Engineering Mathematics and Statistics

Bachelor of Science (BS)

The Engineering Mathematics and Statistics major offered through the Engineering Science Program offers students an opportunity to study pure and applied mathematics as essential components of modern engineering. By combining courses in pure mathematics, applied mathematics, statistics, the physical sciences, and engineering, a student may individualize a program of study, of theory, or of applications of both. It provides a broad foundation for graduate studies in theoretical branches of engineering, as well as in mathematics, and can prepare students for a career in specific sectors of industry or business.

Admission to the Major

Prospective undergraduates to the College of Engineering will apply for admission to a specific program in the college. For further information, please see the College of Engineering's website (http://coe.berkeley.edu/students/prospective-students/admissions.html).

Admission to Engineering Science degree programs via a Change of College application for current UC Berkeley students is competitive as there are few — if any — spaces available in this major for students admitted to other colleges at UC Berkeley. For further information regarding a Change of College to Engineering, please see the College's website (http://coe.berkeley.edu/students/current-undergraduates/change-of-college).

Minor Program

There is no minor program in Engineering Mathematics and Statistics.

Other Majors offered by the Engineering Science Program

Energy Engineering (http://guide.berkeley.edu/undergraduate/degree-programs/energy-engineering) (Major and Minor)
Engineering Physics (http://guide.berkeley.edu/undergraduate/degree-programs/engineering-physics) (Major)
Environmental Engineering Science (http://guide.berkeley.edu/undergraduate/degree-programs/environmental-engineering-science) (Major)

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 Major Requirements

- **MATH 1A** Calculus \[4\]
- **MATH 1B** Calculus \[4\]
- **MATH 53** Multivariable Calculus \[4\]
- **MATH 54** Linear Algebra and Differential Equations \[4\]
- **CHEM 4A** General Chemistry and Quantitative Analysis \[4\]
- **PHYSICS 7A** Physics for Scientists and Engineers \[4\]
- **PHYSICS 7B** Physics for Scientists and Engineers \[4\]
- **PHYSICS 7C** Physics for Scientists and Engineers \[4\]
- **ENGIN 7** Introduction to Computer Programming for Scientists and Engineers \[4\]
- or **COMPSCI 61A** The Structure and Interpretation of Computer Programs \[4\]

Select two from the following:

- **COMPSCI C8** Foundations of Data Science \[4\]
- **COMPSCI 61A** The Structure and Interpretation of Computer Programs \[4\]
- **COMPSCI 61B** Data Structures \[4\]
- **COMPSCI 61B** Data Structures and Programming Methodology \[4\]
- **COMPSCI 61C** Great Ideas of Computer Architecture (Machine Structures) \[4\]
- **COMPSCI 61C** Machine Structures (Lab-Centric) \[4\]
- **COMPSCI 70** Discrete Mathematics and Probability Theory \[4\]
- **ENGIN 7** Introduction to Computer Programming for Scientists and Engineers \[4\]
- **ENGIN 25 & ENGIN 26** Visualization for Design and Three-Dimensional Modeling for Design
- or **ENGIN 27** Introduction to Manufacturing and Tolerancing \[Two of E25, 26, 27 count as one course for this requirement.\]
- **MAT SCI 45 & 45L** Properties of Materials and Properties of Materials Laboratory
- **MATH 55** Discrete Mathematics \[4\]
- **MEC** Introduction to Solid Mechanics \[3\]

1. CHEM 4A is intended for students majoring in chemistry or a closely-related field.
2. Other courses may be used if approved by a faculty adviser.
This course may only be used as a lower division technical elective if not being used to satisfy other requirements above.

**Upper Division Requirements**

Due to the interdisciplinary nature of this major, electives must be selected and approved in consultation with a faculty adviser.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 110</td>
<td>Linear Algebra</td>
<td>4</td>
</tr>
<tr>
<td>MATH 104</td>
<td>Introduction to Analysis</td>
<td>4</td>
</tr>
<tr>
<td>MATH 105</td>
<td>Second Course in Analysis</td>
<td>4</td>
</tr>
<tr>
<td>MATH 185</td>
<td>Introduction to Complex Analysis</td>
<td></td>
</tr>
<tr>
<td>MATH 128A</td>
<td>Numerical Analysis</td>
<td>4</td>
</tr>
<tr>
<td>STAT 134</td>
<td>Concepts of Probability</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>Select three math/statistics technical electives</strong></td>
<td><strong>10-12</strong></td>
</tr>
<tr>
<td></td>
<td>Select one course in mathematics, one course in statistics, and one course from either, from the following:</td>
<td></td>
</tr>
<tr>
<td>MATH 105</td>
<td>Second Course in Analysis</td>
<td>[4]</td>
</tr>
<tr>
<td>MATH 113</td>
<td>Introduction to Abstract Algebra</td>
<td>[4]</td>
</tr>
<tr>
<td>MATH 123</td>
<td>Ordinary Differential Equations</td>
<td>[4]</td>
</tr>
<tr>
<td>MATH 125A</td>
<td>Mathematical Logic</td>
<td>[4]</td>
</tr>
<tr>
<td>MATH 126</td>
<td>Introduction to Partial Differential Equations</td>
<td>[4]</td>
</tr>
<tr>
<td>MATH 130</td>
<td>The Classical Geometries</td>
<td>[4]</td>
</tr>
<tr>
<td>MATH 135</td>
<td>Introduction to the Theory of Sets</td>
<td>[4]</td>
</tr>
<tr>
<td>MATH 140</td>
<td>Metric Differential Geometry</td>
<td>[4]</td>
</tr>
<tr>
<td>MATH 142</td>
<td>Elementary Algebraic Topology</td>
<td>[4]</td>
</tr>
<tr>
<td>MATH 170</td>
<td>Mathematical Methods for Optimization</td>
<td>[4]</td>
</tr>
<tr>
<td>MATH 185</td>
<td>Introduction to Complex Analysis</td>
<td>[4]</td>
</tr>
<tr>
<td>MATH 189</td>
<td>Mathematical Methods in Classical and Quantum Mechanics</td>
<td>[4]</td>
</tr>
<tr>
<td>ENGIN 117</td>
<td>Methods of Engineering Analysis</td>
<td>[3]</td>
</tr>
<tr>
<td>STAT 135</td>
<td>Concepts of Statistics</td>
<td>[4]</td>
</tr>
<tr>
<td>STAT 150</td>
<td>Stochastic Processes</td>
<td>[3]</td>
</tr>
<tr>
<td>STAT 151A</td>
<td>Linear Modelling: Theory and Applications</td>
<td>[4]</td>
</tr>
<tr>
<td>STAT 152</td>
<td>Sampling Surveys</td>
<td>[4]</td>
</tr>
<tr>
<td>STAT 153</td>
<td>Introduction to Time Series</td>
<td>[4]</td>
</tr>
<tr>
<td>STAT 157</td>
<td>Seminar on Topics in Probability and Statistics</td>
<td>[3]</td>
</tr>
<tr>
<td>STAT 158</td>
<td>The Design and Analysis of Experiments</td>
<td>[4]</td>
</tr>
</tbody>
</table>

**Additional upper division technical electives:** select 16 units of upper division engineering courses, in consultation with faculty adviser.

**Technical electives must include 16 units of upper division engineering courses, selected in consultation with the student's faculty adviser, in order to provide depth in an area of engineering with high mathematical content—typically, most of these courses will come from a single engineering department, but courses that complement each other from different departments are also permissible. Note: IND ENG 172 is an alternate course to STAT 134. Students may not receive credit for both STAT 134 and IND ENG 172. IND ENG 172 cannot be used to fulfill engineering unit requirements; it can only be used as a substitution for STAT 134. Engineering courses cannot include: any course taken on a P/ NP basis; BIO ENG 100, COMPSCI 195, COMPSCI H195, DES INV courses (except DES INV 190E), ENGIN 125, ENGIN 157AC, IND ENG 172, ENG 180, IND ENG 185, IND ENG 186, IND ENG 190 series, IND ENG 191, IND ENG 192, IND ENG 195, MEC ENG 191AC, MEC ENG 190K, MEC ENG 191K.

**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/undergraduate/colleges-schools/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:

   - Social and Behavioral Sciences
   - Philosophy and Values
   - Arts and Literature
   - Historical Studies
   - International Studies

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](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. Fulfillment 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](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](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.

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**Free Elective**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
<th>Spring</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 104</td>
<td>4 MATH 105 or 105A</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>MATH 110</td>
<td>4 MATH 128A</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>STAT 134</td>
<td>4 Upper Division Technical Elective</td>
<td>3-4</td>
<td></td>
</tr>
<tr>
<td>Humanities/Social Science Course</td>
<td>3-4 Humanities/ Social Science Course</td>
<td>3-4</td>
<td></td>
</tr>
<tr>
<td>Free Elective</td>
<td>1 Free Elective</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

**Technical Electives**

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
<th>Spring</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Division Technical Electives</td>
<td>11-12 Upp Division Technical Electives</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Free Electives</td>
<td>3-4 Free Electives</td>
<td>3-4</td>
<td></td>
</tr>
</tbody>
</table>

**Total Units: 121-132**

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

2. Two lower division courses in engineering, mathematics, or statistics, chosen in consultation with the faculty adviser; options include CIV ENG C30/MEC ENG C85, COMPSCI C08, COMPSCI 61A, COMPSCI 61B, COMPSCI 61CL, COMPSCI 61CL, COMPSCI 70, ENGIN 7, ENGIN 25, ENGIN 26, ENGIN 27 (two of ENGIN 25, ENGIN 26, ENGIN 27 must be completed to count as one course), MAT SCI 45 plus MAT SCI 45L, MATH 55, but other courses may also be used if approved by a faculty adviser. Courses used to satisfy the two computer science course requirements may NOT also be used for lower division technical electives. They can only be used to complete one requirement.

3. Technical electives must include 16 units of upper division engineering courses, selected in consultation with the student’s faculty adviser, in order to provide depth in an area of engineering with high mathematical content—typically, most of these courses will come from a single engineering department, but courses that complement each other from different departments are also permissible. NOTE: IND ENG 172 is an alternate course to STAT 134. Students may not receive credit for both STAT 134 and IND ENG 172. IND ENG 172 cannot be used to fulfill engineering unit requirements; it can only be used as a substitution for STAT 134. Engineering courses cannot include: any course taken on a P/ NP basis; BIO ENG 100, COMPSCI 195, COMPSCI H195, DES INV courses (except DES INV 190E), ENGIN 125, ENGIN 157AC, ENGIN 180, IND ENG 172, IND ENG 185, IND ENG 186, IND ENG 190 series, IND ENG 191, IND ENG 192, IND ENG 195, MEC ENG 191AC, MEC ENG 190K, MEC ENG 191K.
Three additional upper division technical electives as follows: one in mathematics, one in statistics, and one from either math or statistics from among: MATH 105, MATH 113, MATH 118, MATH 123, MATH 125A, MATH 126, MATH 130, MATH 135, MATH 140, MATH 142, MATH 170, MATH 185, MATH 189, ENGIN 117 (counts as a math elective); STAT 135, STAT 150, STAT 151A, STAT 152, STAT 153, STAT 154, STAT 157, STAT 158.

Engineering Mathematics and Statistics

ENGIN 7 Introduction to Computer Programming for Scientists and Engineers 4 Units

Terms offered: Fall 2018, Summer 2018 10 Week Session, Spring 2018

Elements of procedural and object-oriented programming, Induction, iteration, and recursion. Real functions and floating-point computations for engineering analysis. Introduction to data structures. Representative examples are drawn from mathematics, science, and engineering. The course uses the MATLAB programming language. Sponsoring departments: Civil and Environmental Engineering and Mechanical Engineering.

Introduction to Computer Programming for Scientists and Engineers: Read More [+]

Rules & Requirements

Prerequisites: Mathematics 1B (maybe taken concurrently)

Credit Restrictions: Students will receive no credit for Engineering 7 after completing Engineering 7 or 77. A deficient grade in Engineering 7 or 77 may be removed by taking Engineering W7.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of lecture, 1 hour of discussion, and 4 hours of laboratory per week

Summer: 10 weeks - 3 hours of lecture, 1.5 hours of discussion, and 6 hours of laboratory per week

Additional Details

Subject/Course Level: Engineering/Undergraduate

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

ENGIN W7 Introduction to Computer Programming for Scientists and Engineers 4 Units

Terms offered: Summer 2016 10 Week Session, Summer 2015 10 Week Session, Summer 2014 10 Week Session

Elements of procedural and object-oriented programming. Induction, iteration, and recursion. Real functions and floating-point computations for engineering analysis. Introduction to data structures. Representative examples are drawn from mathematics, science, and engineering. The course uses the MATLAB programming language.

Introduction to Computer Programming for Scientists and Engineers: Read More [+]

Rules & Requirements

Prerequisites: Mathematics 1B (may be taken concurrently)

Credit Restrictions: Students will receive no credit for Engineering W7 after completing Engineering 7 or 77. A deficient grade in Engineering 7 or 77 may be removed by taking Engineering W7.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of web-based lecture, 4 hours of laboratory, and 1 hour of web-based discussion per week

Summer: 10 weeks - 6 hours of web-based lecture, 0 hours of laboratory, and 7.5 hours of web-based discussion per week

Online: This is an online course.

Additional Details

Subject/Course Level: Engineering/Undergraduate

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

Instructor: Papadopoulos

ENGIN 24 Freshman Seminar 1 Unit

Terms offered: Spring 2012, Fall 2011, Fall 2008

The Berkeley Seminar Program is designed to provide students with the opportunity to explore an intellectual topic with a faculty member in a small seminar setting. Berkeley Seminars are offered in all college departments, and topics vary from department to department and semester to semester.

Freshman Seminar: Read More [+]

Rules & Requirements

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

Hours & Format

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

Additional Details

Subject/Course Level: Engineering/Undergraduate

Grading/Final exam status: The grading option will be decided by the instructor when the class is offered. Final exam required.

Freshman Seminar: Read Less [-]
**ENGIN 25 Visualization for Design 2 Units**
Terms offered: Fall 2018, Spring 2018, Fall 2017
Development of 3-dimensional visualization skills for engineering design. Sketching as a tool for design communication. Presentation of 3-dimensional geometry with 2-dimensional engineering drawings. This course will introduce the use of 2-dimensional CAD on computer workstations as a major graphical analysis and design tool. A group design project is required. Teamwork and effective communication are emphasized.

**Objectives Outcomes**

**Course Objectives:**
- Improve 3-dimensional visualization skills; enable a student to create and understand engineering drawings;
- Introduce 2-dimensional computer-aided geometry modeling as a visualization, design, and analysis tool; enhance critical thinking and design skills;
- Emphasize communication skills, both written and oral; develop teamwork skills; offer experience in hands-on engineering projects; develop early abilities in identifying, formulating, and solving engineering problems;
- Introduce students to the societal context of engineering practice.

**Student Learning Outcomes:**
- Upon completion of the course, students shall be able to communicate 3-dimensional geometry effectively using sketches; operate 2-dimensional CAD software with a high degree of skill and confidence; understand and create engineering drawings; visualize 3-dimensional geometry from a series of 2-dimensional drawings.

**Hours & Format**
- Fall and/or spring: 15 weeks - 1 hour of lecture and 2 hours of laboratory per week

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

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**ENGIN 26 Three-Dimensional Modeling for Design 2 Units**
Terms offered: Fall 2018, Spring 2018, Fall 2017
Three-dimensional modeling for engineering design. This course will emphasize the use of CAD on computer workstations as a major graphical analysis and design tool. Students develop design skills, and practice applying these skills. A group design project is required. Teamwork and effective communication are emphasized.

**Objectives Outcomes**

**Course Objectives:**
- Introduce computer-based solid, parametric, and assembly modeling as a tool for engineering design;
- Enhance critical thinking and design skills;
- Emphasize communication skills, both written and oral; develop teamwork skills; offer experience in hands-on, creative engineering projects; reinforce the societal context of engineering practice; develop early abilities in identifying, formulating, and solving engineering problems.

**Student Learning Outcomes:**
- Upon completion of the course, students shall be able to operate 3-dimensional solid modeling software tools with a high degree of skill and confidence; specify dimensions for parts and assemblies such that they can be fabricated, and fit such that they function with the desired result; produce rapid-prototype models of parts and assemblies to demonstrate their desired functionality; understand the design of systems, components, and processes to meet desired needs within realistic constraints.

**Hours & Format**
- Fall and/or spring: 15 weeks - 1 hour of lecture and 2 hours of laboratory per week

**Additional Details**
- **Subject/Course Level:** Engineering/Undergraduate
- **Grading/Final exam status:** Letter grade. Final exam required.
- **Instructors:** Lieu, McMains, Youssefi

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**ENGIN 27 Introduction to Manufacturing and Tolerancing 2 Units**
Terms offered: Fall 2018, Spring 2018, Fall 2017
Geometric dimensioning and tolerancing (GD&T), tolerance analysis for fabrication, fundamentals of manufacturing processes (metal cutting, welding, joining, casting, molding, and layered manufacturing).

**Objectives & Outcomes**

**Course Objectives:** Enable a student to create and understand tolerances in engineering drawings; enhance critical thinking and design skills; emphasize communication skills, both written and oral; offer hands-on experience in manufacturing; develop abilities in identifying, formulating, and solving engineering problems; introduce students to the context of engineering practice.

**Student Learning Outcomes:** Upon completion of the course, students shall be able to fabricate basic parts in the machine shop; understand and communicate tolerance requirements in engineering drawings using industry standard GD&T; use metrology tools to evaluate if physical parts are within specified tolerances; demonstrate familiarity with manufacturing processes; and design parts that can be fabricated realistically and economically using these processes.

**Rules & Requirements**

**Prerequisites:** Engineering 25 (can be taken concurrently)

**Hours & Format**

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

**Additional Details**

**Subject/Course Level:** Engineering/Undergraduate

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

**Instructors:** McMains, Lieu, Domfeld, Taylor

Introduction to Manufacturing and Tolerancing: Read More [+]

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**ENGIN 39B Freshman/Sophomore Seminar 1.5 - 4 Units**
Terms offered: Spring 2010, Spring 2009, Spring 2008
Freshman and sophomore seminars offer lower division students the opportunity to explore an intellectual topic with a faculty member and a group of peers in a small-seminar setting. These seminars are offered in all campus departments; topics vary from department to department and from semester to semester. Enrollment limits are set by the faculty, but the suggested limit is 25.

**Rules & Requirements**

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

**Hours & Format**

Fall and/or spring: 15 weeks - 1.5-4 hours of seminar per week

**Additional Details**

**Subject/Course Level:** Engineering/Undergraduate

**Grading/Final exam status:** The grading option will be decided by the instructor when the class is offered. Final exam required.

Freshman/Sophomore Seminar: Read Less [-]

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**ENGIN 39E Freshman/Sophomore Seminar 1.5 - 4 Units**
Terms offered: Spring 2010, Spring 2009, Spring 2008
Freshman and sophomore seminars offer lower division students the opportunity to explore an intellectual topic with a faculty member and a group of peers in a small-seminar setting. These seminars are offered in all campus departments; topics vary from department to department and from semester to semester. Enrollment limits are set by the faculty, but the suggested limit is 25.

**Rules & Requirements**

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

**Hours & Format**

Fall and/or spring: 15 weeks - 1.5-4 hours of seminar per week

**Additional Details**

**Subject/Course Level:** Engineering/Undergraduate

**Grading/Final exam status:** The grading option will be decided by the instructor when the class is offered. Final exam required.

Freshman/Sophomore Seminar: Read Less [-]
ENGIN 39F Freshman/Sophomore Seminar
1.5 - 4 Units
Terms offered: Fall 2010
Freshman and sophomore seminars offer lower division students the opportunity to explore an intellectual topic with a faculty member and a group of peers in a small-seminar setting. These seminars are offered in all campus departments; topics vary from department to department and from semester to semester. Enrollment limits are set by the faculty, but the suggested limit is 25.
Freshman/Sophomore Seminar: Read More [+]

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

Fall and/or spring: 15 weeks - 1.5-4 hours of seminar per week

Additional Details
Subject/Course Level: Engineering/Undergraduate

Grading/Final exam status: The grading option will be decided by the instructor when the class is offered. Final exam required.

Freshman/Sophomore Seminar: Read Less [-]

ENGIN 40 Engineering Thermodynamics 4 Units
Terms offered: Fall 2018, Fall 2017
Fundamental laws of thermodynamics for simple substances; application to flow processes and to nonreacting mixtures; statistical thermodynamics of ideal gases and crystalline solids; chemical and materials thermodynamics; multiphase and multicomponent equilibria in reacting systems; electrochemistry. Sponsoring Departments: Materials Science and Engineering and Nuclear Engineering.

Engineering Thermodynamics: Read More [+]

Rules & Requirements
Prerequisites: Physics 7B, Mathematics 54; Chemistry 1B recommended
Credit Restrictions: Students will receive no credit for Engineering 40 after taking Engineering 115, Chemical Engineering 141 or Mechanical Engineering 40.

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

Additional Details
Subject/Course Level: Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.
Instructors: Bolind, Persson

Engineering Thermodynamics: Read Less [-]

ENGIN 45 Properties of Materials 3 Units
Terms offered: Spring 2017, Fall 2016, Spring 2016
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 [+]

Objectives Outcomes
Course Objectives: To introduce students to the Materials Science and Engineering Discipline.
To introduce students to the concept of choosing proper materials for specific applications.
To introduce students to the relationships between the structure, processing, properties and performance of materials.

Student Learning Outcomes: The student should be able to read, interpret, and utilize binary equilibrium phase diagrams to control phases and microstructure.
The student should be able to relate materials properties to chemical bonding
The student should be able to select appropriate classes of materials (i.e., metals, ceramics, polymers, glasses, etc.) for specific engineering applications
The student should understand and describe crystalline and non-crystalline structures including concepts of lattices, points, directions, planes, Miller Indices, etc.
The student should understand defects and their influence on the performance of materials.
The student should understand electronic properties and how those properties vary in different classes of materials.
The student should understand how thermal, mechanical, chemical, etc. processing can be applied to control phase transformation kinetics in engineering material systems
The student should understand mechanical behavior of materials including stress – strain curves, strengthening, failure, etc.
The student should understand the relationships between materials processing, structure, properties, and performance.

Rules & Requirements
Prerequisites: Physics 7A (may be taken concurrently)

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

Additional Details
Subject/Course Level: Engineering/Undergraduate

Grading/Final exam status: Letter grade. Final exam required.
Instructors: Martin, Messersmith

Properties of Materials: Read Less [-]
ENGIN 45L Properties of Materials Laboratory
1 Unit
Terms offered: Spring 2017, Fall 2016
This course presents laboratory applications of the basic principles
introduced in the lecture-based course E45 – Properties of Materials.
Properties of Materials Laboratory: Read More [+]

Objectives Outcomes

Course Objectives: The long term objectives of this course are to
provide undergraduate materials science and engineering and other
engineering and science
students hands-on experiences in foundational materials science topics
and to serve as a practical extension to the lecture-based course E45 –
Properties of Materials
To introduce the students to engineering ethics and safe laboratory
procedures

Student Learning Outcomes: The student should be able to illustrate
the basic properties of strength and toughness of a material, including the
stress vs. strain curve, and the microstructure of a fracture surface.
The student should understand how phase diagrams are constructed
from cooling curves and should be able to compare as-solidified
microstructures of different binary alloys.
The student should understand how thermal treatments in restorative
processing of materials that have been mechanically deformed.
The student should understand the effect of thermal processing on the
properties of steel, and understand how to apply TTT diagrams
to ferrous metallurgy.
The student should understand the nature of electrical conductivity in
materials, and be able to investigate the changes in electrical resistivity of
metals, semiconductors and insulators, and to be able to understand the
influence of impurities on the resistivity of these materials.
The students should be able to understand what is meant by the
mechanical behavior of materials
The students should be introduced to concepts of professional
engineering ethics and best practices approaches to laboratory work.

Rules & Requirements

Prerequisites: E45 should be taken concurrently

Hours & Format

Fall and/or spring: 15 weeks - 1.5 hours of laboratory per week

Additional Details

Subject/Course Level: Engineering/Undergraduate
Grading/Final exam status: Letter grade. Alternative to final exam.
Instructors: Martin, Messersmith
Properties of Materials Laboratory: Read Less [-]

ENGIN 47 Supplementary Work in Lower Division Engineering 1 - 3 Units
Terms offered: Fall 2016, Fall 2012, Spring 2012
May be taken only with permission of the Dean of the College of
Engineering. Students with partial credit in a lower division engineering
course may complete the work under this heading.
Supplementary Work in Lower Division Engineering: Read More [+]

Rules & Requirements

Prerequisites: Limited to students who must make up a fraction of a
required lower division course
Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 0 hours of independent study per week
Summer: 8 weeks - 1.5-5.5 hours of independent study per week

Additional Details

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

Supplementary Work in Lower Division Engineering: Read Less [-]

ENGIN 92 Perspectives in Engineering 1 Unit
Terms offered: Fall 2018, Fall 2017, Fall 2016
This series of lectures provides students, especially undeclared
Engineering students, with information on the various engineering
disciplines to guide them toward choice of major. Lecturers describe
research activities, how they made their own career choices, and indicate
future opportunities. Recommended for all Engineering Science students
and required for Engineering undeclared students.
Perspectives in Engineering: Read More [+]

Rules & Requirements

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

Hours & Format

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

Additional Details

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

Perspectives in Engineering: Read Less [-]
ENGIN 93 Energy Engineering Seminar 1 Unit
Terms offered: Fall 2018, Fall 2017, Fall 2016
Weekly seminar with different speakers on energy-related topics. The goal is to expose students to a broad range of energy issues.

Energy Engineering Seminar: Read More [+]

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

Additional Details
Subject/Course Level: Engineering/Undergraduate
Grading/Final exam status: Offered for pass/not pass grade only. Final exam not required.
Instructor: Zohdi

Energy Engineering Seminar: Read Less [-]

ENGIN 98 Directed Group Studies for Lower Division Undergraduates 1 - 4 Units
Terms offered: Fall 2018, Spring 2018, Fall 2017
Seminars for group study of selected topics, which will vary from year to year. Intended for students in the lower division.

Directed Group Studies for Lower Division Undergraduates: 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: 6 weeks - 2.5-10 hours of directed group study per week 8 weeks - 1.5-7.5 hours of directed group study per week 10 weeks - 1.5-6 hours of directed group study per week

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

Directed Group Studies for Lower Division Undergraduates: Read Less [-]

ENGIN 115 Engineering Thermodynamics 4 Units
Terms offered: Fall 2016, Fall 2015, Spring 2015
Fundamental laws of thermodynamics for simple substances; application to flow processes and to nonreacting mixtures; statistical thermodynamics of ideal gases and crystalline solids; chemical and materials thermodynamics; multiphase and multicomponent equilibria in reacting systems; electrochemistry. Sponsoring Departments: Materials Science and Engineering and Nuclear Engineering.

Engineering Thermodynamics: Read More [+]

Rules & Requirements
Prerequisites: Physics 7B, Math 54; Chemistry 1B recommended
Credit Restrictions: Students will receive no credit for Engineering 115 after taking Chemical Engineering 141 or Mechanical Engineering 40

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

Additional Details
Subject/Course Level: Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam required.
Instructors: Bolind, Persson

Engineering Thermodynamics: Read Less [-]

ENGIN 117 Methods of Engineering Analysis 3 Units
Terms offered: Fall 2017, Fall 2015, Fall 2014
Methods of theoretical engineering analysis; techniques for analyzing partial differential equations and the use of special functions related to engineering systems. Sponsoring Department: Mechanical Engineering.

Methods of Engineering Analysis: Read More [+]

Rules & Requirements
Prerequisites: Mathematics 53, 54

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

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

Methods of Engineering Analysis: Read Less [-]
ENGIN 120 Principles of Engineering Economics 3 Units
Terms offered: Fall 2018, Spring 2018, Fall 2017

Rules & Requirements
Prerequisites: Completion of 60 units of an approved engineering curriculum
Credit Restrictions: Students will receive no credit for Engineering 120 after taking Industrial Engineering 120.

Hours & Format
Fall and/or spring: 15 weeks - 2 hours of lecture and 1 hour of discussion per week
Summer: 8 weeks - 4 hours of lecture and 2 hours of discussion per week

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

Principles of Engineering Economics: Read More [+]
ENGIN 125 Ethics, Engineering, and Society 3 Units
Terms offered: Spring 2014, Fall 2013, Spring 2013
How should engineers analyze and resolve the ethical issues inherent in engineering? This seminar-style course provides an introduction to how theories, concepts, and methods from the humanities and social science can be applied to ethical problems in engineering. Assignments incorporate group and independent research designed to provide students an opportunity to contribute novel findings to the emerging field of engineering ethics while building their analytical and communication skills. This course cannot be used to fulfill any engineering technical requirements (units or courses).

Rules & Requirements
Prerequisites: Limited to students who must make up a fraction of a required upper division course
Repeat rules: Course may be repeated for credit without restriction.
Hours & Format
Fall and/or spring: 15 weeks - 2 hours of lecture and 1 hour of discussion per week
Summer: 6 weeks - 5 hours of lecture and 3 hours of discussion per week 8 weeks - 4 hours of lecture and 2 hours of discussion per week

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

Principles of Engineering Economics: Read Less [-]
ENGIN 128 Advanced Engineering Design Graphics 3 Units
Terms offered: Fall 2018, Fall 2017, Fall 2016

Rules & Requirements
Prerequisites: Engineering 26

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

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

Advanced Engineering Design Graphics: Read Less [-]
ENGIN 147 Supplementary Work in Upper Division Engineering 1 - 3 Units
Terms offered: Fall 2016, Fall 2015, Spring 2015
May be taken only with permission of the Dean of the College of Engineering. Students with partial credit in an upper division engineering course may complete the work under this heading.

Rules & Requirements
Prerequisites: Engineering 26

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

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

Supplementary Work in Upper Division Engineering: Read More [+]
Supplementary Work in Upper Division Engineering: Read Less [-]
ENGIN 150 Basic Modeling and Simulation Tools for Industrial Research Applications 3 Units
Terms offered: Fall 1997, Fall 1996, Fall 1995
The course emphasizes elementary modeling, numerical methods & their implementation on physical problems motivated by phenomena that students are likely to encounter in their careers, involving biomechanics, heat-transfer, structural analysis, control theory, fluid-flow, electrical conduction, diffusion, etc. This will help students develop intuition about the strengths and weaknesses of a variety of modeling & numerical methods, as well as develop intuition about modeling physical systems & strengths and weaknesses of a variety of numerical methods, including: Discretization of differential equations, Methods for solving nonlinear systems, Gradient-based methods and machine learning algorithms for optimization, stats & quantification
Basic Modeling and Simulation Tools for Industrial Research Applications: Read More [+]

Rules & Requirements

Prerequisites: ENGIN 7 or COMPSCI 61A, PHYSICS 7A, MATH 53, MATH 54

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

Additional Details

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

ENGIN 157AC Engineering, The Environment, and Society 4 Units
This course engages students at the intersection of environmental justice, social justice, and engineering to explore how problems that are commonly defined in technical terms are at their roots deeply socially embedded. Through partnerships with community-based organizations, students are trained to recognize the socio-political nature of technical problems so that they may approach solutions in ways that prioritize social justice. Topics covered include environmental engineering as it relates to air, water, and soil contamination; race, class, and privilege; expertise; ethics; and engaged citizenship. This course cannot be used to complete any engineering technical or unit requirements.
Engineering, The Environment, and Society: Read More [+]

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

Additional Details

Subject/Course Level: Engineering/Undergraduate
Grading/Final exam status: Letter grade. Alternative to final exam.
Also listed as: IAS 157AC

ENGIN 177 Advanced Programming with MATLAB 3 Units
Terms offered: Spring 2017, Spring 2015, Spring 2014
The course builds an understanding, demonstrates engineering uses, and provides hand-on experience for object-oriented programming as well as exposes a practical knowledge of advanced features available in MATLAB. The course will begin with a brief review of basic MATLAB features and quickly move to class organization and functionality. The introduced concepts are reinforced by examining the advanced graphical features of MATLAB. The material will also include the effective use of programs written in C and FORTRAN, and will cover SIMULINK, a MATLAB toolbox providing for an effective ways of model simulations. Throughout the course, the emphasis will be placed on examples and homework assignments from engineering disciplines.
Advanced Programming with MATLAB: Read More [+]

Rules & Requirements

Prerequisites: 7 or 77; Mathematics 53 and 54 (one of these may be taken concurrently)

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

Additional Details

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

ENGIN 180 Preparing for the Fields and Jobs of the Future 3 Units
Terms offered: Spring 2018
The course is concerned with giving students the tools to prepare for the fields and jobs of the future. Across all university departments and majors, the numbers of students who do not work in the fields in which they’ve received their degrees is not only significant, but growing. For example, anywhere from 20-40% of STEM graduates do not work in the fields in which they received their degrees.
This does not mean that students shouldn’t major in STEM, but that one of the primary purposes of higher education is learning how to learn. Accordingly, this course presents a number of frameworks that are critical for thinking about that which has not yet been invented.
Preparing for the Fields and Jobs of the Future: Read More [+]

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

Additional Details

Subject/Course Level: Engineering/Undergraduate
Grading/Final exam status: Letter grade. Final exam not required.
Instructor: Ian I. Mitroff
Preparing for the Fields and Jobs of the Future: Read Less [-]
ENGIN 194 Undergraduate Research 3 Units
Terms offered: Spring 2018, Fall 2017, Spring 2017
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. Final report and presentation required.
Undergraduate Research: Read More [+]

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 - 0 hours of independent study per week

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

ENGIN 198 Directed Group Studies for Advanced Undergraduates 1 - 4 Units
Terms offered: Fall 2018, Spring 2018, Spring 2017
Group study of selected topics.
Directed Group Studies for Advanced Undergraduates: Read More [+]

Rules & Requirements
Prerequisites: Upper division standing, plus particular courses to be specified by 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: 8 weeks - 1.5-7.5 hours of directed group study per week

Additional Details
Subject/Course Level: 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 [-]