Human Body: Read More [+]

Objectives Outcomes
Course Objectives: The purpose of this course is twofold:
• to learn the fundamental concepts of designing devices to interact with the human body;
• to enhance skills in mechanical engineering and bioengineering by analyzing the behavior of various complex biomedical problems;
• To explore the transition of a device or discovery as it goes from “benchtop to bedside”.

Student Learning Outcomes: RELATIONSHIP OF THE COURSE TO ABET PROGRAM OUTCOMES
(a) an ability to apply knowledge of mathematics, science, and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(d) an ability to function on multi-disciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(f) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Working knowledge of design considerations for creating a device to protect or aid the human body, force transfer and distribution, data analysis, and FDA approval process for new devices. Understanding of basic concepts in orthopaedic biomechanics and the ability to apply the appropriate engineering concepts to solve realistic biomechanical problems, knowing clearly the assumptions involved. Critical analysis of current literature and technology.

Rules & Requirements
Prerequisites: Proficiency in MatLab or equivalent. Prior knowledge of biology or anatomy is not assumed. Physics 7A, Math 1A and 1B

Credit Restrictions: There will be no credit given for MEC ENG C178 / BIO ENG C137 after taking MEC ENG 178.<BR/><BR/>

Hours & Format
Fall and/or spring: 15 weeks - 1-3 hours of lecture per week

Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
MEC ENG C180 Engineering Analysis Using the Finite Element Method 3 Units
Terms offered: Spring 2019, Spring 2018, Spring 2017
This is an introductory course on the finite element method and is intended for seniors in engineering and applied science disciplines. The course covers the basic topics of finite element technology, including domain discretization, polynomial interpolation, application of boundary conditions, assembly of global arrays, and solution of the resulting algebraic systems. Finite element formulations for several important field equations are introduced using both direct and integral approaches. Particular emphasis is placed on computer simulation and analysis of realistic engineering problems from solid and fluid mechanics, heat transfer, and electromagnetism. The course uses FEMLAB, a multiphysics MATLAB-based finite element program that possesses a wide array of modeling capabilities and is ideally suited for instruction. Assignments will involve both paper- and computer-based exercises. Computer-based assignments will emphasize the practical aspects of finite element model construction and analysis.

Engineering Analysis Using the Finite Element Method: Read More [+]

Rules & Requirements
Prerequisites: Engineering 7 or 77 or Computer Science 61A; Mathematics 53 and 54; senior status in engineering or applied science

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 2 hours of laboratory per week

Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Also listed as: CIV ENG C133

Engineering Analysis Using the Finite Element Method: Read Less [-]

MEC ENG 185 Introduction to Continuum Mechanics 3 Units
Terms offered: Fall 2018, Fall 2017, Fall 2016
This course is a general introduction to the fundamental concepts of the mechanics of continuous media. Topics covered include the kinematics of deformation, the concept of stress, and the conservation laws for mass, momentum and energy. This is followed by an introduction to constitutive theory with applications to well-established models for viscous fluids and elastic solids. The concepts are illustrated through the solution of tractable initial-boundary-value problems. This course presents foundation-level coverage of theory underlying a number of sub-fields, including Fluid Mechanics, Solid Mechanics and Heat Transfer.

Introduction to Continuum Mechanics: Read More [+]

Objectives Outcomes
Course Objectives: Students will gain a deep understanding of the concepts and methods underlying modern continuum mechanics. The course is designed to equip students with the background needed to pursue advanced work in allied fields.

Student Learning Outcomes: ABET Outcomes:
(a) an ability to apply knowledge of mathematics, science, and engineering,
(e) an ability to identify, formulate, and solve engineering problems,
(g) an ability to communicate effectively,
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context,
(i) a recognition of the need for, and an ability to engage in life-long learning,
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Rules & Requirements
Prerequisites: Physics 7A, Math 53 and Math 54, as well as some prior exposure to the elementary mechanics of solids and fluids

Credit Restrictions: Students will not receive credit if they have taken ME 287.

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture and 1 hour of discussion per week

Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructors: Casey, Johnson, Papadopoulos, Steigmann

Introduction to Continuum Mechanics: Read Less [-]
MEC ENG 190L Practical Control System Design: A Systematic Loopshaping Approach 1 Unit
Terms offered: Spring 2019, Spring 2018, Fall 2015
After a review of basic loopshaping, we introduce the loopshaping design methodology of McFarlane and Glover, and learn how to use it effectively. The remainder of the course studies the mathematics underlying the new method (one of the most prevalent advanced techniques used in industry) justifying its validity.
Practical Control System Design: A Systematic Loopshaping Approach: Read More [+]
Rules & Requirements
Prerequisites: 132 or Electrical Engineering 128 (EE 20 may suffice) or similar introductory experience regarding feedback control systems
Hours & Format
Fall and/or spring: 15 weeks - 1 hour of lecture per week
Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Packard
Practical Control System Design: A Systematic Loopshaping Approach: Read Less [-]

MEC ENG 190M Model Predictive Control 1 Unit
Terms offered: Spring 2015, Fall 2009
Basics on optimization and polyhedra manipulation. Analysis and design of constrained predictive controllers for linear and nonlinear systems.
Model Predictive Control: Read More [+]
Rules & Requirements
Prerequisites: 132
Hours & Format
Fall and/or spring: 15 weeks - 1 hour of lecture per week
Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam not required.
Instructor: Borrelli
Model Predictive Control: Read Less [-]

MEC ENG 190Y Practical Control System Design: A Systematic Optimization Approach 1 Unit
Terms offered: Spring 2013, Spring 2010, Spring 2009
The Youla-parametrization of all stabilizing controllers allows certain time-domain and frequency-domain closed-loop design objectives to be cast as convex optimizations, and solved reliably using off-the-shelf numerical optimization codes. This course covers the Youla parametrization, basic elements of convex optimization, and finally control design using these techniques.
Practical Control System Design: A Systematic Optimization Approach: Read More [+]
Rules & Requirements
Prerequisites: 132 or Electrical Engineering 128 (EE 20 may suffice) or similar introductory experience regarding feedback control systems
Hours & Format
Fall and/or spring: 15 weeks - 1 hour of lecture per week
Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Packard
Practical Control System Design: A Systematic Optimization Approach: Read Less [-]

MEC ENG 191K Professional Communication 3 Units
Terms offered: Summer 2019 First 6 Week Session, Summer 2019 Second 6 Week Session, Spring 2019
This course is designed to enhance students' written and oral communication skills. Written work consists of informal documents--correspondence, internal reports, and reviews--and formal work--proposals, conference papers, journal articles, and websites. Presentations consist of informal and formal reports, including job and media interviews, phone interviews, conference calls, video conferences, progress reports, sales pitches, and feasibility studies.
Professional Communication: Read More [+]
Rules & Requirements
Prerequisites: English R1A-R1B or equivalent
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week
Summer:
6 weeks - 8 hours of lecture per week
8 weeks - 5.5 hours of lecture per week
Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Alternative to final exam.
Professional Communication: Read Less [-]
MEC ENG 193A Special Topics in Biomechanical Engineering 1 - 4 Units
Terms offered: Spring 2017
This 193 series covers current topics of research interest in biomechanical engineering. The course content may vary semester to semester. Check with the department for current term topics.
Special Topics in Biomechanical Engineering: Read More [+]
Objectives Outcomes
Course Objectives: Course objectives will vary.
Student Learning Outcomes: Student outcomes will vary.
Rules & Requirements
Repeat rules: Course may be repeated for credit when topic changes.
Hours & Format
Fall and/or spring:
6 weeks - 2.5-10 hours of lecture per week
8 weeks - 2-7.5 hours of lecture per week
10 weeks - 1.5-6 hours of lecture per week
15 weeks - 1-4 hours of lecture per week
Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Faculty
Special Topics in Biomechanical Engineering: Read Less [-]

MEC ENG 193B Special Topics in Controls 1 - 4 Units
Terms offered: Fall 2018
This 193 series covers current topics of research interest in controls. The course content may vary semester to semester. Check with the department for current term topics.
Special Topics in Controls: Read More [+]
Objectives Outcomes
Course Objectives: Will vary with course.
Student Learning Outcomes: Will vary with course.
Rules & Requirements
Repeat rules: Course may be repeated for credit when topic changes.
Hours & Format
Fall and/or spring:
6 weeks - 2.5-10 hours of lecture per week
8 weeks - 2-7.5 hours of lecture per week
10 weeks - 1.5-6 hours of lecture per week
15 weeks - 1-4 hours of lecture per week
Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Special Topics in Controls: Read Less [-]
MEC ENG 193C Special Topics in Design 1 - 4 Units
Terms offered: Fall 2018, Fall 2016
This 193 series covers current topics of research interest in design. The course content may vary semester to semester. Check with the department for current term topics.
Special Topics in Design: Read More [+]
Objectives Outcomes
Course Objectives: Will vary with course.
Student Learning Outcomes: Will vary with course.
Rules & Requirements
Repeat rules: Course may be repeated for credit when topic changes.
Hours & Format
Fall and/or spring:
6 weeks - 2.5-10 hours of lecture per week
8 weeks - 2-7.5 hours of lecture per week
10 weeks - 1.5-6 hours of lecture per week
15 weeks - 1-4 hours of lecture per week
Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Faculty
Special Topics in Design: Read Less [-]

MEC ENG 193D Special Topics in Dynamics 1 - 4 Units
Terms offered: Prior to 2007
This 193 series covers current topics of research interest in dynamics. The course content may vary semester to semester. Check with the department for current term topics.
Special Topics in Dynamics: Read More [+]
Objectives Outcomes
Course Objectives: Will vary with course.
Student Learning Outcomes: Will vary with course.
Rules & Requirements
Repeat rules: Course may be repeated for credit when topic changes.
Hours & Format
Fall and/or spring:
6 weeks - 2.5-10 hours of lecture per week
8 weeks - 2-7.5 hours of lecture per week
10 weeks - 1.5-6 hours of lecture per week
15 weeks - 1-4 hours of lecture per week
Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Faculty
Special Topics in Dynamics: Read Less [-]
MEC ENG 193E Special Topics in Energy Science and Technology 1 - 4 Units
Terms offered: Spring 2019, Spring 2018, Spring 2017
This 193 series covers current topics of research interest in energy science and technology. The course content may vary semester to semester. Check with the department for current term topics.
Objectives Outcomes
Course Objectives: Will vary with course.
Student Learning Outcomes: Will vary with course.
Rules & Requirements
Repeat rules: Course may be repeated for credit when topic changes.
Hours & Format
Fall and/or spring:
6 weeks - 2.5-10 hours of lecture per week
8 weeks - 2-7.5 hours of lecture per week
10 weeks - 1.5-6 hours of lecture per week
15 weeks - 1-4 hours of lecture per week
Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Faculty

MEC ENG 193F Special Topics in Fluids 1 - 4 Units
Terms offered: Prior to 2007
This 193 series covers current topics of research interest in fluids. The course content may vary semester to semester. Check with the department for current term topics.
Objectives Outcomes
Course Objectives: Will vary with course.
Student Learning Outcomes: Will vary with course.
Rules & Requirements
Repeat rules: Course may be repeated for credit when topic changes.
Hours & Format
Fall and/or spring:
6 weeks - 2.5-10 hours of lecture per week
8 weeks - 2-7.5 hours of lecture per week
10 weeks - 1.5-6 hours of lecture per week
15 weeks - 1-4 hours of lecture per week
Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Faculty
MEC ENG 193G Special Topics in Manufacturing 1 - 4 Units
Terms offered: Prior to 2007
This 193 series covers current topics of research interest in manufacturing. The course content may vary semester to semester. Check with the department for current term topics.

Objectives Outcomes
Course Objectives: Will vary by course.
Student Learning Outcomes: Will vary by course.

Rules & Requirements
Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format
Fall and/or spring:
6 weeks - 2.5-10 hours of lecture per week
8 weeks - 2-7.5 hours of lecture per week
10 weeks - 1.5-6 hours of lecture per week
15 weeks - 1-4 hours of lecture per week

Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Faculty

Special Topics in Manufacturing: Read Less [-]

MEC ENG 193H Special Topics in Materials 1 - 4 Units
Terms offered: Prior to 2007
This 193 series covers current topics of research interest in materials. The course content may vary semester to semester. Check with the department for current term topics.

Objectives Outcomes
Course Objectives: Will vary with course.
Student Learning Outcomes: Will vary with course.

Rules & Requirements
Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format
Fall and/or spring:
6 weeks - 2.5-10 hours of lecture per week
8 weeks - 2-7.5 hours of lecture per week
10 weeks - 1.5-6 hours of lecture per week
15 weeks - 1-4 hours of lecture per week

Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Faculty

Special Topics in Materials: Read Less [-]
MEC ENG 193I Special Topics in Mechanics 1
- 4 Units
Terms offered: Prior to 2007
This 193 series covers current topics of research interest in mechanics. The course content may vary semester to semester. Check with the department for current term topics.
Special Topics in Mechanics: Read More [+]
Objectives Outcomes
Course Objectives: Will vary with course.
Student Learning Outcomes: Will vary with course.
Rules & Requirements
Repeat rules: Course may be repeated for credit when topic changes.
Hours & Format
Fall and/or spring:
6 weeks - 2.5-10 hours of lecture per week
8 weeks - 2-7.5 hours of lecture per week
10 weeks - 1.5-6 hours of lecture per week
15 weeks - 1-4 hours of lecture per week
Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Faculty
Special Topics in Mechanics: Read Less [-]

MEC ENG 193J Special Topics in MEMS/Nano
1 - 4 Units
Terms offered: Prior to 2007
This 193 series covers current topics of research interest in MEMS/nano. The course content may vary semester to semester. Check with the department for current term topics.
Special Topics in MEMS/Nano: Read More [+]
Objectives Outcomes
Course Objectives: Will vary with course.
Student Learning Outcomes: Will vary with course.
Rules & Requirements
Repeat rules: Course may be repeated for credit when topic changes.
Hours & Format
Fall and/or spring:
6 weeks - 2.5-10 hours of lecture per week
8 weeks - 2-7.5 hours of lecture per week
10 weeks - 1.5-6 hours of lecture per week
15 weeks - 1-4 hours of lecture per week
Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Faculty
Special Topics in MEMS/Nano: Read Less [-]
MEC ENG 193K Special Topics in Ocean Engineering 1 - 4 Units
Terms offered: Prior to 2007
This 193 series covers current topics of research interest in ocean engineering. The course content may vary semester to semester. Check with the department for current term topics.
Special Topics in Ocean Engineering: Read More [+]

Objectives Outcomes
Course Objectives: Will vary by course.
Student Learning Outcomes: Will vary by course.

Rules & Requirements
Repeat rules: Course may be repeated for credit when topic changes.

Hours & Format
Fall and/or spring:
6 weeks - 2.5-10 hours of lecture per week
8 weeks - 2-7.5 hours of lecture per week
10 weeks - 1.5-6 hours of lecture per week
15 weeks - 1-4 hours of lecture per week

Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructor: Faculty

MEC ENG H194 Honors Undergraduate Research 2 - 4 Units
Terms offered: Fall 2018, Spring 2016, Spring 2015
Final report required. Students who have completed a satisfactory number of advanced courses may pursue original research under the direction of one of the members of the faculty. A maximum of three units of H194 may be used to fulfill technical elective requirements in the Mechanical Engineering program (unlike 198 or 199, which do not satisfy technical elective requirements). Students can use a maximum of three units of graded research units (H194 or 196) towards their technical elective requirement.
Honors Undergraduate Research: Read More [+]

Rules & Requirements
Prerequisites: 3.3 cumulative GPA or higher, consent of instructor and adviser, and senior standing
Repeat rules: Course may be repeated for credit without restriction.

Hours & Format
Fall and/or spring: 15 weeks - 2-4 hours of independent study per week
Summer:
6 weeks - 1-5 hours of independent study per week
8 weeks - 4-8 hours of independent study per week

Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam not required.
Honors Undergraduate Research: Read Less [-]
MEC ENG 196 Undergraduate Research 2 - 4 Units
Terms offered: Spring 2016, Fall 2015, Spring 2015
Students who have completed a satisfactory number of advanced courses may pursue original research under the direction of one of the members of the staff. A maximum of three units of 196 may be used to fulfill technical elective requirements in the Mechanical Engineering program (unlike 198 or 199, which do not satisfy technical elective requirements). Students can use a maximum of three units of graded research units (H194 or 196) towards their technical elective requirement. Final report required.

Rules & Requirements
Prerequisites: Consent of instructor and adviser; junior or senior standing
Repeat rules: Course may be repeated for credit without restriction.

Hours & Format
Fall and/or spring: 15 weeks - 2-4 hours of independent study per week
Summer: 6 weeks - 5-10 hours of independent study per week
8 weeks - 4-8 hours of independent study per week

Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Undergraduate Research: Read Less [-]

MEC ENG 197 Undergraduate Engineering Field Studies 1 - 4 Units
Terms offered: Fall 2015, Summer 2015 10 Week Session
Supervised experience relative to specific aspects of practice in engineering. Under guidance of a faculty member, the student will work in industry, primarily in an internship setting or another type of short-time status. Emphasis is to attain practical experience in the field.

Objectives Outcomes
Student Learning Outcomes:

(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

(j) a knowledge of contemporary issues

(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Rules & Requirements
Repeat rules: Course may be repeated for credit without restriction.

Hours & Format
Fall and/or spring: 15 weeks - 3-12 hours of internship per week
Summer: 6 weeks - 8-30 hours of internship per week
10 weeks - 5-18 hours of internship per week

Additional Details
Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.
Undergraduate Engineering Field Studies: Read Less [-]
MEC ENG 198 Directed Group Studies for Advanced Undergraduates 1 - 4 Units
Terms offered: Spring 2019, Spring 2018, Fall 2017
Group study of a selected topic or topics in Mechanical Engineering. Credit for 198 or 199 courses combined may not exceed 4 units in any single term. See College for other restrictions.

Rules & Requirements

Prerequisites: Upper division standing and good academic standing
Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 1-4 hours of directed group study per week
Summer: 10 weeks - 1.5-6 hours of directed group study per week

Additional Details

Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.

MEC ENG 199 Supervised Independent Study 1 - 4 Units
Terms offered: Spring 2018, Spring 2017, Summer 2016 8 Week Session Supervised independent study. Enrollment restrictions apply; see the introduction to Courses and Curricula section of this catalog.

Rules & Requirements

Prerequisites: Consent of instructor and major adviser
Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 1-4 hours of independent study per week
Summer: 6 weeks - 1-5 hours of independent study per week
8 weeks - 1-4 hours of independent study per week

Additional Details

Subject/Course Level: Mechanical Engineering/Undergraduate
Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.