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

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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 Delplanque, Ph.D., Professor
Raissa D'Souza, Ph.D., Professor *(Computer 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. Hafez, Ph.D., Professor
Academic Senate Distinguished Teaching Award
Ronald A. Hess, Ph.D., Professor
Michael R. Hill, Ph.D., Professor
David A. Horsley, 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
Zhaodan Kong, Ph.D., Assistant Professor
Valeria La Saponara, Ph.D., Associate Professor
Seongkyu Lee, Ph.D., Assistant Professor
Barbara S. Linke, Ph.D., Assistant Professor
Mark P. Modera, Ph.D., Professor *(Civil and Environmental Engineering; Mechanical and Aerospace Engineering)*
Jason Moore, Ph.D., Lecturer with Potential Security of Employment
Vinod Narayanan, Ph.D., Professor
Jae Wan Park, Ph.D., Assistant Professor
Bahram Ravani, Ph.D., Professor
Stephen K. Robinson, Ph.D., Professor
Nesrin Sarigul-Klijn, Ph.D., Professor
Benjamin D. Shaw, Ph.D., Professor
Masakazu Soshi, Ph.D., Assistant Professor
Spyros Tseregounis, Ph.D., Lecturer with Security of Employment *(Chemical Engineering and Materials Science; Mechanical and Aerospace Engineering)*
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)*
Kazuo Yamazaki, Ph.D., Professor

Emeriti Faculty

Hector A. Baldis, Ph.D., Professor Emeritus
James W. Baughn, 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 Kollmann, Dr-Ing, 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 Schaaf, Ph.D., Lecturer

The Mechanical and Aerospace Engineering Undergraduate Programs

The Department of Mechanical and Aerospace Engineering administers two undergraduate programs in the College of Engineering: *(1)* Mechanical Engineering, *(2)* Aerospace Science and Engineering.

For more information about our programs, please see *http://mae.ucdavis.edu/ug.php*.

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 mechanical and aerospace sciences.

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 in other 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:

- Be a registered student and have completed at least one quarter (minimum of 12 units) at UC Davis;
- Have completed not more than 135 cumulative units (excluding AP units);
- Be in good academic standing and meet minimum progress requirements;
- Have received a letter grade for all courses that satisfy Engineering degree requirements;
- Have: a) completed at least the following five courses: Mathematics 21A, B, C; Physics 9A and Chemistry 2A and b) have a GPA of 2.800 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 a 2.800 UC GPA in completed engineering courses.

Mechanical Engineering Undergraduate Program

The Mechanical Engineering program is accredited by the Engineering Accreditation Commission of ABET; *http://www.abet.org*.

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 studies, 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 generation to detailed design, 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 mechanical systems.

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, 161, 163

Suggested Advisers. H.H. Cheng, R.T. Farouki, M.R. Hill, B.S. Linke, B. Ravani, M. Soshi, S. Velinsky, K. Yamazaki

Biomedical and 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 potential role in the 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 Dam, 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 (internal combustion 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 so that they 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 efficient, cost-effective systems for power generation, propulsion, heat exchangers, industrial processes, refining, and chemical processing. This area of specialization is important to many industries—aerospace, defense, automotive—as well as to the thermal design of electronic and computer packages.

Suggested technical electives:

Aerospace Science and Engineering 138
Mechanical 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 must have expertise in design, materials, controls, statistical methods, computer software, and microprocessor applications.

Suggested technical electives:

Biomedical 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. Horsley, V. La Saponara, M. Soshi, B. Ravani, K. Yamazaki

System Dynamics and Control. Engineers are increasingly concerned with the performance of integrated dynamics 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 steering, the analysis of fuel 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 mechanical 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. Sarigul-Klijn, 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 yet-to-be-proposed 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, 149
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.

Exclusive of General Education units, the minimum number of units required for the Mechanical Engineering major is 159.

Lower Division Required Courses

	UNITS
Mathematics 21A-21B-21C-21D	16
Mathematics 22A-22B	6
Physics 9A-9B-9C-9D	19
Chemistry 2A-2B or 2AH-2BH	10
Engineering 4	3
Engineering 6 or Mechanical Engineering 5	4
Engineering 17, 35, 45 (or 45Y).	12
Mechanical Engineering 50	4
English 3 or University Writing Program 1, 1Y or 1V, or Comparative Literature 1, 2, 3, or 4, or Native American Studies 5 (grade of C- or better is required)	4
Communication 1 or 3	4

Upper Division Required Courses

Engineering 100, 102, 103, 104, 105, 190	22
Mechanical Engineering 106, 108, 109, 150A, 165, 172	24
Mechanical Engineering 185A & 185B (taken in consecutive quarters), or Aerospace Science and Engineering 130A & 130B	8
Select one course from the following Applied Mathematics Electives: Chemical Engineering 140, Civil & Environmental Engineering 114, Computer Science Engineering 130, Engineering 180, Mathematics 118A, 128A, 128B, Mechanical Engineering 115, 151, Statistics 130A, 131A	4
Select one course from the following System Dynamics/Mechanical Design Electives: Engineering 122, Mechanical Engineering 121, 139, 150B, 154 or 171	4
Select two courses from the following Restricted Electives: Aerospace Science and Engineering 129, 138, 140, 141, 142; Engineering 122, 188, Materials Science and Engineering 180, 182; Mechanical Engineering 134, 152, 161, 163, 164. Students may also choose from Aerospace Science and Engineering 130A, 130B, Mechanical Engineering 121, 139, 150B, 151, 154, 171 if these courses are not used in satisfaction of other degree requirements	8
Technical Elective Requirement	7

At least four units must be taken from any Upper Division Engineering course, which may include courses from the above 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, 2B, 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, 101, 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 100, 102, 103, 104, 106, 108

Upper Division Composition Requirement .... 0 or 4
One course from the following (a grade of C- or better is required): University Writing Program 101, 102E, 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 Saponara, Ph.D., Assistant 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

The Aerospace Science and Engineering program is accredited by the Engineering Accreditation Commission of ABET; *http://www.abet.org*.

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 and fundamental education in mathematics, 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 163.

Lower Division Required Courses

	UNITS
Mathematics 21A-21B-21C-21D	16
Mathematics 22A-22B	6
Physics 9A-9B-9C-9D	19
Chemistry 2A-2B or 2AH-2BH	10
Engineering 4	3
Engineering 6 or Mechanical Engineering 5	4
Engineering 17, 35, 45 (or 45Y)	12
English 3 or University Writing Program 1, 1Y or 1V, or Comparative Literature 1, 2, 3, or 4, or Native American Studies 5 (grade of C- or better is required)	4
Communication 1 or 3	4

Upper Division Required Courses

Engineering 100, 102, 103, 104, 105, 190	22
Mechanical Engineering 106, 108, 109, 165, 172	20
Aerospace Science and Engineering 127, 129, 130A, 130B, 133, 135, 138	28
Select one course from: Engineering 180, Mechanical Engineering 115 or Mathematics 128C	4
Technical electives	12

One course must be chosen from the following astronautics electives: Aerospace Science and Engineering 140, 141 or 142
The remaining units must be taken from: EME 139 or EAE 126 or from the above Astronautics Electives list if not used in satisfaction of other degree requirements.
Up to 4 units may be selected from any upper-division engineering course including any engineering 192 or 199 not used in satisfaction of other degree requirements.
Courses that cannot be used are Biomedical Engineering 110L, Engineering 160, Computer Science Engineering 188 or any 197Tcourse.

Upper Division Composition Requirement .... 0 or 4
One course from the following (grade of C- or better is required): University Writing Program 101, 102E, 104A, 104E, 104T 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, aerostructures, 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 in engineering fundamentals. They 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 aerostructures
- Spacecraft design and operation
- Space environmental studies
- Remote sensing
- Electrical propulsion
- Flight dynamics and control
- Computational fluid dynamics
- Experimental MHD turbulence studies
- Dynamic systems and controls
- Robotics
- Materials modeling
- 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 (EAE) 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, discussions of the practice with respect to engineering principles, ethics, and responsibilities. (P/NP grading only.)—*F. (F.)*

5. 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.—*F. (F.)* 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 instructions, computer-aided manufacturing and their role in the engineering design and development process. GE credit: SciEng | QL, SE, VL.—*F, W, Su. (F, W, Su.)* Farouki, 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 flow, ideal gas mixtures, psychrometrics, reacting mixtures and combustion. GE credit: SciEng | SE.—*F, W, S. (F, W, S.)* Aldredge, Kennedy, Park

108. Measurement Systems (4)
Lecture—2 hours; laboratory—3 hours; discussion—1 hour. Prerequisite: C- or better in Engineering 100 and Engineering 102; Engineering 104 recommended. Restricted to Mechanical Engineering, Aerospace Science & Engineering and Mechanical/Materials Science & Engineering. Stability of flexible systems. Introduction to fluid-structure interaction. Mechanical vibrations. 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. Three units of credit for students who have previously taken Biomedical Engineering 111; two units of credit for students who have previously taken Biological Systems Engineering 165; one unit of credit allowed for students who have completed course 107B (former version of course 108). GE credit: SciEng | QL, SE, VL, WE.—*F, W, S. (F, W, S.)* Erickson, Hill, Horsley, La Saponara

109. Experimental Methods for Thermal Fluids (4)
Lecture—2 hours; laboratory—1.5 hours; discussion—1 hour; extensive writing. Prerequisite: grade of C- or better in course 106. Restricted to Mechanical Engineering, Aerospace Science & Engineering and Mechanical/Materials Science Engineering Majors. Experiments to illustrate principles of thermal-fluid systems. Statistical and uncertainty analysis of data; statistical design of experiments; measurement devices; experiments involving thermodynamic cycles, combustion, compressible and incompressible flows. Not open for credit to students who have completed Chemical Engineering 150A. GE credit: SciEng | QL, SE, VL.—*F, W, S. (F, W, S.)* Aldredge, Davis, Delplanque, Hwang, Kennedy, Robinson

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, sets of linear equations, numerical integration, ordinary differential equations. Not open for credit to students who have taken Applied Science Engineering 115. GE credit: SciEng | SE.—*F, W. (F, W.)* 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, VL.—*S. (S.)* 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 experiments illustrate the dynamic behavior of automobiles, race cars, bicycles, etc. GE credit: SciEng | QL, SE.—*S. (S.)* Karnopp

139. Stability of Flexible Dynamic Systems (4)
Lecture—3 hours; laboratory—3 hours. Prerequisite: grade of C- or better in Engineering 102 and 103. Stability of flexible systems. Introduction to fluid-structure interaction. Mechanical vibrations. Design of mechanical subsystems or systems under constraints. Dynamic instabilities. Flutter. Control effectiveness. Energy extraction from fluid-structure interactions. Design applications to aerospace, mechanical and biomedical systems. No credit for students who have completed Aerospace Science and Engineering 139. GE credit: SciEng | SE.—*S. (S.)* Sarigul-Klijn

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 mechanical measurements using strain gages. GE credit: SciEng | QL, SE, VL, WE.—*F, S, Su. (F, S, Su.)* Hill, Moore, Ravani, Schaaf

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. Principles of engineering mechanics applied to the design and selection of mechanical components. Design projects, which concentrate on conceptual design, engineering analysis, methods of manufacture, material selection, and cost. Introduction to Computer-Aided Design. GE credit: SciEng | QL, SE, VL.—*W, S. (W, S.)* Farouki, Linke

151. Statistical Methods in Design and Manufacturing (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: C- or better in course 150A. Restricted to Restrictions on Enrollment Text: Mechanical Engineering, Aerospace Science and Engineering, Mechanical Engineering/Materials Science and Engineering. Methods of statistical analysis with emphasis on applications in mechanical design and manufacturing. Applications include product evaluation and decision making, stress-strength interference, probabilistic design, systems reliability, and fatigue under random loading. GE credit: SciEng | QL, SE, VL.—*W. (W.)* C. Davis

152. Computer-Aided Mechanism Design (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: C- or better in Engineering 102; C- or better in course 5 or Engineering 6 or Computer Science Engineering 30. Restricted to Mechanical Engineering, Aerospace Science and Engineering, Mechanical Engineering/Materials Science and Engineering. Principles of computer-aided mechanism design. Computer-aided kinematic, static, and dynamic analysis and design of planar mechanisms such as multiple-loop linkages and geared linkages. Introduction to kinematic synthesis of mechanisms. Offered in alternate years. GE credit: SciEng | QL, SE, VL.—*(F.)* Cheng

154. Mechatronics (4)
Lecture—3 hours; laboratory—3 hours. Prerequisite: C- or better in each of the following: Engineering 100 and Engineering 102 and course 50. Restricted to Mechanical Engineering, Aerospace Science and Engineering, Mechanical Engineering/Materials Science and Engineering. Mechatronics system concept and overview, control system design ware architecture, microcontroller and interface technology for mechatronics control, sensor for mechatronics systems, actuator drives. GE credit: SciEng | QL, SE, VL.—*S. (S.)* Yamazaki

161. Combustion and the Environment (4)
Lecture—3 hours; lecture/discussion—1 hour. Prerequisite: grade of C- or better in course 106. Introduction to combustion kinetics; the theory of premixed flames and diffusion flames; turbulent combustion; formation of air pollutants in combustion systems; examples of combustion devices which include internal combustion engines, gas turbines, furnaces and waste incinerators; alternative fuel sources. GE credit: SciEng | QL, SE, VL.—*W. (W.)* Shaw

163. Internal Combustion Engines and Future Alternatives (4)
Lecture—3 hours; laboratory—3 hours. Prerequisite: C- or better in course 50 and course 106. Restricted to Mechanical Engineering, Aerospace Science and Engineering, Mechanical Engineering/Materials Science and Engineering. Fundamentals of internal combustion engine design and performance. Future needs to adapt to environmental concerns, and the feasibility of better alternatives in the future. GE credit: SciEng | QL, SE, VL.—*F. (F.)* Erickson, Park

164. Introduction to Heating, Ventilation and Air Conditioning Systems (4)
Lecture—4 hours. Prerequisite: C- or better in both course 106 and 165. Introduction to basic mechanisms and processes associated with heating, ventilation and air conditioning (HVAC), including equipment and systems used for HVAC in residential and commercial buildings. Only 2 units for students who have completed Civil and Environmental Engineering 125. Offered in alternate years. GE credit: SciEng | SE.—*W.* Modera

165. Heat Transfer (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: C- or better in course 5 or Engineering 6 or Computer Science Engineering 30; C- or better in Engineering 103 and 105. Restricted to Mechanical Engineering, Aerospace Science and Engineering, Mechanical Engineering/Materials Science and Engineering. Conduction, convection, and radiation heat transfer. Computational modeling of heat transfer in engineering. Applications to engineering equipment with the use of digital computers. GE credit: SciEng | QL, SE, VL.—*F, S, Su. (F, S, Su.)* R. Davis, Narayanan, Shaw

171. Analysis, Simulation and Design of Mechatronic Systems (4)
Lecture—3 hours; laboratory—3 hours. Prerequisite: C- or better in Engineering 100 and 102. 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.—*F, W. (F, W.)* Assadian, Horsley, Karnopp

172. Automatic Control of Engineering Systems (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: C- or better in Engineering 100 and 102. Restricted to Mechanical Engineering, Aerospace Science and Engineering, Mechanical Engineering/Materials Science and Engineering. Classical feedback control; block diagrams; control systems performance specifications; steady state errors; rise and settling times; root locus; PID controllers; control design with Bode and Nyquist plots; stability; phase and gain margin; lead and lag compensators; state variable feedback controllers. GE credit: SciEng | QL, SE, VL.—*F, W, S, Su. (F, W, S, Su.)* Eke, Horsley, 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 incorporating appropriate engineering standards and multiple realistic constraints. (Deferred grading only, pending completion of sequence.) GE credit: SciEng | OL, QL, SE, VL, WE.—*W. (W.)* C. Davis, Velinsky, Moore

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.—*S. (S.)* Velinsky, C. Davis, Moore, Robinson

189A. Selected Topics in Mechanical Engineering; Energy Systems and the Environment (1-5)
Prerequisite: consent of instructor. Directed group study in Energy Systems and the Environment. May be repeated for credit when the topic is different. Offered irregularly.

189B. Selected Topics in Mechanical Engineering; Engineering Controls (1-5)
Prerequisite: consent of instructor. Directed group study in Engineering Controls. May be repeated for credit when the topic is different. Offered irregularly.

189C. Selected Topics in Mechanical Engineering; Engineering Dynamics (1-5)
Prerequisite: consent of instructor. Directed group study in Engineering Dynamics. May be repeated for credit when the topic is different. Offered irregularly.

189D. Selected Topics in Mechanical Engineering; Biomechanics (1-5)
Prerequisite: consent of instructor. Directed group study in Biomechanics. May be repeated for credit when the topic is different. Offered irregularly.

189E. Selected Topics in Mechanical Engineering; Fluid Mechanics (1-5)
Prerequisite: consent of instructor. Directed group study in Fluid Mechanics. May be repeated for credit when the topic is different. Offered irregularly.

189F. Selected Topics in Mechanical Engineering; Manufacturing Engineering (1-5)
Prerequisite: consent of instructor. Directed group study in Manufacturing Engineering. May be repeated for credit when the topic is different. Offered irregularly.

189G. Selected Topics in Mechanical Engineering; Mechanical Engineering and Product Design (1-5)
Prerequisite: consent of instructor. Directed group study in Mechanical Engineering and Product Design. May be repeated for credit when the topic is different. Offered irregularly.

189H. Selected Topics in Mechanical Engineering; Mechatronics Systems (1-5)
Prerequisite: consent of instructor. Directed group study in Mechatronics Systems. May be repeated for credit when the topic is different. Offered irregularly.

189I. Selected Topics in Mechanical Engineering; MEMS/Nanotechnology (1-5)
Prerequisite: consent of instructor. Directed group study in MEMS/Nanotechnology. May be repeated for credit when the topic is different. Offered irregularly.

189J. Selected Topics in Mechanical Engineering; Solid and Structural Mechanics (1-5)
Prerequisite: consent of instructor. Directed group study in Solid and Structural Mechanics. May be repeated for credit when the topic is different. Offered irregularly.

189K. Selected Topics in Mechanical Engineering; Thermodynamics (1-5)
Prerequisite: consent of instructor. Directed group study in Thermodynamics. May be repeated for credit when the topic is different. Offered irregularly.

189L. Selected Topics in Mechanical Engineering; Vehicle and Transportation Systems (1-5)
Prerequisite: consent of instructor. Directed group study in Vehicle and Transportation Systems. May be repeated for credit when the topic is different. Offered irregularly.

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

197TC. 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 (1)
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.)—*F. (F.)*

10. From the Wright Brothers to Drones and Quadcopters (2)
Lecture—2 hours. History of aircraft and its influence on society. Topics covered will include Unmanned Aerial Vehicles, safety considerations, economics and privacy issues. Aerodynamics, stability and control will also be introduced. (P/NP grading only.) GE credit: SciEng or SocSci | SE or SS.—*Su. (Su.)*

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.—*S.* Hafez

127. Applied Aircraft Aerodynamics (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: grade of C- or better in Mechanical Engineering 106. Experimental characteristics of wing sections. High-lift devices. Lift and drag at high Mach numbers. Drag aerodynamics. Total aircraft drag estimation. Aerodynamic design procedures. GE credit: QL, SE, SL, WE.—*F. (F.)* Robinson

129. Stability and Control of Aerospace Vehicles (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: grade of C- or better in Engineering 102. Restricted to upper division standing. Aircraft and spacecraft stability and control. Derivation of fundamental equations of motion for aircraft/spacecraft. Specialization of equations for aircraft. Fundamentals of feedback. Aircraft flight control systems. Specialization of equations of motion for orbiting spacecraft. Spacecraft attitude control systems. GE credit: QL, SE.—*W. (W.)* Hess, Kong

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 | SE, QL, VL.—*W. (W.)* 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: OL, SE, SL, VL, WE.—*S. (S.)* 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 due to combined loading. Virtual work principles, and finite element methods. Applications to aerospace structures. GE credit: SE.—*F. (F.)* Sarigul-Klijn

135. Aerospace Structures (4)
Lecture—4 hours. Prerequisite: C- or better in Engineering 104; course 126 or 127 recommended. Analysis and design methods used in aerospace structures. Shear flow in open, closed and multicell beam cross-sections, buckling of flat and curved sheets, tension field beams, local buckling. GE credit: SciEng | QL, SE.—*W. (W.)* La Saponara

137. Structural Composites (4)
Lecture—3 hours; laboratory—1 hour. Prerequisite: grade of C- or better in Engineering 104. Overview of materials and technology for creating structures from fiber reinforced resin matrix composite material systems. Elementary design analysis and case studies emphasizing aeronautical applications. GE credit: SE.—La Saponara

138. Aircraft Propulsion (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: C- or better in Mechanical Engineering 106. Analysis and design of modern aircraft gas turbine engines. Development and application of cycle performance prediction techniques for important engine configurations. Introduction to the operation and design of inlets, compressors, burners, turbines, and nozzles. Cycle design studies for specific applications. GE credit: SciEng | QL, SE.—*W. (W.)* R. Davis

140. Rocket Propulsion (4)
Lecture—4 hours. Prerequisite: C- or better in Mechanical Engineering 106. Restricted to upper division standing. Fluid and thermodynamics of rocket engines, liquid and solid rocket propulsion. Space propulsion concepts and space mission requirements. Not open for credit to students who have taken identical course 189A prior to Fall Quarter 2013. GE credit: SciEng | SE.—*S. (W.)* R. Davis, Delplanque

141. Space Systems Design (4)
Lecture—2 hours; discussion—2 hours. Prerequisite: grade of C- or better in Engineering 102 and Mechanical Engineering 106. Introduction to space systems design including space project organization, requirements definition 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: SciEng | SE.—*F. (F.)* Joshi

142. Orbital Mechanics (4)
Lecture—4 hours. Prerequisite: grade of C- or better in Engineering 102. Restricted to upper division standing. Satellite orbits, multistage rockets, current global boosters, and new technologies. Design application problems include satellites, trajectory optimizations, and interplanetary trajectories. Not open for credit to student who have completed course 189B prior to Fall Quarter 2013. GE credit: SciEng | SE.—*W, Su. (Su.)*

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 to prepare students for any type of flight testing including fixed wing, rotary wing and launch vehicles. Offered irregularly. GE credit: SciEng | 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, regressions and general and detailed uncertainty analysis, including statistical treatment of experimental data intervals, propagation of bias and precision errors, correlated bias approximations, and using jitter programs.—*F. (S.)* C. Davis

208. Measurement Methods in Fluid Mechanics and Combustion (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: course 165 and Engineering 103. Application of shadow, schlieren and other flow visualization methods. Introduction to optics and lasers. Measurement of velocity and concentrations in reacting and nonreacting flows with laser diagnostic techniques including LDV, Rayleigh, Raman and fluorescence scattering and CARS. Offered irregularly.

210A. Advanced Fluid Mechanics and Heat Transfer (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: Engineering 103, 105 and Mechanical Engineering 165. Development of differential equations governing continuity, momentum and energy transfer. Solutions in laminar flow for exact cases, low and high Reynolds numbers and lubrication theory. Dynamics of inviscid flow.—*F. (F.)* Aldredge, Shaw

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.—*W. (W.)* Hwang

211. Fluid Flow and Heat Transfer (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: Engineering 103, 105 and Mechanical Engineering 165 or the equivalent. Design aspects of selected topics; heat conduction, fins; heat transport in ducts, boundary layers and separated flows; heat exchangers.—*W. Erickson, Park, Narayanan*

212. Biomedical Heat and Mass Transport Processes (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: Mechanical Engineering 165, 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 biomedical system and its environment, mass transfer across cell membranes and the design and analysis of artificial human organs. (Same course as Biomedical Engineering 212.) Offered irregularly.—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 equations; second order closures and their simplification; numerical methods; application to boundary layer-type flows; two-dimensional and three-dimensional hydraulic and environmental flows. Offered irregularly.—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.) Offered irregularly.

216. Advanced Thermodynamics (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: Engineering 105. Study of topics important to energy conversion systems, propulsion and other systems using high temperature gases. Classical thermodynamics and quantum statistical mechanics of nonreacting and chemically reacting gases, gas mixtures, and other substances. Offered in alternate years.—*W.* Shaw

217. Combustion (4)
Lecture—3 hours; lecture/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. Offered in alternate years.—*(W.)* 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 overall powerplant performance for one advanced concept such as a fusion, magnetohydrodynamic, or solar electric powerplant.—*(F.)* Erickson

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.—*F. (F.)* Delplanque

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; autocorrelation; spectral density; first passage and fatigue failure; nonlinear systems; phase plane. Offered in alternate years.—Eke

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.—*F. (F.)* Karnopp

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, Kane's methods; computer-aided equation derivation; orientation; Euler; Rodrigues parameters. (Same course as Biomedical Engineering 223.)—*W, S. (W.)* Eke, Ravani

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, robot workspace, path planning, robot programming, real-time architecture and software implementation. (Same course as Biomedical Engineering 225.) Offered irregularly.—Ravani

226. Acoustics and Noise Control (4)
Lecture—4 hours. Prerequisite: Engineering 122. Description of sound using normal modes and waves; interaction between vibrating solids 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.—Sarigul-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, force platform 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.) Offered irregularly.

228. Introduction to BioMEMS (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: BS engineering discipline or consent of instructor. Ideal for beginning graduate or advanced undergraduate students interested in microelectromechanical systems (MEMS) topics related to biological applications. Covers topics from various disciplines related to BioMEMS: mechanical, electrical, biomedical, chemical engineering, and materials science. Offered in alternate years.—*F.* C. Davis

229. Design & Analysis of Micro-Electromechanical Systems (4)
Lecture—4 hours. Prerequisite: consent of instructor; Engineering 45, 100, 104; Engineering 122 recommended. Mechanical design of micro-electronmechanical 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. Offered in alternate years.—*S. (S.)* Horsley

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 kinetic analysis, computation of intersegmental load and muscle forces, applications to gait analysis and sports biomechanics. (Same course as Biomedical Engineering 231.) Offered irregularly.

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 changes in these properties caused by aging and disease. The tissues covered include bone, cartilage and synovial fluid, ligament and tendon. (Same course as Biomedical Engineering 232.)—*S. (S.)* Fyhrie

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

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

237. Analysis 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 aerospace structural analysis.—*S. (F.)* La Saponara

238. Advanced Aerodynamic Design and Optimization (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: consent of instructor. Application of aerodynamic theory to obtain optimum aerodynamic shapes. Both analytic solutions and solutions obtained with numerical optimization techniques will be examined. Includes introduction to the calculus of variations and numerical optimization techniques. Offered irregularly.—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 design optimization methods, with application to modeling of complex mechanical, aerospace and biomedical systems. Application of states of the art in finite elements in optimum design of components under realistic loading conditions and constraints. (Same course as Biomedical Engineering 239.) Offered in alternate years.—*W.* Sarigul-Klijn

240. Computational Methods in Nonlinear Mechanics (4)
Lecture—4 hours. Prerequisite: Applied Science Engineering 115 or Mathematics 128B or Engineering 180. Deformation of solids and the motion of fluids treated with state-of-the-art computational methods. Numerical treatment of nonlinear dynamics; classification of coupled problems; applications of finite element methods to mechanical, aeronautical, and biological systems. (Same course as Biomedical Engineering 240.) Offered irregularly.—Sarigul-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 monolithic and composite construction considered. Buckling of stiffened panels, shells, and thin-walled beams, experimental methods and failure/crippling processes. Offered irregularly.—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 turbomachine and configurations and approximations to optimum dimensions and flow angles. Introduction to through flow analysis. Rotating stall and surge, and aeromechanical considerations. Offered in alternate years.—*S. (S.)* R. Davis

250A. Advanced Methods in Mechanical Design (4)
Lecture—4 hours. Prerequisite: Mechanical Engineering 150A and 150B or the equivalents, or consent of instructor. Applications of 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.—*F. (F.)* Ravani, Velinsky

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. Design projects emphasizing advanced analysis tools.—*W.* 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 phenomenon. Use of stress and strain to predict crack initiation. Use of fracture mechanics to predict failure and crack propagation. Effects of stress concentration, manufacturing, load sequence, irregular loading, and multi-axial loading.—Hill

251. Mechatronics System Design (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: Mechanical Engineering 154 and 172 or Electrical and Computer Engineering 157A, 157B. Motion mechanism design, electric actuator, power electronics motion control, sensor technologies, personal computer-based control systems design, motion control general operating system and real time operating systems, motion control software design, discrete event control software design. Offered in alternate years.—*W. (W.)* Yamazaki

252. Information Processing for Autonomous Robotics (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: Engineering 6, Mechanical Engineering 5, or equivalent programming experience, Mechanical Engineering 154, 171, or consent of instructor. Computational principles for sensing, reasoning, and navigation for autonomous robots. Offered in alternate years.—*W. (W.)* Joshi

253. Network Theory and Applications (4)
Lecture/discussion—4 hours. Prerequisite: Mathematics 22A; Mathematics 22B; Statistics 13 or 120; experience with computer software; or consent of instructor. Develops the mathematical theory underlying growth, structure and function of networks with applications to physical, social, biological and engineered systems. Topics include network growth, resilience, epidemiology, phase transitions, software and algorithms, routing and search control, cascading failures. (Same course as Computer Science Engineering 253.) Offered in alternate years.—*F.* D'Souza

254. Engineering Software Design (4)
Lecture—3 hours; laboratory—3 hours. Prerequisite: Mechanical Engineering 5, Engineering 180. Principle and design of engineering software. 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. Offered in alternate years.—*F.* 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. Interpolation and approximation methods. Intersections, offsets, and blends. Path planning for machining, inspection, and robotics applications. Offered in alternate years.—*S.* 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, performance, 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. Offered irregularly.

261. 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 characteristics. Offered irregularly.

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

263. Introduction to Computational Aerodynamics and Fluid Dynamics (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: Engineering 103 or consent of instructor. Introduction 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, diffusion phenomena, or equilibrium. Application to the incompressible Navier-Stokes equation. Offered irregularly.

264. Computational Aerodynamics (4)
Lecture—4 hours. Prerequisite: Aeronautical Science and Engineering 126, Engineering 180, or consent of instructor. Numerical methods for aerodynamics flow simulation in the transonic regime. Solutions 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. Offered irregularly.—Hafez

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. Offered irregularly.—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. Offered in alternate years.—*(F.)* 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. Offered in alternate years.—*F. (F.)* 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. Limited enrollment. 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. Offered in alternate years.—*S.* Erickson

271. Advanced Modeling and Simulation of Mechatronic Systems (4)
Lecture—3 hours; laboratory—3 hours. Prerequisite: Mechanical Engineering 172 or the equivalent. Multiport 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.—*F. (F.)*

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; benefits and cost of feedback. Analysis and design of control systems based on classical and modern approaches, with emphasis on applications to mechanical and aeronautical systems.—Assadian

274. Analysis and Design of Digital Control Systems (4)
Lecture—3 hours; discussion—1 hour. Prerequisite: Mechanical Engineering 172. Discrete systems analysis; digital filtering; sample data systems; state space and transform design techniques; quantization effects; multi-input, multi-output systems. Offered in alternate years.—*(S.)* Hess

275. Advance Aircraft Stability and Control (4)
Lecture—3 hours; discussion—1 hour. Development and analysis of aircraft equations of motion. Flexible modes. Response to control actuation. Random inputs and disturbances. Stability and control augmentation system design. Handling qualities. Offered in alternate years.—*S.* Hess, Kong

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, fundamentals of interfaces between computers and experimental equipment, programming techniques for data acquisition and control, basic data analysis. Offered in alternate years.

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.)—*F, W, S. (F, W, S.)*

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.)—*F, W, S. (F, W, S.)*

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 associate-in 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.)—*F, W, S. (F, W, S.)*

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

English

(College of Letters and Science)

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

Department Office. 176 Voorhies Hall
530-752-2257; *http://english.ucdavis.edu*

Faculty

Gina Bloom, Ph.D., Associate Professor
Stephanie Boluk, Ph.D., Assistant Professor
Seeta Chaganti, Ph.D., Associate Professor
Academic Senate Distinguished Teaching Award
Joshua Clover, M.F.A., Professor
Lucy Corin, M.F.A., Professor
Gregory Dobbins, Ph.D., Associate Professor
Frances E. Dolan, Ph.D., Professor
Academic Senate Distinguished Teaching Award
Margaret W. Ferguson, Ph.D., Professor
Academic Senate Distinguished Teaching Award
Kathleen Frederickson, Ph.D., Associate Professor
Elizabeth S. Freeman, Ph.D., Professor
Academic Senate Distinguished Teaching Award
Danielle Heard, Ph.D., Assistant Professor
W. Jack Hicks, Ph.D., Senior Lecturer
Pam Houston, B.A., Professor
Hsuan Hsu, Ph.D., Professor
Mark Jerng, Ph.D., Associate Professor
Alessa Johns, Ph.D., Professor
Richard A. Levin, Ph.D., Professor
Academic Senate Distinguished Teaching Award
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Desirée Martín Ph.D., Associate Professor
John Marx, Ph.D., Professor
Tobias Menely, Ph.D., Assistant Professor
Colin Milburn, Ph.D., Professor
Elizabeth Miller, Ph.D., Professor
Katie Peterson, Ph.D., Assistant Professor
Margaret Ronda, Ph.D., Assistant Professor
Parama Roy, Ph.D., Professor
Scott C. Shershow, Ph.D., Professor
Scott Simmon, Ph.D., Professor
David Simpson, Ph.D., Professor
Matthew Stratton, Ph.D., Associate Professor
Matthew Vernon, Ph.D., Assistant Professor
Claire Waters, Ph.D., Professor
Evan Watkins, Ph.D., Professor
Joe Wenderoth, M.F.A., Professor
Michael Ziser, Ph.D., Associate Professor

Emeriti Faculty

Don P. Abbott, Ph.D., Professor Emeritus
Max Byrd, Ph.D., Professor Emeritus
Peter Dale, Ph.D., Professor Emeritus
Joanne F. Diehl, Ph.D., Professor Emerita
Lynn R. Freed, Ph.D., Professor Emerita
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Clarence Major, Ph.D., Professor Emeritus
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Linda A. Morris, Ph.D., Professor Emerita
James J. Murphy, Ph.D., Professor Emeritus
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Gwendolyn Schwabe, M.S., Senior Lecturer Emerita
Gary Snyder, B.A., Professor Emeritus
Raymond B. Waddington, Ph.D., Professor Emeritus
Alan B. Williamson, Ph.D., Professor Emeritus
Karl F. Zender, Ph.D., Professor Emeritus

The Major Program

The study of English develops skills in reading analytically and perceptively and in writing clearly and effectively.

The Program. The English department offers three kinds of courses: composition courses, undergraduate courses, and graduate courses. Composition courses develop skills in reading analytically and in writing persuasively. Undergraduate and graduate courses cover the entire range of English and American literature, as well as creative writing. Students majoring in English may elect a creative writing emphasis or a literature, criticism, and theory emphasis. All majors take courses introducing them to the literatures of various periods and places, to critical theory, and to frontiers of literary expression, such as the relationship of literature to environmentalism or the emergence of new media. The creative writing emphasis focuses on fiction, poetry, and article writing. The literature, criticism, and theory emphasis focuses on advanced critical analysis and research. All majors have the opportunity to work with distinguished writers, critics, scholars, and teachers.

Career Alternatives. Graduates have found the major excellent pre-professional training for careers in teaching, writing, law, medicine, library work, journalism, and more. Many graduates are employed in publishing, marketing, advertising, or the tech sector. Others have worked in local, state, and federal government agencies, as well as in industry. Many have gone on to graduate study in a wide range of fields including English, education, counseling, and more.

A.B. Major Requirements:

UNITS

Preparatory Subject Matter...................20
English 3 or University Writing Program 1..4
One course from: English 40, 43, 44, 45... 4
English 10A, 10B, 10C 12

Depth Subject Matter............................44
English 110A or 110B............................4
Historical Distribution Requirements 20
Three courses focusing on literature written in English before 1800, at least one of which must be on literature written primarily before 1500:
Before 1500
English 111, 113A, 113B
1500-1800
English 115, 117, 122, 123, 142, 150A, 155A, 185A
One course focusing on literature written in English between 1800 and 1900:
English 130, 133, 143, 144, 155B, 158A, 181A, 185B
One course focusing on literature written in English between 1900 and present:
English 137N, 138, 146N, 147, 150B, 155C, 156, 158B, 166, 167, 168, 181B, 185C
Non-Historical Distribution Requirements ... 8
One course on literature and ethnicity, literature and gender, or literature and sexuality:
English 125, 139, 140, 141, 166, 167, 178, 179, 181A, 181B, 185A, 185B, 185C, 186
One course in film and media studies, language studies, cultural studies and contexts, literature and science/technology, or literature and the environment:
English 105, 106, 107, 120, 160, 161A, 161B, 162, 164/Science and Technology Studies 164, 171A, 171B, 172, 173, 175, 180, 182, 183, 184; Linguistics 106; Science and Technology Studies 173
Please note that while some courses are identified as fulfilling more than one