292. Seminar in Solid-State Technology (1) Seminar—1 hour. Prerequisite: graduate standing. Lectures on various topics in solid-state technology by various visiting specialists in the field. May be repeated for credit (S/U grading only).—II, III.

293. Computer Engineering Research Seminar (1) Seminar—1 hour. Prerequisite: graduate standing or consent of instructor. Lectures, tutorials, and seminars on topics in computer engineering. May be repeated for credit up to four times. (S/U grading only)—II, III, IV.

294. Communications, Signal and Image Processing Seminar (1) Seminar—1 hour. Prerequisite: graduate standing. Communications, signal and image processing, video engineering and computer vision. May be repeated for credit. (S/U grading only)—I, II, III.

295. Systems, Control and Robotics Seminar (1) Seminar—1 hour. Prerequisite: graduate standing. Seminars on current research in systems and control by faculty and visiting experts. Technical presentations and lectures on current topics in robotics research and robotics technology. May be repeated for credit. (S/U grading only)—I, II, III.

296. Photonics Research Seminar (1) Seminar—1 hour. Prerequisite: graduate standing. Lectures on photonics and related areas by faculty and visiting experts. May be repeated for credit. (S/U grading only)—II, III.

298. Group Study (1-5) Prerequisite: consent of instructor. (S/U grading only.)

299. Research (1-12) (S/U grading only.)

Professional

390. The Teaching of Electrical Engineering (1) Discussion—1 hour. Prerequisite: meet qualifications for teaching assistant and/or associate-in in Electrical Engineering. Participation as a teaching assistant or associate-in in a designated engineering course. Methods of leading discussion groups or laboratory sections, writing and grading quizzes, use of laboratory equipment, and grading laboratory reports. May be repeated for credit. (S/U grading only)—I, II.

396. Teaching Assistant Training Practicum (1-4) Prerequisite: graduate standing. May be repeated for credit. (S/U grading only)—I, II, III, IV, V, VI.

Engineering: Mechanical and Aerospace Engineering

(College of Engineering)

C. P. (Case) van Dam, D. Engr., Chairperson of the Department
Benjamin D. Shaw, Ph.D., Vice Chairperson of the Department

Department Office, 2132 Bainer Hall 530-752-1850, Fax 530-752-4158; http://mae.ucdavis.edu

Faculty
Ralph C. Aldredge, III, Ph.D., Professor
Harry H. Cheng, Ph.D., Professor
Cristina E. Davis, Ph.D., Professor
Roger Davis, Ph.D., Professor
Jean-Pierre Deplanque, Ph.D., Professor
Raissa D’Souza, Ph.D., Professor
(Computing Science; Mechanical and Aerospace Engineering)
Fidelis O. Eke, Ph.D., Professor
Paul A. Erickson, Ph.D., Associate Professor
Rida T. Farouki, Ph.D., Professor
Mohamed M. Fisch, Ph.D., Professor
Academic Senate Distinguished Teaching Award
Ronald A. Hess, Ph.D., Professor
Michael R. Hill, Ph.D., Professor
David A. Horley, Ph.D., Professor
David Hwang, Ph.D., Professor
Niels G. Jensen, Ph.D. Professor
(Chemical Engineering and Materials Science; Mechanical and Aerospace Engineering)
Sanjay S. Joshi, Ph.D., Associate Professor
Ian M. Kennedy, Ph.D., Professor
Valeria La Saponara, Ph.D., Associate Professor
Barbara S. Linke, Ph.D., Assistant Professor
Mark Modera, Ph.D., Professor
(Civil and Environmental Engineering; Mechanical and Aerospace Engineering)
Jan Wan Park, Ph.D., Assistant Professor
Bahram Ravani, Ph.D., Professor
Stephen K. Robinson, Ph.D., Professor
Nesrin Sanligik-Klijn, Ph.D., Professor
Benjamin D. Shaw, Ph.D., Professor
Masakazu Sashi, Ph.D., Assistant Professor
C. P. (Case) van Dam, D. Engr., Professor
Steven A. Velinsky, Ph.D., Professor
Anthony S. Wexler, Ph.D., Professor
(Civil and Environmental Engineering; Mechanical and Aerospace Engineering; Land, Air and Water Resources)
Kazu Yamazaki, Ph.D., Professor

Emeriti Faculty
Hector A. Baltis, Ph.D., Professor Emeritus
James W. Baugh, Ph.D., Professor Emeritus
Academic Senate Distinguished Teaching Award
Charles W. Beadle, Ph.D., Professor Emeritus
Jean-Jacques Chattot, Ph.D., Professor Emeritus
Harry A. Dwyer, Ph.D., Professor Emeritus
Andrew A. Frank, Ph.D., Professor Emeritus
Jerald M. Henderson, D. Engr., Professor Emeritus
Myron A. Hoffman, Sc.D., Professor Emeritus
Mont Hubbard, Ph.D., Professor Emeritus
Maury L. Hull, Ph.D., Professor Emeritus
Dean C. Karnopp, Ph.D., Professor Emeritus
John D. Kemper, Ph.D., Professor Emeritus
Wolfgang Kalthoff, Ph.D., Professor Emeritus
Donald L. Margolis, Ph.D., Professor Emeritus
Allan A. McKillop, Ph.D., Professor Emeritus
Bruce R. White, Ph.D., Professor Emeritus

Affiliated Faculty
James Schoaf, Ph.D., Lecturer

The Mechanical and Aerospace Engineering Undergraduate Programs

The Department of Mechanical and Aerospace Engineering administers three undergraduate programs in the College of Engineering: (1) Mechanical Engineering, (2) Mechanical Engineering/Materials Science and (3) Aerospace Science and Engineering. For more information about our programs, please see http://mae.ucdavis.edu/ug.php.

The Mechanical Engineering/Materials Science program is not accepting new students.

Mission. The Department of Mechanical and Aerospace Engineering is committed to educating future engineers so that they may contribute to the economic growth and well-being of the state, the nation, and the world, and to the advancement of knowledge in the associated applied sciences so that graduates may practice in a broad range of industries, pursue graduate study, participate in research and development, and/or pursue entrepreneurial endeavors.

Objectives. The objectives of the programs offered in Mechanical and Aerospace Engineering include the following: to prepare its graduates to practice mechanical and/or aerospace engineering in a broad range of industries, to enable interested graduates to pursue graduate education, to prepare its graduates to participate in research and development, and to offer creative and innovative efforts in science, engineering, and technology and to allow interested graduates to pursue entrepreneurial endeavors.

Preparatory Requirements. In order to change to any major offered by the Department of Mechanical and Aerospace Engineering, students must:

• Have a registered student and have completed at least one quarter (minimum of 12 units) at UC Davis;  
• Have completed more than 30 cumulative units (excluding AP units);  
• Be in good academic standing and meet minimum progress requirements;  
• Have a gPA of 2.80 or better in all completed Mathematics, Physics, Biology and Chemistry courses required for your intended major, and have received a C- or better in each of these courses;  
• Have no grade lower than a C- in any completed engineering course required for your intended major(s) taken at UC Davis;  
• Have 2.00 UC GPA in completed engineering courses.

Mechanical Engineering Undergraduate Program


The mechanical engineer uses basic science in the design and manufacture of complex engineering systems, requiring the application of physical and mechanical principles to the development of machines, energy conversion systems, materials, and equipment for guidance and control. Work in this broad field of engineering requires a thorough knowledge of mathematics, physics, chemistry, material science, applied mechanics, thermodynamics, heat transfer, mass transfer, electricity, manufacturing processes, and economics.

The Mechanical Engineering program is designed to provide knowledge in mechanical engineering and associated applied sciences so that graduates may practice in a broad range of industries, pursue graduate study, participate in research and development, and/or pursue entrepreneurial endeavors.

Areas of Interest

Students spend their third year in further study of fundamental courses, and in the fourth year they may tailor their studies to their interests by selecting courses in controls and systems analysis, fluid mechanics, heat transfer, mechanical design or thermodynamics. Students can either prepare for graduate study in mechanical engineering or obtain a broad background for entering engineering practice.

Students may select elective courses from among the areas of interest listed below.

Mechanical Design. The creation and improvement of products, processes, or systems that are mechanical in nature are the primary activities of a professional mechanical engineer. The development of a product from concept to manufacturing requires a well-designed system, manufacturing process selection and planning, quality control and assurance, and life cycle considerations are areas of study and specialization in the area of mechanical design.

Solutions to such major social problems as environmental pollution, the lack of mass transportation, the lack of raw materials, and energy shortages, will depend heavily on the engineer’s ability to create new types of machinery and new mechanisms. The engineer-designer must have a solid and relatively broad background in the basic physical and engineering sciences and have the ability to synthesize the information from such a background in creative problem solving. In addition to having technical competence, the designer must be able to...
consider the socioeconomic consequences of a design and its possible impact on the environment. Product safety, reliability, and economics are other considerations. Suggested technical electives: Aerospace Science and Engineering 133, 139, Biological Systems Engineering 114, 120, 165; Biomedical Engineering 118/Electrical and Computer Engineering 147 Engineering 122, 160 (only one unit of credit towards Technical Electives requirement); Materials Science and Engineering 180, 181, 182; Mechanical Engineering 121, 134, 150B, 151, 152, 154, 156, 157


Biomedical and Mechanical Engineering Fluid Mechanics. This field of study is based on the fundamentals of fluid mechanics and their broad range of applications in the biomedical and engineering areas. Areas of current research include blood circulation and its role in the potential regulation of normal physiological function and in the development of disease; groundwater and atmospheric flows and their implications for pollutant transport and environmental concerns; aerodynamic flow around transportation vehicles and its impact on vehicle performance; and flow in combustion engines and other energy systems with considerations of efficiency and environmental impact. These areas are investigated both experimentally and computationally. Suggested technical electives: Aerospace Science and Engineering 138 Engineering 160 (only one unit of credit towards technical requirements); Chemical Engineering 161A, 161B; Civil and Environmental Engineering 144, 149; Mechanical Engineering 161, 163 Suggested Advisers. R.C. Aldredge, M. Hafez, I.M. Kennedy, S.K. Robinson, B.D. Shaw, C.P. van Damin, A.S. Wexler

Combustion and the Environment. Combustion is widely used for energy generation, propulsion, heating, and waste disposal, as well as for many other applications. Mechanical engineers are often heavily involved with the design of combustion systems (aerodynamics, propulsion engines, gas turbines, furnaces, etc.) and deal with aspects of combustion ranging from increasing efficiencies to reducing pollutant emissions. This specialization is for those who would like to work in fields that use combustion, or that deal with pollution related to combustion. With the current increased emphasis on reducing pollutants while maintaining or increasing efficiency, the efforts of mechanical engineers in designing and improving combustion systems are becoming more important. Suggested technical electives: Mechanical Engineering 161, 163; Civil and Environmental Engineering 149, 150 Suggested Advisers. R.C. Aldredge, R. Davis, P.A. Erickson, I.M. Kennedy, B.D. Shaw

Heat Transfer, Thermodynamics, and Energy Systems. This specialization emphasizes the fundamentals of heat transfer and thermodynamics, and their application to the design of advanced engineering systems. The objective of the program is to introduce students to the fundamental processes of heat transfer and thermodynamics in complex engineering systems and to familiarize students with methods that are able to design more efficient, cost-effective, and reliable systems with less environmental pollution and impact. An understanding of heat transfer and thermodynamics is required for the design of advanced, cost-effective systems for power generation, propulsion, heat exchangers, industrial processes, refining, and chemical processing. This area of specialization is important to many industries—particularly the automobile—as well as to the thermal design of electronic and computer packages. Suggested technical electives: Aerospace Science and Engineering 138 Engineering 161, 163 Suggested Advisers. R.C. Aldredge, R. Davis, P.A. Erickson, I.M. Kennedy, J.W. Park, B.D. Shaw

Manufacturing. Manufacturing is concerned with the conversion of raw materials into finished products by a variety of processes, such as machining, forming, casting, and molding. Modern manufacturing technology is increasingly dependent upon integration with computer-aided design systems and precision computer controls. State-of-the-art laboratories offer the opportunity for hands-on experience with a wide spectrum of manufacturing equipment. Manufacturing engineers deal with design, materials, controls, statistical methods, computer software, and microprocessor applications. Suggested technical electives: Aerospace Engineering 118/Electrical and Computer Engineering 147; Electrical and Computer Engineering 160 Materials Science and Engineering 180, 181 Mechanical Engineering 150B, 151, 154 Suggested Advisers. H.H. Cheng, R.T. Farouki, B.S. Linke, D.A. Horsey, V. La Saponara, M. Soshi, B. Ravani, K. Yamazaki

System Dynamics and Control. Engineers are increasingly concerned with the performance of integrated dynamic systems in which it is not possible to optimize component parts without considering the overall system. System dynamics and control specialists are concerned with the modeling, analysis, and simulation of all types of dynamic systems and with the use of automatic control techniques to change the dynamic characteristics of systems in useful ways. The emphasis in this program is on the physical systems that are closely related to mechanical engineering, but the techniques for studying these systems apply to social, economic, and other dynamic systems. Ongoing research includes projects on continuously variable transmissions, active and semi-active suspension systems, modeling and control of vehicle dynamics, electromechanical actuator design, electronically controlled wheel slip analysis of vehicle management systems, and the design of flight-control systems with humans in the loop. Suggested technical electives: Aerospace Science and Engineering 129, 139, 141; Electrical and Computer Engineering 160 Engineering 122 Mechanical Engineering 121, 134, 154 Suggested Advisers. F.O. Eke, R.A. Hess, S. Joshi

Ground Vehicle Systems. An important aspect of mechanical engineering is the design of more environmentally benign surface vehicles that provide efficient individual and public transportation. Innovations in the field require competence in vehicle dynamics, control of vehicle dynamics, power sources and power transmission, lightweight structures and systems, alternatively fueled power systems, including electrical drives and fuel cells, and metabolic systems. Suggested technical electives: Aerospace Science and Engineering 127, 129, 139; Civil and Environmental Engineering 130, 149, 160; Engineering 122, 160 (only one unit of credit towards technical electives requirement) Mechanical Engineering 121, 134, 152

Suggested Advisers. P.A. Erickson, M. Hill, J. Park, N. Sargülijkjin, S. Velinsky

Transportation Systems. As society recognizes the increasing importance of optimizing transportation systems to minimize environmental degradation and energy expenditure, engineers will need to consider major innovations in the way people and goods are moved. Such innovations will require competence in vehicle dynamics, propulsion and control, and an understanding of the problems caused by present-day modes of transportation. Vehicle control requires an understanding of sensors and actuators, and the integration of vehicle-control concepts into overall vehicular dynamics. Competence in these areas allows for the development of alternative propulsion concepts, such as electric, hybrid, and fuel cell. Suggested technical electives: Aerospace Science and Engineering 127, 129; Biological Systems Engineering 114, 120 Civil and Environmental Engineering 131, 139 Engineering 122, 160 (only one unit of credit towards Technical Electives requirement) Mechanical Engineering 134, 150B, 161, 163 Suggested Advisers. P.A. Erickson, J.W. Park, S. Velinsky

Mechanical Engineering Program Requirements

Students are encouraged to adhere carefully to all prerequisite requirements. The instructor is authorized to drop students from a course for which stated prerequisites have not been completed. Excessive of General Education units, the minimum number of units required for the Mechanical Engineering major is 157.

Lower Division Required Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics 21A-21B-21C-21D</td>
<td>16</td>
</tr>
<tr>
<td>Mathematics 22A-22B</td>
<td>6</td>
</tr>
<tr>
<td>Physics 9A-9B-9C-9D</td>
<td>19</td>
</tr>
<tr>
<td>Chemistry 2A-2B or 2AH-2BH</td>
<td>10</td>
</tr>
<tr>
<td>Engineering 4</td>
<td>3</td>
</tr>
<tr>
<td>Engineering 6 or Mechanical Engineering 5</td>
<td>4</td>
</tr>
<tr>
<td>Engineering 17, 35, 45 (or 45Y)</td>
<td>12</td>
</tr>
<tr>
<td>Mechanical Engineering 50</td>
<td>4</td>
</tr>
<tr>
<td>English 2 or University Writing Program 1, 1Y or 1V, or Comparative Literature 1, 2, 3, or 4, or Native American Studies 5</td>
<td>4</td>
</tr>
<tr>
<td>Communication 1 or 3</td>
<td>4</td>
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</tbody>
</table>

Upper Division Required Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering 100, 102, 103, 104, 105</td>
<td>19</td>
</tr>
<tr>
<td>Mathematical Engineering 106, 107A &amp; 8, 150A, 165, 172</td>
<td>22</td>
</tr>
<tr>
<td>Mechanical Engineering 185A &amp; 185B (taken in consecutive quarters), or Aerospace Science and Engineering 130A &amp; 130B</td>
<td>22</td>
</tr>
<tr>
<td>Engineering 190</td>
<td>3</td>
</tr>
<tr>
<td>Select one course from the following Applied Mathematics Electives:</td>
<td></td>
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<tr>
<td>Engineering 180</td>
<td>3</td>
</tr>
<tr>
<td>Mathematics 128C, Mechanical Engineering 115</td>
<td>3</td>
</tr>
<tr>
<td>Statistics 131A</td>
<td>4</td>
</tr>
<tr>
<td>Select one course from the following System Dynamics/Mechanical Design Electives:</td>
<td></td>
</tr>
<tr>
<td>Aerospace Science and Engineering 129, 139, 140, 141, 142</td>
<td>4</td>
</tr>
<tr>
<td>Materials Science and Engineering 180, 182, Mechanical Engineering 134, 151, 152, 161, 163</td>
<td>4</td>
</tr>
<tr>
<td>Students must also choose from Aerospace Science and Engineering 130A, 130B, Mechanical Engineering 150B, 154, 171</td>
<td>4</td>
</tr>
<tr>
<td>If these courses are not used in upper division elective courses</td>
<td></td>
</tr>
<tr>
<td>Technical Elective Requirement</td>
<td>7</td>
</tr>
</tbody>
</table>

Quarter Offered: I=Fall; II=Winter; III=Spring; IV=Summer; 2015-2016 offering in parentheses

Pre-Fall 2011 General Education (GE): AH=Arts and Humanities; SE=Science and Engineering; SS=Social Sciences; Div=Domestic Diversity; Writ=Writing Experience

Fall 2011 and on Revised General Education (GE): AH=Arts and Humanities; SE=Science and Engineering; SS=Social Sciences; AGCH=American Cultures; DD=Domestic Diversity; OL=Oral Skills; QL=Quantitative; SL=Scientific; VL=Visual; WC=World Cultures; W=Writing Experience

Suggested Advisers. P. A. Erickson, M. Hill, J. Park, N. Sargülijkjin, S. Velinsky
At least four units must be taken from any Upper Division Engineering course, which may include any of the following System Dynamics/ Mechanical Design or Restricted Elective lists if these courses are not used in satisfaction of other degree requirements. Up to 4 units may be selected from Mechanical Engineering 185A/B or any engineering 192, 199 not used in satisfaction of other degree requirements. Courses that cannot be used are Biomedical Engineering 110L, Engineering 160, 191, 198 (Gearing up for Graduate School/ undergraduate research), Computer Science Engineering 188 or any 197T course.

Up to three units may be used from the following technical electives list: Agricultural and Resource Economics 100A, 100B, 112
Applied Biological Systems Technology 101, 142, 165
Atmospheric Science 149, 160
Biological Sciences 2A, 28, 2C
Chemistry 2C, 2CH, 8A, 8B and any upper division course except Chemistry 195 and 197
Economics 100, 101, 102, 103, 122
Engineering: Any upper division course offered in the college of engineering except Biomedical Engineering 110L, Engineering 160, 191, 198 (Gearing up for grad school/undergraduate research), Computer Science Engineering 188 or any 197T course.
Environmental and Resource Sciences 100, 100L, 121, 131, 136, 185, 186, 186L
Exercise Biology 102
Fiber and Polymer Science 100 (same as Materials Science Engineering 147)
Food Science and Technology 159, 160
Geology 17, 32, 35, 36, 50, 50L, 60, 100, 100L, 101L, 130, 131, 160, 162, 163
Hydrologic Science 110, 124, 134, 141, 142, 143, 144, 146, 151, 182
Management 11A, 11B, 100, 120, 140, 150, 160, 170, 180
Mathematics: any upper division course except Mathematics 197TC
Physics 9HE and any upper division course except Physics 160 (restricted to one unit of technical elective), 195, 197T
Statistics: any upper division course except Statistics 110, 123, 124, 123, 104, 106, 108
Upper Division Composition Requirement ................................................. 4 or 8
One course from a following (a grade of C- or better is required): University Writing Program 101, 102, 104A, 104E, 104T or passing the Upper-Division Composition Exam.

The Mechanical Engineering/Materials Science Undergraduate Program


The Mechanical Engineering/Materials Science program is not accepting new students through Undergraduate Admissions or the change of major process.

The Mechanical Engineering/Materials Science program is a combined major that offers students a unique interdisciplinary experience requiring work with mechanical engineering and material science and engineering students. In addition to performing work in portions of the mechanical engineering program described above, this program provides the background to understand the structure, properties, and behavior of materials and to pursue these fields in industry and/or graduate scholarship.

Students are encouraged to adhere carefully to all prerequisite requirements. The instructor is authorized to drop students from a course for which stated prerequisites have not been completed.

Effective of General Education units, the minimum number of units required for the Mechanical Engineering/Materials Science major is 170.

Lower Division Required Courses

| Mathematics | 21A-21B-21C-21D | 16 |
| Physics | 9A-9B-9C-9D | 6 |
| Chemistry | 2A-2B | 10 |
| Engineering | 122 | 3 |
| Engineering | 6 | 5 |
| English | 3 or University Writing Program 1, 1Y or 1V, or Comparative Literature 1, 2, 3, or 4, or Native American Studies 5 | 4 |
| Communication | 1 or 3 | 3 |

Upper Division Required Courses

| Engineering | 100, 102, 103, 104, 105 | 19 |
| Mechanical Engineering 185A & 185B or Materials Science and Engineering 188A & B (taken in consecutive quarters) | 4 |
| Materials Science and Engineering 160, 162, 164, 174 | 16 |
| One course chosen from Materials Science and Engineering 172, 180, 181, 182, 188A (if not used to satisfy above core requirement) | 4 |
| One laboratory course chosen from Materials Science and Engineering 162L or 174L | 2 |
| Select one course from: Engineering 180, Mathematics 128C, Mechanical Engineering 115; Statistics 131A | 4 |
| Engineering 190 | 3 |
| Technical Electives | 10 |
| One course chosen from the following System Dynamics/Mechanical Design electives: Engineering 122, Mechanical Engineering 121, 150B, 154 | |
| Two courses must be chosen from Aerospace Science and Engineering 129, 130A, 130B, 138, 139, 189A, 189B, Mechanical Engineering 147, Mechanical Engineering 134, 151, 152, 161, 163 | 22 |
| Mechanical Engineering 150B, 154 if not used for the System Dynamics/Mechanical Design elective requirement above. Students may also choose from Materials Science and Engineering 180, 181, 182, if these courses are not used for a Materials Science and Engineering requirement above. | |
| A combined total of 4 units of Mechanical Engineering 185A & B, Materials Science and Engineering 188A & B or any course numbered 192 or 199 not used in satisfaction of core requirements may be applied to the technical elective degree requirement. | |

Upper Division Composition Requirement ................................................. 4 or 8
One course from the following (a grade of C- or better is required): University Writing Program 101, 102A, 102B, 102G, 102E, 104A, 104C, 104A, 104E, 104T or passing the Upper-Division Composition Exam.

Division of Aerospace Science and Engineering

The Division of Aerospace Science and Engineering administers the Aerospace Science and Engineering Program within the Department of Mechanical and Aerospace Engineering.

Faculty
Roger Davis, Ph.D., Professor
Jean-Pierre Delplanque, Ph.D., Professor
Fidelis O. Eke, Ph.D., Professor
Mohamed M. Hafez, Ph.D., Professor
Academic Senate Distinguished Teaching Award
Ronald A. Hess, Ph.D., Professor
Sanjay S. Joshi, Ph.D., Associate Professor
Valeria La Sarapena, Ph.D., Associate Professor
Professor Stephen K. Robinson, Ph.D., Professor
Nesrin Sarigul-Klijn, Ph.D., Professor
C. P. (Case) van Dam, D. Engr., Professor

The Aerospace Science & Engineering Undergraduate Program


Aerospace Science and Engineering majors learn to apply the principles of the physical sciences and engineering to the design of aerospace vehicles. Specific objectives include the design, development and manufacture of aerospace vehicles and other transportation systems through the integration of disciplines associated with aerodynamics, propulsion, structures, and guidance/control.

Our Bachelor of Science degree in Aerospace Science and Engineering provides a broad background in the physical sciences, and the engineering sciences. These fundamentals, when complemented by the required technical courses, prepare students for employment in government or industry, while simultaneously establishing an excellent foundation for graduate studies.

Students are encouraged to adhere carefully to all prerequisite requirements. The instructor is authorized to drop students from a course for which stated prerequisites have not been completed.

Exclusive of General Education units, the minimum number of units required for the Aerospace Science and Engineering major is 140.

Lower Division Required Courses

| Mathematics | 21A-21B-21C-21D | 16 |
| Physics | 9A-9B-9C-9D | 6 |
| Chemistry | 2A-2B | 10 |
| Engineering | 122 | 3 |
| Engineering | 6 | 5 |
| Engineering | 122 | 4 |
| Mechanical Engineering | 110L, Engineering 147 | 12 |
| Mechanical Engineering 115; Statistics 131A | 4 |
| Technical Electives | 10 |
| One course chosen from the following System Dynamics/Mechanical Design electives: Engineering 122, Mechanical Engineering 121, 150B, 154 | |
| Two courses must be chosen from Aerospace Science and Engineering 129, 130A, 130B, 138, 139, 189A, 189B, Mechanical Engineering 147, Mechanical Engineering 134, 151, 152, 161, 163 | 22 |
| Select one course from: Engineering 180, Mathematics 128C, Mechanical Engineering 115; Statistics 131A | 4 |
| Engineering 190 | 3 |
| Technical Electives | 10 |

Upper Division Required Courses

| Engineering | 100, 102, 103, 104, 105 | 19 |
| Select one course from: Engineering 180, Mechanical Engineering 150B, 154 if not used for the System Dynamics/Mechanical Design elective requirement above. Students may also choose from Materials Science and Engineering 180, 181, 182, if these courses are not used for a Materials Science and Engineering requirement above. | |
| A combined total of 4 units of Mechanical Engineering 185A & B, Materials Science and Engineering 188A & B or any course numbered 192 or 199 not used in satisfaction of core requirements may be applied to the technical elective degree requirement. | |

Upper Division Composition Requirement ................................................. 4 or 8
One course from the following (a grade of C- or better is required): University Writing Program 101, 102A, 102B, 102G, 102E, 104A, 104C, 104A, 104E, 104T or passing the Upper-Division Composition Exam.
One course from the following (grade of C- or better is required): University Writing Program 101, 102, 104, 104A, or passing the Upper-Division Composition Exam.

The Graduate Program in Mechanical and Aeronautical Engineering

M.S. and Ph.D. 530-752-0581

The defining element of graduate study in the Mechanical and Aeronautical Engineering Program is interdisciplinary design. Research within this graduate program advances design in diverse fields such as vehicles, plasma MHD propulsion, biomechanics, aerostuctures, sensors, combustion, and energy systems. Graduate students acquire skills both to address fundamental issues in these areas and to design complex, multi-component systems.

The highly collaborative environment fosters multidisciplinary research while drawing on the study of mathematics, experimental and space plasma science, electrical engineering, materials science, materials modeling, molecular dynamics and numerical analysis, bioengineering, space physics, and nanotechnology in addition to the core areas. Recruiters from industry are active here, knowing that, in addition to having hands-on design experience, our students are well grounded academically. The study with professors who “wrote the book” on their discipline, and work on design projects with researchers who are international authorities in their field. Our graduate students are able to work closely with faculty in a friendly but demanding environment where teamwork and faculty mentoring are important, as is the cross-disciplinary, collaborative culture that is unique to UC Davis.

Research Highlights:

- Aeronautics and aerodynamics
- Spacecraft design and operation
- Space environment studies
- Remote sensing
- Electrical propulsion
- Flight dynamics and control
- Computational fluid dynamics
- Experimental MHD turbulence studies
- Dynamic systems and controls
- Roboticics
- Manufacturing and Mechanical design
- Reacting flows
- Heat transfer
- Automotive system dynamics
- Biosensors/Microelectromechanical Systems (MEMS)
- Molecular self-assembly
- Radiation effects in solids
- Nonlinear dynamics and phase-locking
- Biofluid mechanics
- Biosolid mechanics
- Sports biomechanics
- Energy Systems/Fuel Cell/Hybrid Vehicle Technology
- High energy density science and applications
- Nuclear fusion energy
- Wind energy

Research Facilities and Partnerships:

- Center for Computational Fluid Dynamics
- Institute of Transportation Studies
- Center for Advanced Highway Maintenance and Construction Technology
- GATE Center for Hybrid Electric Vehicles
- Aeronautical Wind Tunnel Facility

Complete Information on our website at http://mae.ucdavis.edu/grad_studies/.

Courses in Engineering: Mechanical (EME)

Courses in Mechanical Engineering (EME) are listed below; courses in Aerospace Science and Engineering (AE) are listed immediately following; graduate courses in Mechanical and Aeronautical Engineering (MAE) follow.

Lower Division

1. Mechanical Engineering (1)

Lecture—1 hour. Description of the field of mechanical engineering with examples taken from industrial applications, discussion with respect to engineering principles, ethics, and responsibilities.

2. Computer Programming for Engineering Applications (4)

Lecture—3 hours; laboratory—3 hours. Prerequisite: Mathematics 16A or 21A (may be taken concurrently). Structured programming in C for solving problems in engineering. Introduction to MATLAB and comparison study of C/C++ with MATLAB. Not open for credit to students who have completed course 124. GE credit: QL, SE, SL, VL—II (I) Cheng

50. Manufacturing Processes (4)

Lecture/discussion—3 hours; laboratory—3 hours. Prerequisite: C- or better in Engineering 4 and Physics 9A. Restricted to Mechanical Engineering and Mechanical Engineering/Materials Science Engineering majors. Modern manufacturing methods, safety, manufacturing inspections, computer-aided manufacturing and their role in the engineering design and development process. GE credit: SciEng | QL, SE, VL—II, III, IV (II, III, IV) Linke, Soshi

92. Internship in Mechanical Engineering (1-5)

Internship. Prerequisite: lower division standing; approval of project prior to period of internship. Supervised work-study experience in engineering. May be repeated for credit. (P/NP grading only.)

97TC. Mentoring and Tutoring Engineering in the Community (1-4)

Prerequisite: consent of instructor. Mentoring, coaching, tutoring and/or supervision of students in K-12 schools in Engineering-related topics. May be repeated for credit. (P/NP grading only.)

99. Special Study for Undergraduates (1-5)

Prerequisite: consent of instructor; lower division standing. (P/NP grading only.)

Upper Division

106. Thermo-Fluid Dynamics (4)

Lecture—4 hours. Prerequisite: C- or better in Engineering 103 and 105. Restricted to Mechanical Engineering, Aerospace Science and Engineering, and Mechanical Engineering/Materials Science Engineering majors. Inviscid incompressible flow, compressible flows, psychrometrics, reacting mixtures and combustion. GE credit: SciEng | QL, SE—II, III, IV (II, III, IV) Delplanque, Kennedy, Shaw

107A. Experimental Methods (3)

Lecture—2 hours; laboratory—3 hours. Prerequisite: C- or better in Mechanical Engineering 106. Restricted to Mechanical Engineering, Aerospace Science & Engineering and Mechanical/Materials Science Engineering majors. Emphasis is to illustrate principles of thermal-fluid systems. Statistical and uncertainty analysis of data; statistical design of experiments; measurement devices; experiments involving thermosyphon cycles, combustion, compressible and incompressible flows. Two units of credit for students who have previously taken Chemical Engineering 155A; one unit of credit for students who have previously taken Chemical Engineering 155B; two units of credit for students who have previously taken Civil and Environmental Engineering 141L. GE credit: SciEng | QL, SE, VL—II, III, IV (II, III, IV) Erickson, Kennedy, Park, Shaw

107B. Experimental Methods (3)

Lecture—2 hours; laboratory—3 hours. Prerequisite: C- or better in Engineering 100 and Engineering 102, Engineering 104 recommended. Restricted to Mechanical Engineering, Aerospace Science & Engineering and Mechanical Engineering/Materials Science Engineering majors. Experiments to illustrate principles of mechanical systems. Theory of measurements; Signal analysis; Demonstration of basic sensors for mechanical systems; Experimental project design; Experiments involving voltage measurement; strain gauges, dynamic systems of 0th, 1st and 2nd order. Only two units of credit for students who have previously taken Biomedical Engineering 111. Only one unit of credit for students who have previously taken Biological Systems Engineering 165. GE credit: SciEng | QL, SE, VL, WE—II, III, IV (II, III, IV) Hill, Horsley, La Saponara

115. Introduction to Numerical Analysis and Methods (4)

Lecture—3 hours; lecture/discussion—1 hour. Prerequisite: C- or better in Engineering 6 or course 5 or Computer Science Engineering 30 or Chemical and Materials Science Engineering 6; C- or better in Mathematics 21A, 21B, 21C, 21D, 22A, 22B; C- or better in Physics 9A, 9B, 9C. Number representation, Taylor expansions, error and stability analysis, roots of nonlinear equations, l' Hopital's rule, optimization, numerical integration, ordinary differential equations. Not open for credit to students who have taken Applied Science Engineering 115. GE credit: SciEng | QL—II, III (II) Jensen

121. Engineering Applications of Dynamics (4)

Lecture—3 hours; laboratory—3 hours. Prerequisite: C- or better in Engineering 102; C- or better in Engineering 6 or course 5 or Computer Science Engineering 30. Restricted to Mechanical Engineering, Aerospace Science and Engineering, and Mechanical Engineering/Materials Science Engineering majors. Technical elective that revisits dynamic principles with emphasis on engineering applications; stressing importance of deriving equations of motion and setting these into format for computer solution with computer simulation lab. Students gain experience with solving complex, real engineering applications. GE credit: SciEng | QL, SE, SL—II, III (III) Karnopp, Margolis

134. Vehicle Stability (4)

Lecture—3 hours; laboratory—3 hours. Prerequisite: C- or better in Engineering 102. Restricted to Mechanical Engineering, Aerospace Science and Engineering, and Mechanical Engineering/Materials Science Engineering majors. Introduction to the static and dynamic stability characteristics of transportation vehicles with examples drawn from aircraft, high-performance automobiles, rail cars and boats. Laboratory experiment illustrates dynamic behavior of automobiles, race cars, bicycles, etc. GE credit: SciEng | QL, SE, SL—II, III, IV (III) Karnopp

150A. Mechanical Design (4)

Lecture—3 hours; discussion—1 hour. Prerequisite: C- or better in: Engineering 45 or Engineering 45Y; C- or better in both Engineering 104 and course 50 (may be taken concurrently). Restricted to Mechanical Engineering, Aerospace Science and Engineering, Mechanical Engineering/Materials Science and Engineering majors. Principles of engineering mechanics applied to mechanical design. Theories of static and fatigue failure of metals. Design projects emphasizing the progression from conceptualization to hardware. Experimental stress analysis and computer measurements using strain gages. GE credit: SciEng | QL, SE, VL, WE—II, III, IV (II, III, IV) Farouki, Hill, Rovani, Soshi

150B. Mechanical Design (4)

Lecture—3 hours; discussion—1 hour. Prerequisite: C- or better in course 150A. Restricted to Mechanical Engineering, Aerospace Science and Engineering, Mechanical Engineering/Materials Science and Engineering majors. Principles of engineering mechanics applied to the design and selection of mechanical components. Design projects, which concentrate on conceptual design, engineering analysis, methods of
171. Analysis, Simulation and Design of Mechatronic Systems (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: C- or better in Engineering 102 and 104. Restricted to Mechanical Engineering, Aerospace Science and Engineering, Mechanical Engineering/Materials Science and Engineering. Modeling of dynamic engineering systems in various energy domains. Analysis and design of dynamic systems. Response of linear systems. Digital computer simulation and physical experiments. GE credit: SciEng | QL, SE, VL—II. (II.) Hubbard

172. Automatic Control of Engineering Systems (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: C- or better in Engineering 102 and 104. Restricted to Mechanical Engineering, Aerospace Science and Engineering, Mechanical Engineering/Materials Science and Engineering. Principles of control. Feedback concepts; control design with Bode and Nyquist plots; stability; phase and gain margins; lead and lag compensators; state variable feedback controllers. GE credit: SciEng | QL, SE, VL—II. (II, III.) Eke, Joshi

185A. Mechanical Engineering Systems Design Project (4)
Lecture—1 hour; laboratory—3 hours. Prerequisite: C- or better in course 150A and course 165 (may be taken concurrently); Communications 1 or 3 recommended. Upper division composition recommended. Restricted to Senior standing in Mechanical Engineering (EMEC). Major mechanical engineering design experience; the mechanical engineering design process and its use in the design of engineering systems involving appropriate engineering standards and multiple realistic constraints. (Deferred grading only, pending completion of sequence.) GE credit: SciEng | OL, QL, SE, VL, WE—II, III, IV. (II, III.) Davis, Velinsky

185B. Mechanical Engineering Systems Design Project (4)
Lecture—1 hour; laboratory—3 hours. Prerequisite: course 185A and senior standing in the Department of Mechanical and Aerospace Engineering. Major mechanical engineering design experience; the mechanical engineering design process and its use in the design of engineering systems incorporating appropriate engineering standards and multiple realistic constraints. (Deferred grading only, pending completion of sequence.) GE credit: sci | OL, QL, SE, VL, WE—II, III, IV. (II, III.) Velinsky, C. Davis

189A-L. Selected Topics in Mechanical Engineering (1-5)
Seminars/Workshops—1-5 hours. Prerequisite: consent of instructor. Directed group study of selected topics in separate sections in (A) Energy Systems and the Environment, (B) Engineering Controls, (C) Engineering Dynamical Systems, (D) Biomechanics, (E) Fluid Mechanics, (F) Manufacturing Engineering, (G) Mechanical Engineering and Product Design, (H) Mechatronics, (I) MEMS/Nanotechnology, (J) Solid and Structural Mechanics, (K) Thermodynamics, (L) Vehicle and Transportation Systems. May be repeated for credit when the topic is different.

192. Internship in Engineering (1-5)
Internship. Preparation standing; approval of project prior to period of internship. Supervised work experience in mechanical engineering. May be repeated for credit. (P/NP grading only)

197C. Mentoring and Tutoring Engineering in the Community (1-4)
Prerequisite: upper division standing; consent of instructor. Mentoring, coaching, tutoring and/or supervision of students in K-12 schools in Engineering-related topics. May be repeated for credit. (P/NP grading only)

198. Directed Group Study (1-5)
Prerequisite: consent of instructor. (P/NP grading only)

199. Special Study for Advanced Undergraduates (1-5)
Prerequisite: consent of instructor. (P/NP grading only)

Courses in Aerospace Science and Engineering (EAE)

Lower Division

1. Introduction to Aerospace Science Engineering (V)
Lecture—1 hour. Description of the field of aerospace engineering with examples from industry, government, and research. Aerospace engineering principles, ethics, and responsibilities. (P/NP grading only—II. I.)

99. Special Study for Undergraduates (1-5)
Prerequisite: consent of instructor and lower division standing. (P/NP grading only)

Upper Division

126. Theoretical and Computational Aerodynamics (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: C- or better in course 127; C- or better in Engineering 180 or Applied Science Engineering 115 or Mechanical Engineering 115 or Mathematics 128C. Development of general equations of fluid motion. Study of flow field kinematics and dynamics. Flow about a body. Thin airfoil theory. Viscous effects. Applications of numerical methods to wing analysis and design. GE credit: SciEng | SE.—III. Hafez

127. Applied Aircraft Aerodynamics (4)

129. Stability and Control of Aerospace Vehicles (4)

130A. Aircraft Performance and Design (4)
Lecture—2 hours; discussion—1 hour; laboratory—3 hours. Prerequisite: C- or better in course 127; C- or better in course 129 (may be taken concurrently). Major aircraft design experience with multiple realistic constraints including aerodynamics, performance analysis, weight estimation, stability and control, and appropriate engineering standards. GE credit: SciEng | QL, SE, VL, WE.—II. (II.) van Dam

130B. Aircraft Performance and Design (4)
Lecture—2 hours; discussion—1 hour; laboratory—3 hours. Prerequisite: grade of C- or better in course 130A. Restricted to upper division standing. Major aircraft design experience incorporating multiple realistic constraints including: refinement and iteration of initial design; cost analysis, detailed design, and analysis of aircraft structure, propulsion system; aerodynamics, stability, and control/handling qualities; manufacturing, or appropriate engineering standards. GE credit: SciEng | QL, SE, VL, WE.—II. III. (III.) van Dam

133. Finite Element Methods in Structures (4)
Lecture—3 hours; laboratory—3 hours. Prerequisites: grade of C- or better in Engineering 104. Open to College of Engineering Students. Introduction to the aerospace structural design process. History of aircraft and spacecraft materials. Effects of loading beyond elastic limit. Deflections and stresses
Lecture—2 hours; discussion—2 hours. Prerequisite: 141. Space Systems Design (4) Hafez Rocket engines, liquid and solid rocket propulsion. In Engineering 103 and 105. Restricted to upper Engineering 103 and 104. Overview of materials and technology for creating structures from fiber reinforced resin matrix composite material systems. Lab work to the operation and design of inlets, compressors, burners, turbines, and nozzles. Cycle design studies for specific applications. GE credit: ScEnG | QL, SE. —I. (II.) La Saponara

137. Structural Composites (4) Lecture—3 hours; laboratory—1 hour. Prerequisite: grade of C- or better in Engineering 102 and 103. Structural dynamics of flexible structures. Introduction to analysis of differential equations governed by linear systems or systems under aerostatic constraints. Dynamics instabilities. Control effectiveness. Unsteady aerodynamics. Flutter. Aeroelastics in design. Applications to aerospace, mechanical and biomedical systems. GE credit: SE. —III. (III.) Sarigul-Klijn

139. Structural Dynamics and Aeroelasticity (4) Lecture—3 hours; laboratory—3 hours. Prerequisite: grade of C- or better in Engineering 102 and 103. Structural dynamics of flexible structures. Introduction to analysis of differential equations governed by linear systems or systems under aerostatic constraints. Dynamics instabilities. Control effectiveness. Unsteady aerodynamics. Flutter. Aeroelastics in design. Applications to aerospace, mechanical and biomedical systems. GE credit: SE. —III. (III.) Sarigul-Klijn

140. Rocket Propulsion (4) Lecture—4 hours. Prerequisite: grade of C- or better in Engineering 102 and 103. Analysis and design of modern aircraft gas turbine engines. Development and application of cycle performance prediction techniques for important engine configurations. Lab work to the operation and design of inlets, compressors, burners, turbines, and nozzles. Cycle design studies for specific applications. GE credit: ScEnG | QL, SE. —II. (II.) R. Davis

141. Space Systems Design (4) Lecture—3 hours; discussion—1 hour. Prerequisite: grade of C- or better in Engineering 102 and 103. Design aspects of selected space systems design and specification concepts formulation, system tradeoffs, subsystem design. Prototype space mission concepts are presented and a multidisciplinary mission design is developed that considers all relevant architecture elements. Offered in alternate years. GE credit: ScEnG | QL, SE. —I. (I.) Hafez

142. Orbital Mechanics (4) Lecture—4 hours. Prerequisite: grade of C- or better in Engineering 102 and 103. Design of upper division standing. Satellite orbits, multistage rockets, current global boosters, and new technologies. Design application problems include satellites, trajectory optimization, and interpolation of trajectory trajectories. Not open for credit to students who have completed course 189A prior to Fall Quarter 2013. GE credit: ScEnG | QL, SE. —IV. (IV.) Hafez

189C. Flight Simulation and Testing in Design of Aircraft and Spacecraft (4) Lecture—3 hours; laboratory—3 hours. Prerequisite: Engineering 102; consent of the instructor. Teaches flight test techniques together with data analysis methods, prepares students for any type of flight testing including fixed wing, rotary wing and launch vehicles. Offered irregularly. GE credit: ScEnG | QL, SE. —Sarigul-Klijn

198. Directed Group Study (1-5) Prerequisite: consent of instructor. (P/NP grading only)

199. Special Study for Advanced Undergraduates (1-5) Prerequisite: consent of instructor. (P/NP grading only)

Courses in Mechanical and Aeronautical Engineering (MAE) (formerly courses in Aeronautical Science and Engineering and Mechanical Engineering)

Graduate

207. Engineering Experimentation and Uncertainty Analysis (4) Lecture—3 hours; discussion—1 hour. Prerequisite: Mechanical Engineering 107A and 107B. Design and analysis of engineering experiments with emphasis on measurement standards, data analysis, regression analysis, and uncertainty analysis, including statistical treatment of experimental data intervals, propagation of bias and precision errors, correlated bias approximations, and using jitter programs. —C. Davis


210A. Advanced Fluid Mechanics and Heat Transfer (4) Lecture—3 hours; discussion—1 hour. Prerequisite: Engineering 102 and Mechanical Engineering 105. Development of differential equations governing continuum, momentum and energy transfer. Solutions in laminar flow for exact cases, low and high Reynolds numbers and lubrication theory. Dynamics of inviscid flow. —Aldredge

210B. Advanced Fluid Mechanics and Heat Transfer (4) Lecture—3 hours; discussion—1 hour. Prerequisite: course 210A. Study of stability and transition to turbulence. Introduction to the physics of turbulence. Modeling of turbulence for numerical determination of momentum and heat transfer. —Aldredge

211. Fluid Flow and Heat Transfer (4) Lecture—3 hours; discussion—1 hour. Prerequisite: Engineering 102 and Mechanical Engineering 105 or the equivalent. Design aspects of selected topics; heat conduction, fins; heat transfer in ducts, boundary layers, and separated flows; heat exchangers. —Erickson, Park

212. Biomedical Heat and Mass Transport Processes (4) Lecture—3 hours; discussion—1 hour. Prerequisite: Mechanical Engineering 105 and Biological Systems Engineering 125, Chemical Engineering 153 or the equivalent. Application of principles of heat and mass transfer to biomedical systems related to heat exchange between the body and its environment, mass transfer across cell membranes and the design and analysis of artificial human organs. (Same course as Biomedical Engineering 212.) —Aldredge

213. Advanced Turbulence Modeling (4) Lecture—4 hours. Prerequisite: course 210B. Methods of analyzing turbulence; kinematics and dynamics of homogeneous turbulence; Reynolds stress and heat flux closures; order closures and their simplification; numerical methods; application to boundary layer flows; two-dimensional and three-dimensional hydrodynamic and environmental flows. —Aldredge

215. Biomedical Fluid Mechanics and Transport Phenomena (4) Lecture—3 hours; discussion—1 hour. Prerequisite: Engineering 103 or Chemical Engineering 150B or Civil and Environmental Engineering 141. Application of fluid mechanics and transport to biomedical systems. Flow in normal physiological function and pathological conditions. Topics include circulatory and respiratory flows, effect of flow on cellular processes, transport in the arterial wall and in tumors, and tissue engineering. (Same course as Biomedical Engineering 215.)

216. Advanced Thermodynamics (4) Lecture—3 hours; discussion—1 hour. Prerequisite: Engineering 103 and 105, Mechanical Engineering 106. Restricted to graduate students. Review of chemical thermodynamics and chemical kinetics. Discussion of reacting flows, their governing equations and transport phenomena; detonations; laminar flame structure and turbulent combustion. —Alaldredge, Kennedy, Shaw

218. Advanced Energy Systems (4) Lecture—3 hours; discussion—1 hour. Prerequisite: Engineering 103 and 105, or the equivalent. Review of options available for advanced power generation. Detailed study of basic power balances, component efficiencies, and performance for one advanced concept such as a fusion, magnetohydrodynamic, or solar electric power generation. —C. Davis

219. Introduction to Scientific Computing in Solid and Fluid Dynamics (4) Lecture—3 hours; laboratory—3 hours. Prerequisite: Engineering 103 and 104. Scientific calculations with finite element and finite-difference methods for multi-dimensional problems in solid and fluid dynamics are performed with examples in C, C++, FORTRAN, and MATLAB script files. Derivation of the basic equations of motion in finite volume form with applications to elasticity, waves. —DeLaplante

220. Mechanical Vibrations (4) Lecture—4 hours. Prerequisite: Engineering 122. Multiple degrees of freedom; damping measures; Rayleigh’s method; vibration absorbers; eigenvalues and modeshapes; modal coordinates; forced vibrations; random processes and vibrations; auto-correlation; spectral density; first passage and fatigue failure; nonlinear systems; phase plane.

222. Advanced Dynamics (4) Lecture—4 hours. Prerequisite: Engineering 102. Dynamics of particles, rigid bodies and distributed systems with engineering applications; generalized coordinates; Hamilton’s principle; Lagrange’s equations; Hamilton/Jacobi theory; modal dynamics orthogonality; wave dynamics; dispersion.

223. Multibody Dynamics (4) Lecture—4 hours. Prerequisite: Engineering 102. Coupled rigid-body kinematics/dynamics, reference frames; vector differentiation; configuration and motion constraints; holonomicity; generalized speeds; partial velocities; mass; inertia tensor/theorems; angular momentum; generalized forces; comparing Newton/Euler, Lagrange’s methods; computer-aided equation derivation; orientation; Euler; Rodrigues parameters. (Same course as Biomedical Engineering 223.)

225. Spatial Kinematics and Robotics (4) Lecture—3 hours; laboratory—3 hours. Prerequisite: C Language and course 222. Spatial kinematics, screw theory, spatial mechanisms analysis and synthesis, robot kinematics and dynamics, robotic work space, path planning, robot programming, some architecture and software implementation. (Same course as Biomedical Engineering 225.) Offered in alternate years. —Ravani
226. Acoustics and Noise Control (4)
Lecture—4 hours. Prerequisite: Engineering 122.
Description of sound using normal modes and wave interaction in rooms and sound fields; sound absorption in enclosed spaces; sound transmission through barriers; applications in design, acoustic enclosures and sound walls, room acoustics, design of quiet machinery. —Sarigül-Klijn

227. Research Techniques in biomechanics (4)
Lecture—2 hours; laboratory—4 hours; term paper or discussion—1 hour. Prerequisite: Mathematics 22B and consent of instructor; Exercise Science 115 recommended. Experimental techniques for biomechanical analysis of human movement. Techniques evaluated include data acquisition and analysis by computer, forceplate analysis, strength assessment, planar and three-dimensional videography, data reduction and smoothing, body segment parameter determination, electromyography, and biomechanical modeling. (Same course as Biomedical Engineering 227/Exercise Science 227) —Williams, Hawkins

228. Introduction to BioMEMS (4)
Discussion—4 hours. Prerequisite: SS 104 or equivalent. Modeling and analysis of microfluidic and microstructural systems related to biological applications. Covers topics from various disciplines related to BioMEMS: mechanical, electrical, biomedical, chemical engineering, and materials science. Offered in alternate years — I. Davis

Lecture—4 hours. Prerequisite: consent of instructor; Engineering 45, 100, 104; Engineering 122 recommended. Mechanical design of micro-electromechanical systems (MEMS). Device modeling: lumped parameter models; energy methods; nonlinearities; electrical and mechanical noise sources. Actuation and measurement methods: capacitive, piezoresistive, thermal, piezoelectric, and optical techniques. Review of basic electronics: bridge circuits, amplitude modulation, lock-in detection. —Harsley

231. Musculo-Skeletal System biomechanics (4)
Lecture—4 hours. Prerequisite: Engineering 102. Mechanics of skeletal muscle and mechanical models of muscle, solution of the inverse dynamics problem, theoretical and experimental methods of kinematic and dynamic analysis, computation of joint torques and muscle forces, applications to gait analysis and sports biomechanics. (Same course as Biomedical Engineering 231.) —Velinsky

232. Skeletal Tissue Mechanics (3)
Lecture—3 hours; laboratory—1 hour. Prerequisite: Engineering 104B. Overview of the mechanical properties of the various tissues in the musculoskeletal system, the relationship of these properties to anatomic and histologic structure, and the effects of these properties caused by aging and disease. The tissues covered include bone, cartilage and synovial fluid, ligament, and tendon. —Velinsky

233. Aerodynamics in Nature and Technology (4)
Lecture—4 hours. Prerequisite: Engineering 103. Introduction to aerodynamics in nature, fundamental laws of aerodynamics, atmospheric boundary layers, pedestrian-level winds in urban areas. Criteria for laboratory modeling of atmospheric flows, wind tunnel testing. —Velinsky

234. Design and Dynamics of Road Vehicles (4)
Lecture—4 hours. Prerequisite: Mechanical Engineering 134A. Analysis and numerical simulation of road vehicles with emphasis on suspension applications. —Velinsky

235. Aerodynamics in Nature and Technology (4)
Lecture—4 hours. Prerequisite: Engineering 103. Introduction to aerodynamics in nature, fundamentals of aerodynamics, atmospheric boundary layers, pedestrian-level winds in urban areas. Criteria for laboratory modeling of atmospheric flows, wind tunnel testing. —Velinsky

236. Aerodynamics in Nature and Technology (4)
Lecture—4 hours. Prerequisite: Engineering 103. Introduction to aerodynamics in nature, fundamentals of aerodynamics, atmospheric boundary layers, pedestrian-level winds in urban areas. Criteria for laboratory modeling of atmospheric flows, wind tunnel testing. —Velinsky

237. Analytical and Design of Composite Structures (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: Engineering 104 or equivalent. Modeling and analysis methodology for composite structures including response and failure. Laminated plate bending theory. Introduction to failure processes. Includes discussion of aerodynamic analysis. —La Saponara

238. Advanced Aerodynamic Design and Optimization (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: consent of instructor. Application of aerodynamic theory to optimum aerodynamic shapes. Advanced design techniques. —van Dam

239. Advanced Finite Elements and Optimization (4)
Lecture—4 hours. Prerequisite: Engineering 180 or Applied Science 115 or Mathematics 128C. Introduction to advanced finite elements and direct optimization methods, with application to modeling of complex mechanical, aerospace and biomedical systems. Application of states of the art in finite elements to mechanical design optimization techniques. —van Dam

240. Computational Methods in Nonlinear Mechanics (4)
Lecture—4 hours. Prerequisite: Applied Science Engineering 115 or Mathematics 128B or Engineering 180. Deformations of solids and the motion of fluids treated with state-of-the-art computational methods. Numerical nonlinear dynamics; classification of coupled problems; applications of finite element methods to mechanical, aeronautical, and biological systems. (Same course as Biomedical Engineering 239) —Sarigül-Klijn

242. Stability of Thin-Walled Structures (4)
Lecture—4 hours. Prerequisite: Engineering 104 or equivalent. Static stability of thin-walled aerospace structures treated from both theoretical and practical design perspectives. Both analytic and composite construction considered. Buckling of stiffened panels, shells, and thin-walled beams, experimental methods and failure/crippling processes. —La Saponara

248. Advanced Turbomachinery (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: Engineering 103 and 105. Preliminary aerodynamic design of axial and radial flow compressors and turbines. Design of diffusers. Selection of turbomachinery and configurations and approximations to optimum dimensions and flow angles. Introduction to through flow analysis. Rotating stall and surge, and aerodynamic considerations. —R. Davis

250A. Advanced Methods in Mechanical Design (4)
Lecture—4 hours. Prerequisite: Mechanical Engineer- ing 150A and 150B or the equivalent, or consent of instructor. Advanced techniques of solid mechanics to mechanical design problems. Coverage of advanced topics in stress analysis and static failure theories with emphasis in design of machine elements. Design projects emphasizing advanced analysis tools for life cycle evaluation. —Ravanì

250B. Advanced Methods in Mechanical Design (4)
Lecture—4 hours. Prerequisite: course 250A. Applications of advanced techniques of solid mechanics to mechanical design problems. Advanced topics in variational methods of mechanics with emphasis in design of machine elements. Problems empha- sizing advanced analysis tools. —Hill

250C. Mechanical Performance of Materials (4)
Lecture—4 hours. Prerequisite: undergraduate course in stress analysis and mechanical behavior of materials. Occurrence, mechanisms, and prediction of fatigue and fracture phenomena. Use of stress and strain to predict crack initiation. Use of fracture mechanics to study failure and crack propagation. Effects of stress concentration, stress intensity, crack sequence, irregular loading, and multi-axial loading. —Velinsky

251. Mechatronics System Design (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: Engineering 154, 157A, 157B; Mechanical Engineering 126, Electrical and Computer Engineering 157A, 157A. Motion mechanism design, electric actuator, power electronics and control systems, personal computer-based control systems design, motion control general system design, closed-loop control systems, motion control software design, discrete event control software design. Offered in alternate years. —I. Yamazaki

252. Information Processing for Autonomous Robotics (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: Engineering 6, Mechanical Engineering 5, or equivalent. Advanced programming experience, Mechanical Engineering 124, 171, 172. Computational principles for sensing, reasoning, and navigation for autonomous robots. —Joshi

254. Engineering Software Design (4)
Lecture—3 hours; laboratory—3 hours. Prerequisite: Mechanical Engineering 126. Study of object-oriented and object-oriented approaches to software design. Advanced topics in engineering software design, applications of object-oriented programming, very high-level languages, real-time multi-thread computing and sensor fusion, Web-based network computing, graphics, and GUI in engineering. —Cheng

255. Computer-Aided Design and Manufacturing (4)
Lecture—3 hours; laboratory—3 hours. Prerequisite: proficiency in a high level programming language such as Fortran, Pascal, or C. Representation and processing of geometrical information in design and manufacturing. Numeric and symbolic computations. Coordinate systems and transformations. Bezier and B-spline curves and surfaces. Interpola- tion and approximation methods. Intersections, offsets, and blends. Path planning for machining inspection, and robotics applications. —Farouki

258. Hybrid Electric Vehicle System Theory and Design (4)
Lecture—3 hours; laboratory—3 hours. Prerequisite: Mechanical Engineering 150B, graduate standing in Mechanical and Aeronautical Engineering. Advanced vehicle design for fuel economy, perfor- mance, and low emissions, considering regulations, societal demands and manufacturability. Analysis and verification of computer design and control of vehicle systems in real vehicle tests. Advanced engine concepts. —Farouki

260. Gas Dynamics (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: Engineering 103 or the equivalent. Flow of compressible fluids. Isentropic flow. Flow with friction, heat transfer, chemically reacting gas and particle mixtures. Normal and oblique shock waves, combustion, blast and expansion waves. Method of charac- teristics. —Farouki

262. Aerodynamics (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: Mechanical Engineering 126. Study of inviscid and viscous flows about aerodynamic shapes at subsonic, transonic and supersonic conditions. Application of aerodynamic theory to design for reduced drag and increased lift. —Farouki

263. Introduction to Computational Aerodynamics and Fluid Dynamics (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: Engineering 103 or consent of instructor. Introduc- tion to numerical methods for solution of fluid flow problems. Discretization techniques and solution algorithms. Finite difference solutions to classical model equations pertinent to wave phenomena, dis- fusion phenomena, or applications. Application to the incompressible Navier-Stokes equation. —Farouki

264. Computational Aerodynamics (4)
Lecture—4 hours. Prerequisite: Aeronautical Science and Engineering 126, Engineering 180, or consent of instructor. Numerical and computational aerodynamics flow simulation in the transonic regime. Solution of steady and unsteady potential and compressible boundary layer equations. Numerical
schemes for mixed type equations and shock waves/numerical grid generation. Viscous/inviscid interaction and coupling procedures. — Holleis

266. Advanced Wind-Tunnel Testing (4)
Lecture—2 hours; discussion—1 hour; laboratory—3 hours. Prerequisite: undergraduate course in fluid dynamics. Aspects of low-speed wind-tunnel testing for solving aeronautical and non-aeronautical problems including tunnel corrections, scale effects, force and moment measurements, and flow visualization. — van Dam

267. Parallel Computations in Fluid/Thermal Sciences (4)
Lecture—2 hours; discussion—2 hours. Prerequisite: Mechanical Engineering 106, 165, Engineering 180 or equivalent; or consent of instructor. Programming languages and constructs for engineering analysis on parallel computers including MPI (distributed), OpenMP (shared), and Fortran95. Graduate or junior/senior undergraduate as a technical elective.—R. Davis

268. Wind Power Engineering (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: Engineering 102 and 103, or equivalent, or consent of instructor. Fundamentals for understanding the conversion of wind power to mechanical power and electricity. Related engineering, economic and societal issues.—van Dam

269. Fuel Cell Systems (4)
Lecture—2 hours; discussion—2 hours. Prerequisite: Mechanical Engineering 106, 107, 165, or equivalent, or consent of instructor; graduate or junior/senior undergraduate as a technical elective. Basics of electrochemistry and fuel cell engines in mobile and stationary applications. Aspects of fuel cell energy converters and their subsystems including practice with existing fuel cell and hydrogen systems on campus. Limited enrollment. — Erickson

271. Advanced Modeling and Simulation of Mechanistic Systems (4)
Lecture—3 hours; laboratory—3 hours. Prerequisite: Mechanical Engineering 172 or the equivalent. Multitrip models of mechanical, electrical, hydraulic, and thermal devices; bond graphs, block diagrams and state space equations; modeling of multiple energy domain systems; three-dimensional mechanics; digital simulation laboratory. — Horsley

272. Theory and Design of Control Systems (4)
Lecture—4 hours. Prerequisite: Mechanical Engineering 172 or the equivalent. Mathematical representations of linear dynamical systems. Feedback principles, behavior and state of feedback. Analysis and design of control systems based on classical and modern approaches, with emphasis on applications to mechanical and aeronautical systems. — Horsley

Lecture—3 hours; discussion—1 hour. Prerequisite: Mechanical Engineering 172. Discrete systems analysis; digital filtering, simple data systems; state space and transform design techniques; quantization effects; multi-input, multi-output systems.—Hess

275. Advance Aircraft Stability and Control (4)

276. Data Acquisition and Analysis (4)
Lecture—3 hours; discussion—1 hour. Application of computers for data acquisition and control. Topics include computer architecture, characteristics of transducers, hardware for laboratory applications of computers, functional details of interfaces between computers and experimental equipment, programming techniques for data acquisition and control, basic data analysis.—Hill

290C. Graduate Research Conference (1)
Discussion—1 hour. Prerequisite: consent of instructor. Individual and/or group conference on problems, progress, and techniques in mechanical and aeronautical engineering research. May be repeated for credit. (S/U grading only)—I, II, III. [I, II, III]

297. Seminar (1)
Discussion—1 hour. Prerequisite: consent of instructor. Current topics in engineering including developments in mechanical and aeronautical engineering with presentations by students, faculty, and visitors. May be repeated for credit. (S/U grading only)—I, II, III, 1, II, III.

298. Group Study (1-5)

299. Research (1-12)
Prerequisite: consent of instructor. (S/U grading only.)

Professional

390. The Teaching of Aeronautical Science and Engineering (1)
Discussion—1 hour. Prerequisite: meet qualifications for teaching assistant and/or associated in Aeronautical Science and Engineering. Methods of leading discussion groups or laboratory sections, writing and grading quizzes, use of laboratory equipment, and grading laboratory reports. May be repeated for credit. (S/U grading only)—I, II, III, 1, II, III.

396. Teaching Assistant Training Practicum (1-4)
Prerequisite: graduate standing. May be repeated for credit. (S/U grading only)—I, II, III, 1, II, III.

English

[College of Letters and Science]

Elizabeth Miller, Ph.D., Chairperson of the Department

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Faculty

Don P. Abbott, Ph.D., Professor
Gina Bloom, Ph.D., Associate Professor
Nathan Brown, Ph.D., Assistant Professor
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Joshua Clover, M.F.A., Professor
Lucy Corin, M.F.A., Associate Professor
Gregory Dobbins, Ph.D., Associate Professor
Frances E. Dolan, Ph.D., Professor
Seeta Chaganti, Ph.D., Associate Professor
Kathleen Fredericksen, Ph.D., Assistant Professor
Lynn R. Freed, Ph.D., Professor
Elisabeth S. Freeman, Ph.D., Professor
Danielle Heard, Ph.D., Assistant Professor
Jack Hicks, Ph.D., Senior Lecturer
Pam Houston, B.A., Professor
Hsuan Hsu, Ph.D., Associate Professor
Alexa Johns, Ph.D., Associate Professor
Richard A. Levin, Ph.D., Professor
Academic Senate Distinguished Teaching Award
Margaret W. Ferguson, Ph.D., Professor
Kathleen Fredericksen, Ph.D., Assistant Professor
Nathan Brown, Ph.D., Assistant Professor
Laurie Richardson, Ph.D., Professor
Some have established their own businesses. Graduates have found the major excellent pre-professional training for graduate study in English, as well as for careers in teaching, writing, law, medicine, and library work. Many graduates are employed in journalism, publishing, advertising, and public information. Others have worked in local, state, and federal government agencies, as well as in industry and agriculture. Some have established their own businesses.

A.B. Major Requirements:

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>English 3 or University Writing</td>
<td>4</td>
</tr>
<tr>
<td>Program 1</td>
<td>4</td>
</tr>
<tr>
<td>One course from: English 40, 43, 44</td>
<td>4</td>
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<tr>
<td>English 10A, 10B, 10C</td>
<td>12</td>
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Graduates have found the major excellent pre-professional training for graduate study in English, as well as for careers in teaching, writing, law, medicine, and library work. Many graduates are employed in journalism, publishing, advertising, and public information. Others have worked in local, state, and federal government agencies, as well as in industry and agriculture. Some have established their own businesses.