MATH 209C. Real Analysis (4) Lecture, 3 hours; outside research, 3 hours. Prerequisite(s): MATH 209B. Topics include complex measures, general measure spaces, integration on product spaces, and Lebesgue spaces.

MATH 210A. Complex Analysis (4) Lecture, 3 hours; outside research, 3 hours. Prerequisite(s): MATH 151C, MATH 165A. Studies include complex analytic functions, Cauchy's theorem, Cauchy's integral formula and the Laurent series, and the residue theorem.

MATH 210B. Complex Analysis (4) Lecture, 3 hours; outside research, 3 hours. Prerequisite(s): MATH 210A. Studies include entire and meromorphic functions, normal families and the Riemann mapping theorem, and harmonic functions and the Dirichlet problem.

MATH 211A. Ordinary Differential Equations (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): MATH 151C. Topics include the existence and uniqueness of solutions, linear differential equations, singularities of the first and second kind, self-adjoint eigenvalue problems on a finite interval, and singular self-adjoint boundary-value problems for second-order equations.

MATH 211B. Ordinary Differential Equations (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): MATH 211A. Topics include the method of averaging and numerical integration, autonomous systems, the method of Liapounov, and stability for linear systems.

MATH 212. Partial Differential Equations (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): MATH 151C and MATH 165A. Classical theory of initial and boundary value problems for hyperbolic, parabolic and elliptic partial differential equations.

MATH 216A. Combinatorial Theory (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): CS 111/MATH 111. Addresses the solving of combinatorial problems by studying their morphisms (transformations preserving the problem). Covers optimum path problems and their variants. Develops general techniques and work through the solutions of challenging special cases. Particular focus given to utilizing symmetry to systematically reduce a problem.

MATH 216B. Combinatorial Theory (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): MATH 216A. Addresses the solving of combinatorial problems by studying their morphisms (transformations preserving the problem). Covers optimum flow problems. Develops general techniques and work through the solutions of challenging special cases. Particular focus given to utilizing symmetry to systematically reduce a problem.

MATH 217. Theory of Probability (4) Lecture, 3 hours; outside research, 3 hours. Prerequisite(s): MATH 209C. Topics include independence, strong limit theorems including the strong law and the Kolmogorov three-series theorem, weak law and the central limit theorem, the Helly-Bray theorem, and Bochner's theorem on positive definite functions.

MATH 221. Several Complex Variables (4) Lecture, 3 hours; research, 3 hours. Prerequisite(s): MATH 151A, MATH 151B, MATH 165A, MATH 165B. Hartog's theorem, domains of holomorphy, pseudo-convexity, Levi's problem, coherent analytic sheaves, Cartan's theorems A and B.

MATH 223. Algebraic Number Theory (4) Lecture, 3 hours; outside research, 3 hours. Prerequisite(s): MATH 201A. Topics include algebraic number theory, principal ideal domains, integral independence, algebraic number fields, classical ideal theory in Dedekind domains, classes of ideals, valuations, and p-adic numbers.

MATH 224. Introduction to Homological Algebra (4) Lecture, 3 hours; outside research, 3 hours. Prerequisite(s): MATH 201C or consent of instructor. Theory of derived functors and its application to rings and associative algebras.

MATH 225. Commutative Algebra (4) Lecture, 3 hours; outside research, 3 hours. Prerequisite(s): MATH 201C. Covers basic theory of commutative rings, primary decomposition, integral dependence and valuation rings, and the intersection theorem of Krull.

MATH 227A. Lie Algebras (4) Lecture, 3 hours; outside research, 3 hours. Prerequisite(s): MATH 201A, MATH 201B. Studies include basic definitions, solvable and nilpotent Lie algebras, and structure and classification of semisimple Lie algebras.

MATH 227B. Lie Algebras (4) Lecture, 3 hours; outside research, 3 hours. Prerequisite(s): MATH 227A. Studies include enveloping algebras and representation theory, representations of semisimple Lie algebras, generalization to Kac-Moody Lie algebras, and modular Lie algebras.

MATH 228. Functional Analysis (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): MATH 209A, MATH 209B, MATH 209C. Topological linear spaces; function spaces; linear operators; spectral theory; operational calculus; and further selected topics.

MATH 232A. Geometry I (Introduction to Manifolds) (4) Lecture, 3 hours; outside research, 3 hours. Prerequisite(s): MATH 131 and MATH 151C. Basic notions and examples; vector fields and flows; tensors and vector bundles; differential forms, integration and deRham's theorem.

MATH 232B. Geometry II (Introduction to Differential) (4) Lecture, 3 hours; outside research, 3 hours. Prerequisite(s): MATH 232A. Local and global theory of curves. Surfaces in R3: the Gauss map, fundamental forms, curvature. Riemannian geometry: the Levi-Civita connection, curvature, geodesics, exponential map, completeness, Gauss-Bonnet theorem for surfaces.


MATH 242. Mathematical Physics: Quantum Mechanics (4) Lecture, 3 hours; outside research, 3 hours. Prerequisite(s): MATH 209A, MATH 209B, MATH 209C, MATH 228; or consent of instructor. Foundations of quantum theory together with the relevant mathematics. Probabilistic interpretation of quantum mechanics, self-adjoint operators and physical observables, noncommutativity and the uncertainty principle. Spectral theory for (unbounded) self-adjoint operators. Stone's theorem and other topics.

MATH 243A. Algebraic Geometry (4) Lecture, 3 hours; outside research, 3 hours. Prerequisite(s): MATH 201A, MATH 201B. Topics include algebraic varieties in affine and projective space and their basic attributes such as dimension, degree, tangent space, and singularities; and products, mappings, and correspondences.

MATH 243B. Algebraic Geometry (4) Lecture, 3 hours; outside research, 3 hours. Prerequisite(s): MATH 243A. Topics include further study of varieties, sheaves, and cohomology and detailed study of curves and special topics.

MATH 246A. Algebraic Topology (4) Lecture, 3 hours; outside research, 3 hours. Prerequisite(s): MATH 205A; MATH 205B or equivalent. Topics include simplicial and cell complexes, polyhedra, manifolds, homology and cohomology theory, and homotopy theory.

MATH 246B. Algebraic Topology (4) Lecture, 3 hours; outside research, 3 hours. Prerequisite(s): MATH 246A. Covers topics such as topological indices, Lefschetz fixed point theorem, Poincare duality, vector bundles and characteristic classes, and transformation groups.

MATH 260. Seminar (1-4) variable hours. Prerequisite(s): consent of department. Seminar on special topics of mathematics in preparation for individual research. Course is repeatable.

MATH 289. Colloquium in Mathematics (1) Prerequisite(s): graduate standing. Specialized discussions by staff, students and visiting scientists on current research topics in Mathematics. Graded Satisfactory (S) or No Credit (NC). Course is repeatable.

MATH 290. Directed Studies (1-6) Prerequisite(s): consent of instructor. Research and special studies in mathematics. Graded Satisfactory (S) or No Credit (NC). Course is repeatable.

MATH 299. Research for Thesis or Dissertation (1-12) Prerequisite(s): consent of department. Graded Satisfactory (S) or No Credit (NC). Course is repeatable.

Professional Course

MATH 302. Apprentice Teaching (2-4) Lecture, 0-1 hour; seminar, 2-4 hours; consultation, 1-2 hours. Prerequisite(s): appointment as a teaching assistant or associate in Mathematics. Supervised training for teaching in lower- and upper-division Mathematics courses. Topics include effective teaching methods, such as those involved in leading mathematics discussions, preparing and grading examinations, and relating to students. Required each quarter of all teaching assistants and associates in Mathematics. Units to be decided in consultation with graduate advisor. Graded Satisfactory (S) or No Credit (NC). Course is repeatable.

Mechanical Engineering

Subject abbreviation: ME
The Marian and Rosemary Bouns
College of Engineering

Shankar Mahalingam, Ph.D., Chair
Department Office, A342 Bourns Hall
(951) 827-5830; www.me.ucr.edu

Professors
Reza Abbasi-Chian, Ph.D.
Qing Jiang, Ph.D.
Shankar Mahalingam, Ph.D.
Kambiz Vafai, Ph.D.
Akula Venkatram, Ph.D.
Guanshui Xu, Ph.D.

Associate Professors
Guillermo Aguilar, Ph.D.
Cengiz Ozkan, Ph.D.
3. PHYS 040A, PHYS 040B, PHYS 040C

Major Requirements
1. Lower-division requirements (74 units)
   a) BIOL 003, BIOL 005A, BIOL 051A
   b) CHEM 001A, CHEM 001B, CHEM 01LA, CHEM 01LB
   c) EE 001A, EE 01LA
   d) MATH 008B or MATH 009A, MATH 009B, MATH 009C, MATH 01A, MATH 01B, MATH 046
   e) ME 001A, ME 001B, ME 001C, ME 009, ME 010, ME 018
   f) PHYS 040A, PHYS 040B, PHYS 040C

2. Upper-division requirements (77 units)
   a) ME 100A, ME 103, ME 110, ME 113, ME 114, ME 116A, ME 118, ME 120, ME 130, ME 135, ME 170A, ME 170B, ME 175A, ME 175B, ME 175C
   b) STAT 100A

c) Choose one Focus Area:
   (1) Mechanics of Materials and Structures
      Sixteen (16) units of technical electives chosen from ME 100B, ME 121, ME 153, ME 156, ME 180, ME 197
   (2) Energy and Environment
      Sixteen (16) units of technical electives chosen from ME 100B, ME 116B, ME 117, ME 135, ME 136, ME 197
   (3) Design and Manufacturing
      Sixteen (16) units of technical electives chosen from ME 121, ME 122, ME 131, ME 133, ME 153, ME 156, ME 174, ME 180, ME 197
   (4) General Mechanical Engineering
      Sixteen (16) units of technical electives chosen from selected from the following list, in consultation with an advisor:
      ME 100B, ME 116B, ME 117, ME 121, ME 122, ME 131, ME 133, ME 136, ME 137, ME 138, ME 153, ME 156, ME 174, ME 180, ME 197

Visit the Student Affairs Office in the College of Engineering or www.engr.ucr.edu/studentaffairs for a sample program.

Graduate Program
The Department of Mechanical Engineering offers graduate educational programs leading to M.S. and Ph.D. degrees in Mechanical Engineering. Broad areas of research include 1) mechanics and materials, 2) fluids and thermal sciences and 3) information computation and design. Specific research focus areas include the following:
- Air quality, small and large-scale pollutant dispersion in urban flows, turbulent combustion and wildland fire behavior, engine emissions and nanoparticle science, thermal and electrical properties of nanowires and nanotubes, direct energy conversion, porous media and multiphase transport, bioheat transfer, biomedical optics, and medical laser applications
- Wafer fab processing, thin film mechanics and nanotechnology, bio-inspired materials, mechanical behavior of thin films and other small-featured structures, mechanics of interfaces and surfaces, mechanical properties of carbon nanotubes and ferroelectric/piezoelectric materials, sensing and imaging, mechanics of geophysical materials, advanced material synthesis, composites, MEME, BioMEMS, biomedical devices, and processing of nanocrystalline materials
- Artificial intelligence, computer-aided design or manufacturing, process planning, sensor networks, and distributed computing and control

Visit www.me.ucr.edu/programs/gradindex.html, for detailed information on the research programs of individual faculty members.

Combined B.S. + M.S. Five-Year Program
The college offers a combined B.S. + M.S. program in Mechanical Engineering designed to lead to a Bachelor of Science degree as well as a Master of Science degree in five years. Applicants for this program must have a high school GPA above 3.6, a combined SAT Reasoning score above 1950 (or ACT plus Writing equivalent), complete the Entry Level Writing Requirement before matriculation, and have sufficient mathematics preparation to enroll in calculus in their first quarter as freshmen.

Interested students who are entering their junior year should check with their academic advisor for information on eligibility and other details.

Admission
In addition to the following requirements, all applicants must meet the general requirements of the Riverside Division of the Academic Senate and the UCR Graduate Council as set forth in this catalog under the Graduate Studies section.

Language Requirement
All international students whose first language is not English must demonstrate proficiency in spoken English by securing at least a “conditional pass” score on the TAST or SPEAK test before they can be appointed as a TA. However, to be considered for subsequent TA appointments, they must secure a “clear pass” on the TAST or SPEAK. The fee associated with this test is paid by the department for the first attempt only. The TAST or SPEAK requirement is, however, waived for international students who are appointed as GSRs or are self-supported throughout their studies at UCR.

Master’s Degree
The Department of Mechanical Engineering offers the M.S. degree in Mechanical Engineering.

Admission
Applicants should have an undergraduate degree in engineering, physical sciences, or mathematics; a satisfactory GPA for the last two years of their undergraduate studies;
and high scores on the GRE General Test. All official transcripts, official GRE reports and three letters of recommendation must be submitted for evaluation. Foreign students and permanent residents whose first language is not English must also submit an acceptable TOEFL test score prior to admittance; the minimum TOEFL exam score is 550 (paper-based), 213 (computer-based), or 80 (Internet-based).

The M.S. degree in Mechanical Engineering can be earned by either completing a thesis (Plan I), which reports a creative investigation of a defined problem, or passing a comprehensive examination (Plan II). A minimum of three quarters of residency is required. Students should enroll in 12 units each quarter unless the graduate advisor grants an exception.

Course work used to satisfy the student's undergraduate degree requirements may not be applied toward the 36-unit M.S. requirement. 

**Plan I (Thesis)** requires completion of a minimum of 36 units of upper-division and graduate-level approved course work and submission of an acceptable thesis. At least 24 of these units must be in graduate courses (200-series courses), a minimum of four of these being Mechanical Engineering graduate courses (ME 200 or higher, excluding ME 250, ME 290, ME 297, ME 298I, and ME 299). The student must take 1 unit of seminar (ME 250) and at least 7 but no more than 11 units of directed or thesis research credits (ME 297 or ME 299). No more than 8 units of course work may be satisfied with directed studies (ME 290) or individual internship (ME 298I). Students must defend the thesis.

**Plan II (Comprehensive Examination)** requires completion of a minimum of 36 units of upper-division and graduate-level approved course work and successfully passing a comprehensive examination. At least 24 of these units must be in graduate courses (200 series courses), a minimum of four of these being Mechanical Engineering graduate courses (ME 200 or higher, excluding ME 250, ME 290, ME 297, ME 298I, and ME 299). The student must take 1 unit of seminar (ME 250) and no more than 7 units of directed studies (ME 290) or individual internship (ME 298I). The comprehensive examination covers a broad range of topics chosen from upper-division and graduate courses the student has taken. This examination is prepared and administered by the graduate program committee. It is held during the spring quarter of every year.

**Doctoral Degree**

The Department of Mechanical Engineering offers the Ph.D. degree in Mechanical Engineering. 

**Admission** An M.S. or equivalent degree in engineering or physical sciences or mathematics is normally required for admission to the Ph.D. program, although applicants with exceptional undergraduate or research record may be admitted directly into the Ph.D. program without an M.S. degree. Applicants for the Ph.D. degree must also meet the same requirements as for the master's programs. Students in the M.S. program of Mechanical Engineering who desire to pursue the Ph.D. degree must formally apply for admission to the Ph.D. program.

The procedure for satisfying the requirements for the Ph.D. degree in Mechanical Engineering at UCR consists of four principal parts:

1. Successful completion of an approved program of coursework
2. Passing a written and oral preliminary examination
3. Oral defense of a dissertation proposal written and submitted by the candidate
4. Defense and approval of the dissertation

**Course Work** Although there is no strict course or unit requirement, the department recommends a minimum of 36 units of graduate-level and upper-division courses, exclusive of seminar and research (ME 250, ME 297, and ME 299). In addition, students must fulfill a six-quarter residency requirement. Students must take a seminar (ME 250) for at least three quarters. They must pursue a program of study that includes the following:

   1. A major area of study intended to increase the student's depth of knowledge in a major area (i.e., an area of specialty in mechanical engineering); and
   2. A minor area of study intended to support and increase the student's breadth of knowledge in the major area, the minor area being in a basic science area related to the student's area of specialty.

A coherent program of at least 24 units of graduate course work (including 16 units of Mechanical Engineering Graduate courses) in the major area should satisfy the major requirement. A coherent program of at least 12 units of graduate or upper-division course work, or both, in the minor area should satisfy the minor requirement. The student and the faculty advisor should formulate this program within two quarters after admission to the program, and it must be approved by the student's advisor and graduate committee. Changes to the program may occur as the student's research progresses and should be documented after consultation with the advisor and graduate committee.

**Written and Oral Preliminary Examination** The examination aims to screen candidates for pursuing doctoral studies. It is administered by the graduate program committee and is composed of two sessions:

   1. Session 1: Engineering Principles
   2. Session 2: An area of specialty in mechanical engineering

Normally, both sessions are completed within a one-week period. Session 1 is a written examination designed to test understanding of concepts and methods used in mechanical engineering. It covers three subject areas to be selected by the student. For details, consult the departmental guidelines. Problems will be typical of those encountered in upper-division courses of undergraduate engineering curricula in U.S. schools with graduate-level understanding. Session 2 is conducted orally and assesses the student's ability to conduct independent research. Consult departmental guidelines for details. The preliminary examination is normally offered once every year in the spring quarter.

**Dissertation and Final Oral Examination** After successfully completing the preliminary examination, the student, with advice from the advisor, recommends a qualifying committee and prepares a dissertation proposal. The dissertation proposal consists of a written document and an oral presentation or defense. Typically, the student submits a dissertation proposal to the qualifying committee within one year after successfully completing the preliminary examination. The qualifying committee chair normally schedules an oral defense within one month of the written proposal submission. The presentation is given only to the qualifying committee members. The student is advanced to candidacy after successfully completing this examination.

After completing the dissertation research, a written draft copy of the completed dissertation must be submitted to the dissertation committee for review, evaluation, and determination of whether the draft thesis is ready for oral defense. Once a draft has been approved for defense, an oral defense of the dissertation is scheduled and is open to the entire academic community. This defense consists of a presentation, followed by a question-and-answer period conducted by the dissertation committee and the audience. After successfully defending the dissertation, the candidate must submit final copies of the dissertation that comply with the format requirements set forth by the Graduate Division. Copies are given to the department and the dissertation advisor, in addition to those required by the Graduate Division.

Consult departmental guidelines for appointments to qualifying and dissertation committees. Refer to the department's graduate program guidelines for further details.

**Lower-Division Courses**

**ME 001A. Introduction to Mechanical Engineering (1)** Laboratory, 3 hours. Prerequisite(s): none. An introduction to mechanical engineering as a field of study and as a profession. Orientes students to the curriculum, faculty, and resources in the Department of Mechanical Engineering. Graded Satisfactory (S) or No Credit (NC). Credit is awarded for only one of ENGR 010 or ME 001A.

**ME 001B. Introduction to Mechanical Engineering (1)** Laboratory, 3 hours. Prerequisite(s): none. An introduction to mechanical-engineering and computer-aided design. Students design, analyze, prototype, and test a mechanical device using modern methods. Graded Satisfactory (S) or No Credit (NC).
ME 001C. Introduction to Mechanical Engineering (1) Laboratory, 3 hours. Prerequisite(s): MATH 008B or MATH 009A or MATH 09HA. An introduction to engineering problem solving and computations using EXCEL and MATLAB. Topics include functions, scalar and array operations, graphics, linear algebra, and symbolic mathematical operations with applications in mechanical engineering.

ME 009. Engineering Graphics and Design (4) Lecture, 3 hours; laboratory, 3 hours. Prerequisite(s): none. Graphical concepts and projective geometry relating to spatial visualization and communication in design, including technical sketching, instrument drawing, and computer-aided drafting and design.

ME 010. Statics (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): MATH 099C, PHYS 040A. Covers equilibrium of coplanar force systems; analysis of frames and trusses; noncoplanar force systems; friction; and distributed loads.

ME 018. Introduction to Engineering Computation (2) Lecture, 1 hour; laboratory, 3 hours. Prerequisite(s): ME 001C. An introduction to the use of MATLAB in engineering computation. Covers scripts and functions, programming, input/output, two- and three-dimensional graphics, and elementary numerical analysis.

### Upper-Division Courses

ME 100A. Thermodynamics (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): MATH 010A, ME 018, PHYS 040B. Introduces basic concepts and applications of thermodynamics relevant to mechanical engineering. Topics include work and energy, the first law of thermodynamics, properties of pure substances, control volume and control mass analysis, the Carnot cycle, heat and refrigeration cycles, the second law of thermodynamics, entropy, and reversible and irreversible processes. Credit is awarded for only one of CHE 100 or ME 100A.

ME 100B. Thermodynamics (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): ME 100A. Topics include the second law of thermodynamics, entropy function, entropy production, analysis of cycles, vapor power systems, gas power systems, refrigeration and heat pump systems, equations of state, thermodynamic property relations, ideal gas mixtures and psychrometrics, multicomponent systems, combustion, and reacting mixtures.

ME 103. Dynamics (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): MATH 046, ME 010 with a grade of “C-” or better, ME 018. Topics include vector representation of kinematics and kinetics of particles; Newton's laws of motion; force-mass-acceleration, work-energy, and impulse-momentum methods; kinematics of systems of particles; and kinematics and kinet- ics of rigid bodies.

ME 110. Mechanics of Materials (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): MATH 046, ME 010 with a grade of “C-” or better, ME 018. Topics include mechanics of deformable bodies subjected to axial, torsional, shear, and bending loads; combined stresses; columns; energy design; and their applications to the design of structures.

ME 113. Fluid Mechanics (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): MATH 046, PHYS 040B, ME 010 with a grade of “C-” or better, ME 018. Introduces principles of fluid mechanics relevant to mechanical engineering. Topics include shear stresses and viscosity, fluid statics, pressure, forces on submerged surfaces, Bernoulli and mechanical energy equations, control volume approach, mass conserva- tion, momentum and energy equations, the differential approach, turbulent flow in pipes, and lift and drag. Credit is awarded for only one of CHE 114 or ME 113.

ME 114. Introduction to Materials Science and Engineering (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): CHEM 001B, PHYS 040C, upper-division standing. Covers materials classification, atomic structure and interatomic bonding, crystal structure of metals, imperfections in solids, diffusion, mechanical properties of engineering materials, strengthening mechanisms, basic concepts of fracture and fatigue, phase diagrams, ceramics, polymers, and composites.

ME 116A. Heat Transfer (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): MATH 046, ME 100A, ME 113 (ME 113 may be taken concurrently). Introduces the analysis of steady and transient heat conduction, fin and heat generating systems, two-dimensional conduction, internal and external forced convection, natural convection, radiation heat transfer, heat exchangers, and mass transfer. Credit is awarded for only one of CHE 116 or ME 116A.

ME 116B. Heat Transfer (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): ME 116A. Covers analytical and numerical methods in heat transfer and fluid mechanics. Topics include heat conduction and convection, gaseous radiation, boiling and condensation; general aspects of phase change, mass transfer principles, multihot heat transfer and the simulation of thermal fields, and the heat transfer process.

ME 117. Combustion and Energy Systems (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): ME 100A, ME 113, ME 118. Discusses premixed and diffusion flames, fuel-air thermochromy, combustion-driven engine design and operation, engine cycle analysis, fluid mechanics in engine components, pollutant formation, and gas turbines.

ME 118. Mechanical Engineering Modeling and Analysis (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): MATH 046, ME 018. Introduces data analysis and modeling used in engineering through the software package MATLAB. Numerical methods include descriptive and inferential statistics, sampling and bootstrapping, fitting linear and nonlinear models to observed data, interpolation, numerical differential equations, and integration, and solution of systems of ordinary differential equations. Final project involves the development and evaluation of a model for an engineering system. Credit is awarded for only one of ENGR 118 or ME 118.

ME 120. Linear Systems and Controls (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): EE 001A, EE 011A, ME 103. Introduces the modeling and analysis of dynamic systems, emphasizing the common features of mechanical, hydraulic, pneumatic, thermal, electrical, and electromechanical systems. Controls are introduced through state equations, equilibrium, linearization, stability, and time and frequency domain analysis.

ME 121. Feedback Control (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): ME 118, ME 120. Introduces students to the analysis and design of feedback control systems using classical control methods. Topics include control system terminology, block diagrams, analysis and design of control systems, stability criteria, root locus, Bode plots, and an introduction to analysis in state-space.

ME 122. Vibrations (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): ME 103. Covers free and forced vibration of discrete systems with and without damping resonance; matrix methods for multiple degree-of- freedom systems; normal modes, coupling, and normal coordinates; and use of energy methods.

ME 130. Kinematic and Dynamic Analysis of Mechanisms (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): ME 009, ME 103. Explores the kinematics and dynamics of planar mechanisms including linkages, cam mechanisms, and gear trains. Introduces concepts of multibody dynamics.

ME 131. Design of Mechanisms (4) Lecture, 3 hours; laboratory, 3 hours. Prerequisite(s): ME 130. Involves design of planar, spherical, and spatial mechanisms using both exact and approximate graphical and analytical techniques. Requires a computer-aided design project.

ME 133. Introduction to Mechatronics (4) Lecture, 3 hours; laboratory, 3 hours. Prerequisite(s): ME 120, ME 130. Introduces hardware, software, sensors, actuators, physical systems models, and control theory in the context of control system implementation. Covers data acquisition (Labview), sensors, actuators, electric circuits and components, semiconductor electronics, logic circuits, signal processing using analog operational amplifiers, programmable logic controllers, and microcontroller programming and interfacing. Uses MATLAB and simulink.

ME 135. Transport Phenomena (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): ME 100A, ME 113, ME 116A. Introduces new concepts of thermodynamics, fluid mechanics, and heat transfer: thermodynamics, combustion, one-dimensional compressible flow, and turbomachinery. Integrates the most important concepts of transport of momentum, heat, and mass.

ME 136. Environmental Impacts of Energy Production and Conversion (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): ME 100A, ME 113, ME 116A. Covers thermodynamics, heat transfer, and fluid mechanics as applied to the examination of the environmental impacts of energy production and conversion. Topics include pollution associated with fossil fuel combustion, environmental impacts of energy use, turbulent transport of pollutants, and principles used in the design of pollution control equipment.

ME 137. Environmental Fluid Mechanics (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): ME 100A, ME 113. Covers the application of fluid mechanics to problems in the atmosphere and oceans. Topics include hydrostatic balance, Coriolis effects, geostrophic balance, boundary layers, turbulence, tracer and heat transport.

ME 138. Transport Phenomena in Living Systems (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): MATH 046, PHYS 040B. An introduction to the application of the basic conservation laws of mechanics (mass, linear momentum, and energy) to the modeling of complex biological systems. Emphasizes how these concepts can explain and predict life processes.

ME 153. Finite Element Methods (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): ME 118. Covers weak form formulation, the Galerkin method, and its computational implementation, mesh generation, data visualization, as well as programming finite element codes for practical engineering applications.

ME 156. Mechanical Behavior of Materials (4) Lecture, 3 hours; laboratory, 3 hours. Prerequisite(s): senior standing; ME 110; ME 114. Introduces the theory and experimental techniques for testing the mechanical behavior of materials and structures. Covers the fundamental mechanisms of deformation and failure of metals, ceramics, polymers, composite materials, and electronic materials as well as structural design and materials selection.
ME 170A. Experimental Techniques (4) Lecture, 3 hours; laboratory, 3 hours. Prerequisite(s): EE 001A, EE 011A, ME 118. Covers the principles and practice of measurement and control, and the design implementation of experiments. Topics include dimensional analysis, error analysis, signal-to-noise problems, filtering, data acquisition and data reduction, and statistical analysis. Includes experiments on the use of electronic devices and sensors, and practice in technical report writing.

ME 170B. Experimental Techniques (4) Laboratory, 6 hours; discussion, 2 hours. Prerequisite(s): ME 103, ME 110, ME 113, ME 116A, ME 170A. Analysis and verification of engineering theory using laboratory measurements in advanced, project-oriented experiments involving fluid flow, heat transfer, structural dynamics, thermodynamic systems, and electromechanical systems.

ME 174. Machine Design (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): ME 009, ME 103, ME 110, ME 114. Introduction to the fundamentals of strength-based design. Topics include deflection and stiffness, static failure, and fatigue failure. Applies these topics to the design of standard machine components such as shafts, fasteners, and gears. Includes a design project. Sawyer

ME 175A. Professional Topics in Engineering (2) Lecture, 2 hours. Prerequisite(s): senior standing in Mechanical Engineering; ME 009, ME 170A. Topics include technical communication, team work, project management, engineering economics, professional ethics, and computer-aided design. Satisfactory (S) or No Credit (NC) grading is not available.

ME 175B. Mechanical Engineering Design (3) Lecture, 2 hours; laboratory, 3 hours. Prerequisite(s): senior standing in Mechanical Engineering; ME 125 (may be taken concurrently); ME 170B; ME 175A (may be taken concurrently). Students in teams define a design problem and conceive and detail the design solution. Lecture topics include design theory, design for safety, reliability, manufacture, and assembly. Graded In Progress (IP) until ME 175B and ME 175C are completed, at which time a final, letter grade is assigned.

ME 175C. Mechanical Engineering Design (3) Lecture, 1 hour; discussion, 1 hour; laboratory, 3 hours. Prerequisite(s): senior standing in Mechanical Engineering; ME 175B. Students create, test, and evaluate a prototype based on the project design generated in ME 175B. Lecture topics include prototyping techniques, design verification, and special topics in design. Satisfactory (S) or No Credit (NC) grading is not available.

ME 180. Optics and Lasers in Engineering (4) Lecture, 3 hours; laboratory, 3 hours. Prerequisite(s): senior standing; ME 010, ME 110, ME 170A. Focuses on the principles of optics and lasers, optical measurement techniques, and laser material interactions. Involves applications of optical methods using coherent and incoherent lights in mechanical engineering deformation and stress analysis; optical data acquisition and image analysis; and applications of lasers in material processing and characterization.

ME 190. Special Studies (1-5) Individual study, 3-15 hours. Prerequisite(s): consent of instructor, department chair, and Mechanical Engineering Undergraduate Program Committee chair. Individual study to meet special curricular needs. Requires a final written report. Course is repeatable to a maximum of 9 units.

ME 197. Research for Undergraduates (1-4) Outside research, 3-12 hours. Prerequisite(s): consent of instructor and Mechanical Engineering Undergraduate Program Committee chair. Directed research in a particular subject relevant to mechanical engineering. Requires a final written technical report. Course is repeatable to a maximum of 8 units.

Graduate Courses

ME 200. Methods of Engineering Analysis (4) Lecture, 4 hours. Prerequisite(s): graduate standing in engineering or consent of instructor. Topics include linear algebra theory, vector spaces, eigenvalue problems, complex analytic functions, contour integration, integral transforms, and basic methods for solving ordinary and partial differential equations in mechanical engineering applications.

ME 201. Computational Methods in Engineering (4) Lecture, 4 hours. Prerequisite(s): graduate standing or consent of instructor. Explores numerical methods with computer applications. Topics include solution of nonlinear algebraic equations, solution of systems of linear equations, interpolation, integration, statistical description of data, model fitting, Fast Fourier Transform and applications, and numerical solution of ordinary and partial differential equations.

ME 221. Advanced Dynamics (4) Lecture, 4 hours. Prerequisite(s): ME 103 or consent of instructor. Introduces spatial kinematics and dynamics of a rigid body, multi-rigid-body systems, and robot manipulators. Topics include Newton's and Euler's laws, Lagrange's equations, Hamilton's equations, and variational principles.

ME 230. Computer-Aided Engineering Design (4) Lecture, 3 hours; laboratory, 3 hours. Prerequisite(s): graduate standing or consent of instructor. Introduces fundamentals of interactive computer graphics, three-dimensional representations of curves and surfaces, Bezier parameterizations, and optimization methods. Demonstrates applications of computer graphics and computational geometry to mechanical system simulations, computer-aided design, and engineering design.

ME 231. Pen-Based Computing (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): graduate standing or consent of instructor; computer programming experience. Introduces computational techniques for pen-based user interfaces. Covers fundamental issues such as ink segmentation, sketch parsing, and shape recognition. Explores the topic of sketch understanding, including reasoning about context and correcting errors, and issues related to building practical pen-based systems. Includes a project in which students build a pen-based application. May be taken Satisfactory (S) or No Credit (NC) grading.

ME 240A. Fundamentals of Fluid Mechanics (4) Lecture, 4 hours. Prerequisite(s): graduate standing or consent of instructor. Introduction to fluid mechanics. Explores an introduction to the study of fluid motions, stress tensor, the Navier-Stokes equations, boundary conditions, exact solutions, vorticity, and boundary layers.

ME 240B. Fundamentals of Fluid Mechanics (4) Lecture, 4 hours. Prerequisite(s): ME 240A or consent of instructor. Continues the study of fluid mechanics and introduces stability analysis and turbulence.

ME 241A. Fundamentals of Heat and Mass Transfer (4) Lecture, 4 hours. Prerequisite(s): ME 240A or consent of instructor. Introduces heat and mass transfer with an emphasis on formulation of problems. Topics include conduction, convection, radiation, and species conservation and the analytical and numerical solution of transport problems. Mechanical Engineering graduate students receive a letter grade; other students receive a letter grade or Satisfactory (S) or No Credit (NC) grade.

ME 241B. Transport through Porous Media (4) Lecture, 4 hours. Prerequisite(s): graduate standing. Covers current theories on flow, heat, and mass transfer and the mechanisms of multiphase transport in porous media. Mechanical Engineering graduate students receive a letter grade; other students receive a letter grade or Satisfactory (S) or No Credit (NC) grade.

ME 241C. Electronic Cooling and Thermal Issues in Microelectronics (4) Lecture, 4 hours. Prerequisite(s): graduate standing. Discusses thermal issues associated with the life cycle of electronic products. Covers passive, active, and hybrid thermal management techniques, computational modeling approaches, and advanced thermal management concepts such as single phase, phase change, and heat pipes. Mechanical Engineering graduate students receive a letter grade; other students receive a letter grade or Satisfactory (S) or No Credit (NC) grade.

ME 242. Turbulence in Fluids (4) Lecture, 4 hours. Prerequisite(s): ME 240A or consent of instructor. An introduction to the application of fundamental conservation laws of mechanics (mass, momentum, and energy) to the modeling of complex turbulent natural and human-made flows. Covers tensor notation, statistical and spectral analysis, and basic turbulent closure techniques, including understanding of turbulence with intuitive insight into the problems that cannot be rigorously solved. May be taken Satisfactory (S) or No Credit (NC) by students advanced to candidacy for the Ph.D.

ME 244. Nanoscale Heat Transfer and Energy Conversion (4) F Lecture, 4 hours. Prerequisite(s): at least two of EE 201, EE 202, ME 100A, ME 116A, or equivalents. Explores fundamental processes of energy transport and conversion at short length and time scales. Introduces classical and quantum-mechanical size effects on electrons, phonons, and photons. Topics include modes of energy storage, coupling between energy carriers, and electrical and thermal transport using the Boltzmann transport equation and/or kinetic theory. May be taken Satisfactory (S) or No Credit (NC) with consent of instructor and graduate advisor.

ME 246. Computational Fluid Dynamics with Applications (4) Lecture, 3 hours; laboratory, 3 hours. Prerequisite(s): ME 240A or consent of instructor. Introduces finite difference, finite volume, and finite element; spectral methods, governing equations for nonreacting and reacting flows; and stability and convergence for steady and unsteady problems. Students use commercial computational fluid dynamics (CFD) software for the course project.

ME 247. Applied Combustion and Environmental Applications (4) Lecture, 4 hours. Prerequisite(s): graduate standing or consent of instructor. Topics include chemical reaction thermodynamics and kinetics of fuel-air mixtures, governing equations for reacting flows, premixed flame structure and propagation, diffusion flame analysis, ignition theory, droplet and spray combustion, pollutant formation in internal combustion engines, pollution control, principles of air pollution, and atmospheric transport.

ME 250. Seminar in Mechanical Engineering (1 or 2) Seminar, 1-2 hours. Prerequisite(s): graduate standing. Seminar in selected topics in mechanical engi-
neering presented by graduate students, staff, faculty, and invited speakers. Students who present a seminar receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable.

ME 261. Theory of Elasticity (4) Lecture, 4 hours. Prerequisite(s): ME 110 or consent of instructor. Introduction to tensors, strain, equations of motion, and constitutive equations. Topics include typical boundary value problems of classical elasticity, problems of plane strain and plane stress, and variational principles.

ME 266. Mechanics and Physics of Materials (4) Lecture, 4 hours. Prerequisite(s): graduate standing or consent of instructor. Introduces the structure and properties of materials; the characterization and modeling of mechanical, thermal, electric, and magnetic properties of materials; and coupling properties. Topics include phase transformations and brittle-to-ductile transitions.

ME 267. Finite Element Methods in Solid Mechanics (4) Lecture, 4 hours. Prerequisite(s): ME 261 or consent of instructor. Covers the formulation and implementation of finite element methods, including the Galerkin and energy methods. Topics include the static and dynamic analysis of mechanical and multiphysical systems and techniques of automatic mesh generation.

ME 270. Introduction to Microelectromechanical Systems (4) Lecture, 4 hours. Prerequisite(s): ME 110, ME 114, or equivalents. An introduction to the design and fabrication of microelectromechanical systems (MEMS). Topics include bulk and surface micromachining processes; material properties; mechanisms of transduction; applications in mechanical, thermal, optical, radiation, and biological sensors and actuators; fabrication of microfluidic devices; BioMEMS and applications; packaging and reliability concepts; and metrology techniques for MEMS. Also discusses directions for future research.

ME 272. Nanoscale Science and Engineering (4) Lecture, 3 hours; laboratory, 3 hours. Prerequisite(s): ME 01H or consent of instructor. An overview of the machinery and science of the nanometer scale. Topics include patterning of materials via scanning probe lithography; electron beam lithography; nanomprinting; self-assembly; mechanical, electrical, magnetic, and chemical properties of nanoparticles, nanotubes, nanowires, and biomolecules (DNA, protein); self-assembled monolayers; and nanocomposites and synthetic macromolecules.

ME 278. Imperfections in Solids (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): graduate standing in Chemical and Environmental Engineering or Computer Science or Electrical Engineering or Mechanical Engineering. Covers fundamentals of crystal structures and crystal defects, including the generation of point defects; nucleation and propagation of dislocations; perfect and partial dislocations; twins, stacking faults, and transformations; mechanics of semiconductor and metallic thin films and multilayered structures.

ME 290. Directed Studies (1-6) Individual study. 3-18 hours. Prerequisite(s): graduate standing; consent of instructor and graduate advisor. Individual study. directed by a faculty member of selected topics in mechanical engineering. Graded Satisfactory (S) or No Credit (NC). Course is repeatable to a maximum of 9 units.

ME 297. Directed Research (1-4) Outside research. 3-18 hours. Prerequisite(s): graduate standing; consent of instructor. Research conducted under the supervision of a faculty member on selected problems in mechanical engineering. Graded Satisfactory (S) or No Credit (NC). Course is repeatable to a maximum of 9 units.

ME 299. Research for the Thesis or Dissertation (1-12) Outside research, 3-36 hours. Prerequisite(s): graduate standing; consent of instructor. Research in mechanical engineering for the M.S. thesis or Ph.D. dissertation. Graded satisfactory (S) or No Credit (NC). Course is repeatable.

Professional Course

ME 302. Apprentice Teaching (1-4) Seminar, 1-4 hours. Prerequisite(s): appointment as a teaching assistant or an associate in Mechanical Engineering. Topics include effective teaching methods, such as those involved in leading discussion sections and preparing and grading examinations, and student-instructor relations in lower- and upper-division Mechanical Engineering courses. Required each quarter of teaching assistants and associates in Mechanical Engineering. Graded Satisfactory (S) or No Credit (NC). Course is repeatable to a maximum of 12 units.

Media and Cultural Studies

Subject abbreviation: MCS
College of Humanities, Arts, and Social Sciences

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D. Charles Whitney, Ph.D. (Creative Writing)

Associate Professors
Keith Harris, Ph.D. (English)
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Assistant Professors
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Kenneth Rogers, Ph.D.
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Alicia Arrizon, Ph.D. (Women’s Studies)
Mariam Beevi-Lam, Ph.D. (Comparative Literature and Foreign Languages)
Michelle Bloom, Ph.D. (Comparative Literature and Foreign Languages)
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Alessandro Fornazzari, Ph.D. (Hispanic Studies)
Christine Gailey, Ph.D. (Women’s Studies)
John Ganim, Ph.D. (English)
Catherine Gudis, Ph.D. (History)
George Haagerty, Ph.D. (English)
Stephanie Hammer, Ph.D. (Comparative Literature and Foreign Languages)
Steven Helfand, Ph.D. (Economics)
Erith Jaffe-Berg, Ph.D. (Theatre)
Martin Johnson, Ph.D. (Political Science)
Jodi Kim, Ph.D. (Ethnic Studies)
John Namjun Kim, Ph.D. (Comparative Literature and Foreign Languages)
Katherine Kinney, Ph.D. (English)
Margherita Long, Ph.D. (Comparative Literature and Foreign Languages)
Tiffany Lopez, Ph.D. (English)
Rene Lysoff, Ph.D. (Music)
Patricia Morton, Ph.D. (Art History)
Voris Nuneley, Ph.D. (English)
Marina Pianco, Ph.D. (Spanish/Portuguese)
Michelle Raheja, Ph.D. (English)
Rebekah Richert, Ph.D. (Psychology)
Dylan Rodriguez, Ph.D. (Ethnic Studies)
Robin Russin, Ph.D. (Theatre)
Christina Schwenkel, Ph.D. (Anthropology)
Anna Scott, Ph.D. (Dance)
Theda Shapiro, Ph.D. (Comparative Literature and Foreign Languages)
Maurya Simon, Ph.D. (Creative Writing)
Priya Srinvavan, Ph.D. (Dance)
Erika Suderburg, Ph.D. (Art)
Anne Sutherland, Ph.D. (Anthropology)
James Tobias, Ph.D. (English)
Carole-Anne Tyler, Ph.D. (English)
Marguerite Waller, Ph.D. (Comparative Literature and Foreign Languages/Women’s Studies)
Jonathan Walton, Ph.D. (Religious Studies)
Jane Ward, Ph.D. (Sociology)
Ellen Wartella, Ph.D. (Psychology)
Devra Weber, Ph.D. (History)
Raymond Williams, Ph.D. (Hispanic Studies)
Andrew Winer, M.F.A. (Creative Writing)
Deborah Wong, Ph.D. (Music)
Victor Zordan, Ph.D. (Computer Science and Engineering)
Stephen E. Cullenberg, Ph.D.
Dean, College of Humanities, Arts, and Social Sciences, ex officio

Major

The Department of Media and Cultural Studies offers the B.A. in Media and Cultural Studies, an interdisciplinary examination of film, video, television, multimedia, and visual culture with a primary emphasis on history and theory and a secondary focus on production. The major consists of three curricular tracks, in one of which students may concentrate:

1. Film and Visual Media
2. Film, Literature, and Culture
3. Ethnography, Documentary, and Visual Culture

The Media and Cultural Studies major combines the breadth of an interdisciplinary major with a precise focus on visual media. Its interdisciplinary structure brings together approaches to visual media that would usually be separated by discipline. Students have a unique opportunity to acquire critical skills in the reading and analysis of media texts together with those involved in various modes of media production. This applied experience includes training in creative, documentary, and ethnographic video; photography; multimedia production;