

## 2011-13 Cal Poly Catalog

### Mechanical Engineering Department

## ME—MECHANICAL ENGINEERING

### ME 134 Introduction to Mechanical Engineering (1)

Introduction to mechanical engineering and its application in professional practice. Includes design, analysis, testing and dissection of mechanical engineering systems, from simple machines to more complicated systems. 1 laboratory.

### ME 151 Engineering Design Communication I (2)

Communication of designs to manufacturing using basic definitions of points, lines and planes in space. Pictorials, orthographic projection, section views and auxiliary views. Techniques from geometry, vectors, analysis, and spatial definitions integrated to provide information to both the design and manufacturing processes. 1 lecture, 1 laboratory.

### ME 152 Engineering Design Communication II (2)

Use of advanced communication principles to communicate project designs to manufacturing processes. Projects evaluated in terms of meeting design criteria. Techniques of advanced communication including weld symbols, threaded fasteners, dimensioning and tolerancing. Use of computers to enhance these processes. 1 lecture, 1 laboratory. Prerequisite: ME 151.

### ME 211 Engineering Statics (3)

Analysis of forces on engineering structures in equilibrium. Properties of forces, moments, couples, and resultants. Equilibrium conditions, friction, centroids, area moments of inertia. Introduction to mathematical modeling and problem solving. Vector mathematics where appropriate. 3 lectures. Prerequisite: MATH 241 (or concurrently), PHYS 131 or PHYS 141.

### ME 212 Engineering Dynamics (3)

Analysis of motions of particles and rigid bodies encountered in engineering. Velocity, acceleration, relative motion, work, energy, impulse, and momentum. Further development of mathematical modeling and problem solving. Vector mathematics where appropriate. 3 lectures. Prerequisite: MATH 241; ME 211 or ARCE 211.

### ME 234 Philosophy of Design (3)

General approach to the meaning of engineering design. Conceptual blocks, creativity, design process, design considerations and elements. 3 lectures.

### ME 236 Thermal Measurements (3)

Introduction to principles of experimental measurement, including practical instrument reading, data collection, and uncertainty analysis. Techniques for measuring temperature, pressure, and other parameters. Introduction to theory and practice of writing lab reports and communication of experimental data. 2 lectures, 1 laboratory. Prerequisite: CHEM 125, ENGL 134, PHYS 132.

### ME 251 Intermediate Solid Modeling (1)

Continuation of solid modeling introduced in ME 152, using current software and hardware. Creation of more involved part models with varied configurations and dynamic assembly models. Working drawings produced from the models. Introduction to mass and inertia using the chosen software. Emphasis of group work and peer review in the production of parts for assemblies. 1 laboratory. Prerequisite: ME 152 or equivalent. *Formerly ME 153.*

### ME 270 Selected Topics (1–4)

Directed group study of selected topics. The Schedule of Classes will list title selected. Total credit limited to 8 units. 1 to 4 lectures. Prerequisite: Open to undergraduate students and consent of instructor.

### ME 302 Thermodynamics I (3)

Properties of working fluids and fundamental relations for processes involving the transfer of energy. First and second laws of thermodynamics, irreversibility and availability. 3 lectures. Prerequisite: PHYS 132, ME 212 or CHEM 128.

### ME 303 Thermodynamics II (3)

Vapor and gas power cycles, refrigeration cycles, thermodynamic relations, psychrometrics, and chemical reactions. 3 lectures. Prerequisite: ME 236, ME 302.

### ME 305 Introduction to Mechatronics (4)

Introduction to microcontrollers and assembly language programming. Emphasis on components and techniques for interfacing that are typical of embedded microcontroller applications (A/D conversion, D/A conversion, interrupts, timers, and pulse-width modulation). Laboratory exercises involve real-time interfacing of microcontrollers to external mechanical and/or electromechanical devices. 3 lectures, 1 laboratory. Prerequisite: EE 321 and EE 361, or consent of instructor.

### ME 318 Mechanical Vibrations (4)

Free and forced vibration response of single and multiple degree of freedom systems. Experimental studies of the dynamic behavior of structures and machines. Instrumentation methods utilized in field and laboratory. 3 lectures, 1 laboratory. Prerequisite: ME 326, MATH 344. Recommended: EE 201.

### ME 320 Consumer Energy Guide (4)

GE Area F

Interdisciplinary connection of everyday consumer decisions with energy costs, security, and global warming. Energy consumption by home appliances and automobiles. Methods to reduce the individual "energy footprint" with renewable energy, purchasing carbon offsets, and behavioral modifications. 4 lectures. Prerequisite: Junior standing and completion of GE Areas A and B. Fulfills GE Area F.

### ME 321 Solar Energy (4)

GE Area F

Methods of utilizing solar energy. Energy concepts, collection and storage systems; greenhouse effect. Commercial and residential building applications. Solar power generation and recent technical developments. International achievements in solar energy with emphasis on solar energy application in developing countries for water purification and other life support functions. 4 lectures. Prerequisite: Junior standing, PHYS 131 or PHYS 123, and completion of GE Area B. Fulfills GE Area F.

### ME 326 Intermediate Dynamics (4)

Continuation of ME 212. Additional analysis of planar motion of rigid bodies with particular attention to the kinematics of mechanisms. Rotating reference frames. Introduction to three dimensional dynamics. Dynamic simulation of mechanisms. 3 lectures, 1 activity. Prerequisite: MATH 244 (or concurrent), ME 212, CSC 231 or CSC 234 or CPE/CSC 101.

### ME 328 Introduction to Design (4)

Design of machine parts by stress and deflection. Effects of fluctuating stresses and stress concentration. Design of shafts and other machine parts. Modern industrial design practice using standard components and design layout drawings. 3 lectures, 1 laboratory. Prerequisite: CE 207, ME 152, MATE 210, CSC 231 or CSC 234, ME 212, ME 234.

### ME 329 Intermediate Design (4)

Design of mechanical equipment and systems using various machine elements and components such as threaded fasteners, power screws, springs, gears, bearings, clutches, prime movers, etc. Decision modeling based on technical and economic feasibility. 3 lectures, 1 laboratory. Prerequisite: ME 318 (or concurrent), ME 328.

### ME 341 Fluid Mechanics I (3)

Fluid statics. Conservation equations of fluid dynamics. Viscous flow, boundary layer concepts, lift and drag, compressible flow, turbomachinery. 3 lectures. Prerequisite: ME 212 or ARCE 225.

### ME 343 Heat Transfer (4)

Basic principles of heat transfer. Conduction, convection, radiation, and combined modes. Optional thermal engineering design project. 4 lectures. Prerequisite: ME 341, ME 302 or CHEM 305, MATH 244, CSC 231 or CSC 234.

### ME 346 Thermal Science Laboratory (1)

Heat transfer and thermodynamic experiments covering combined free convection and radiation, transient conduction, energy conversion, heat exchanger, polytropic blowdown, steam turbine, and refrigeration cycles. 1 laboratory. Prerequisite: ME 303, ME 341, ME 343.

### ME 347 Fluid Mechanics II (4)

Conservation equations of fluid dynamics. Viscous flow, boundary layer concepts, lift and drag, compressible flow, turbomachinery. Laboratory measurement of turbomachine performance, velocity profiles, boundary layers on surfaces. 3 lectures, 1 laboratory. Prerequisite: ME 236, ME 341, ME 302 or consent of instructor.

**ME 359 Fundamentals of HVAC Systems (4)**

Fundamentals of heating, ventilating and air-conditioning (HVAC) systems, human comfort and indoor air quality, primary and secondary systems and components. 3 lectures, 1 laboratory. Prerequisite: ME 302.

**ME 400 Special Problems for Advanced Undergraduates (1-4)**

Individual investigation, research, studies, or surveys of selected problems. Total credit limited to 4 units. Prerequisite: Consent of instructor.

**ME 401 Stress Analysis (4)**

Advanced strength of materials: behavior of disks, plates, and shells. Theory of elasticity. Energy methods. 3 lectures, 1 laboratory. Prerequisite: CE 207, MATH 344, ME 328 or consent of instructor.

**ME 402 Orthopedic Biomechanics (4)**

Biomechanical analysis of the musculoskeletal system. Emphasis on the use of statics, dynamics, strength of materials, viscoelasticity, and poroelasticity to analyze the mechanical loads acting on human joints, the mechanical properties of tissues, and the design of artificial joints. 3 lectures, 1 laboratory. Prerequisite: ME 328 or consent of instructor.

**ME 404 Applied Finite Element Analysis (4)**

Finite element based solutions to engineering problems with an emphasis on elastostatic problems in structural mechanics. The power and pitfalls associated with the finite element method highlighted through practical modeling assignments. Introduces the use of commercial finite element codes. 3 lectures, 1 laboratory. Prerequisite: ME 329 or CE 351 or BMED 410. *Crosslisted as BMED/CE/ME 404.*

**ME 405 Mechatronics (4)**

Microprocessor applications in machine control and product design. Applied electronics. Drive technology; transducers and electromechanical systems. Real-time programming. Mechatronic design methodology. 3 lectures, 1 laboratory. Prerequisite: ME 305 and ME 329 (or concurrent), or CPE/EE 329 and CPE/EE 369, or consent of instructor.

**ME 410 Experimental Methods in Mechanical Design I (4)**

Bonded resistance strain gages for static and dynamic measurements; rosettes, bridge circuits, lead wire effects, special gages. Data acquisition systems, and measurement of displacement, velocity, and acceleration. Photoelastic methods including birefringent coatings. Applications in mechanical design and metrology. 3 lectures, 1 laboratory. Prerequisite: ME 328. Recommended: ME 318.

**ME 412 Composite Materials Analysis and Design (4)**

Behavior of unidirectional fiber composites. Properties of short-fiber composites, and orthotropic lamina. Analysis of laminated composites. Strength and hygrothermal behavior of composite materials. Structural optimization. 3 lectures, 1 laboratory. Prerequisite: AERO 331 or ME 328.

**ME 415 Energy Conversion (4)**

Engineering aspects of energy sources, conversion and storage. Topics selected from fossil fuel systems, nuclear power, thermoelectric systems, thermionic converters, fuel cells, magnetohydrodynamic generators, and geothermal, tidal, wind and ocean temperature energy conversion systems. 4 lectures. Prerequisite: ME 302.

**ME 416 Ground Vehicle Dynamics and Design (4)**

Design of ground vehicles for directional stability and control. Tire mechanics and their effects on vehicle performance. Simulation of vehicle dynamics using digital computer. Synthesis of steering mechanism and suspension system. ~~3 lectures, 1 laboratory 2 laboratories.~~ Prerequisite: ME 318, ME 328. *Change effective Winter 2012.*

**ME 422 Mechanical Control Systems (4)**

Modeling and control of physical systems. Design of mechanical, hydraulic and electrical systems using time response, frequency response, state space, and computer simulation. 3 lectures, 1 laboratory. Prerequisite: ME 318.

**ME 423 Robotics: Fundamentals and Applications (4)**

Introduction to robots and their types. Homogeneous transformations. Kinematic equations and their solutions. Motion trajectories, statics, dynamics, and control of robots. Robot programming. Actuators, sensors and vision systems. 3 lectures, 1 laboratory. Prerequisite: ME 326, ME 422.

**ME 424 Design of Piping Systems (4)**

Pipe specifications and pertinent codes. Valves, fittings, pumps and compressors. The transportation function of piping as related to power plants, refineries, slurry systems, pumping systems and drainage. Philosophy of system

design. 3 lectures, 1 laboratory. Prerequisite: CE 207, ME 347, CSC 231, MATE 210.

**ME 428 Senior Design Project I (3)**

First of three courses taken sequentially in component and system design using real-world problems. Small teams study and apply techniques of the engineering design process including problem definition, concept generation, feasibility studies and decision making. Practice of professional skills including written and oral communication, teaming, project management, societal responsibility and ethics. 1 lecture, 2 laboratories. Prerequisite: ENGL 149, ME 329, ME 343 or consent of instructor.

**ME 429 Senior Design Project II (2)**

Continuation of a project begun in ME 428. Activities focused on detail design, analysis and material procurement. 2 laboratories. Prerequisite: ME 428. *Formerly ME 481.*

**ME 430 Senior Design Project III (1)**

Completion of a project begun in ME 428 and continued in ME 429. Design verified through prototyping and testing. 1 laboratory. Prerequisite: ME 429.

**ME 431 Mechanical Design Techniques (4)**

Comprehensive study of various design methods and techniques. Techniques used to explore various structural concepts such as prestressing, shaping, sizing, etc. Simulation of systems using digital computer. Design criteria identification of design parameters and constraints. 3 lectures, 1 laboratory. Prerequisite: ME 329.

**ME 432 Petroleum Reservoir Engineering (4)**

Types of reservoirs and reservoir rocks. Measurement and interpretation of physical properties of reservoir rocks and fluids: porosity, permeability, compressibility, electrical resistivity, fluid saturation, viscosity, solution gas and PVT properties of reservoir fluids. Introduction to flow in porous media, reserve calculations for different reservoirs and computer applications. 3 lectures, 1 laboratory. Prerequisite: ME 341.

**ME 434 Enhanced Oil Recovery (4)**

Primary, secondary, and tertiary (enhanced) oil recovery methods. Waterflooding, polymerflooding, gas injection, steam injection, in-situ combustion, chemical flooding, miscible flooding. Performance calculations and computer applications in EOR. 4 lectures. Prerequisite: ME 302, ME 347, ME 343.

**ME 435 Drilling Engineering (4)**

Theory and practice of oilwell planning, drilling, well logging, and completion applied to the development of new oil and gas production, from onshore and offshore fields. 4 lectures. Prerequisite: ME 329, ME 347.

**ME 436 Petroleum Production Engineering (4)**

Design and operation of surface and subsurface equipment required in oil production. Processes and systems involved are rod pumping, gas lifting, acidizing, hydraulic fracturing, fluid gathering and storage, separation of oil, gas, water and sediment from produced fluid. Includes equipment used in enhanced oil recovery processes. 4 lectures. Prerequisite: ME 329, ME 347.

**ME 440 Thermal System Design (4)**

Design and optimization of thermal systems. Engineering economics, thermal component sizing, steady-state simulation, and optimization techniques applied to the design and performance analysis of thermal systems. 3 lectures, 1 laboratory. Prerequisite: ME 303, ME 347, ME 343.

**ME 441 Single Track Vehicle Design (4)**

Design of single track vehicles, including handling characteristics, ergonomics and human power, strength and stiffness considerations, braking and suspension. Laboratory focus on designing a single track vehicle, including fabrication of a handling prototype. 3 lectures, 1 laboratory. Prerequisite: ME 318, ME 329, or consent of instructor.

**ME 443 Turbomachinery (4)**

Performance characteristics of various types for liquids and for gases. Criteria for proper selection of type and main dimensions. Cavitation criteria. Gas turbine cycles and performance. Two-dimensional cascades. Axial flow turbines and compressors. Centrifugal compressors and radial-inflow turbines. 4 lectures. Prerequisite: ME 303, ME 347, ME 343, MATH 344.

**ME 444 Combustion Engine Design (4)**

Application of design parameters to the various engine cycles. Aspects of the combustion processes. Emission regulation effects on engine design. Static and

dynamic loading. 3 lectures, 1 laboratory. Prerequisite: ME 303, ME 343, ME 347.

**ME 445 Convective Heat and Mass Transfer (4)**

Forced convection in laminar and turbulent flow, free convection, diffusion, combined heat and mass transfer. 4 lectures. Prerequisite: ME 347, ME 343.

**ME 446 Advanced and Hybrid Vehicle Design (4)**

Systematic methodology to design and optimize hybrid powertrains. Exploration of conventional and hybrid powertrain subsystem models and application in a vehicle simulation, including internal combustion engines, electric motors and generators, transmissions, batteries, fuel cells, hydraulic reservoirs, ultracapacitors, flywheels, etc. Analytical modeling and optimization. 3 lectures, 1 laboratory. Prerequisite: ME 329 and ME 303.

**ME 450 Solar Power Systems (4)**

High and intermediate temperature systems for conversion of solar energy to mechanical power and heat. Thermal energy storage and total thermal energy system design. Recommended as a complement to ME 415. 3 lectures, 1 laboratory. Prerequisite: ME 343.

**ME 456 HVAC Air and Water Distribution System Design (4)**

Air and water distribution components and systems and the design of these systems with applications to the heating, ventilating and air-conditioning (HVAC) industry. 3 lectures, 1 laboratory. Prerequisite: ME 302, ME 347.

**ME 457 Refrigeration Principles and Design (4)**

Basic engineering principles of refrigeration processes including: vapor compression cycles, multipressure systems, absorption systems, steam jet cooling, air cycles, and low temperature refrigeration. 3 lectures, 1 laboratory. Prerequisite: ME 341, ME 343.

**ME 458 Building Heating and Cooling Loads (4)**

Building heating and cooling load calculations, estimating energy consumption and operating costs for heating, ventilating and air-conditioning system design and selection. 3 lectures, 1 laboratory. Prerequisite: ME 303, and ME 343.

**ME 459 HVAC Senior Design Project I (3)**

First quarter of a two quarter sequence. Team project work in designing heating, ventilating and air-conditioning (HVAC) systems. New developments, policies and practices in the HVAC industry. Professional ethics relevant for practicing engineers. 1 lecture, 2 laboratories. Prerequisite: ME 456, ME 458.

**ME 460 HVAC Senior Design Project II (2)**

Continuation of work begun in ME 459. Team project designing heating, ventilating and air-conditioning (HVAC) systems. 2 laboratories. Prerequisite: ME 459.

**ME 461, 462 Senior Project I, II (2) (3)**

Selection and completion of a project under faculty supervision. Projects typical of problems which graduates must solve in their fields of employment. Project results are presented in a formal report. Minimum 150 hours total time. Prerequisite: Senior standing, ME 303, ME 343 and ME 329 (or concurrent).

**ME 470 Selected Advanced Topics (1-4)**

Directed group study of selected topics for advanced students. Open to undergraduate and graduate students. The Schedule of Classes will list title selected. Total credit limited to 12 units. 1 to 4 lectures. Prerequisite: Consent of instructor.

**ME 471 Selected Advanced Laboratory (1-4)**

Directed group laboratory study of selected topics for advanced students. Open to undergraduate and graduate students. The Schedule of Classes will list title selected. Total credit limited to 8 units. 1 to 4 laboratories. Prerequisite: Consent of instructor.

**ME 488 Wind Energy Engineering (4)**

Engineering aspects of windpower systems including mechanical design, support structure design, aerodynamic analysis, wind field analysis, system concepts and analysis, and economics. 4 lectures. Prerequisite: ME 329, ME 347, ME 302.

**ME 493 Cooperative Education Experience (2) (CR/NC)**

Part-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Credit/No Credit grading only. No major credit allowed; total credit limited to 6 units. Prerequisite: Sophomore standing and consent of instructor.

**ME 494 Cooperative Education Experience (6) (CR/NC)**

Full-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Credit/No Credit grading only. No major credit allowed; total credit limited to 18 units. Prerequisite: Sophomore standing and consent of instructor.

**ME 495 Cooperative Education Experience (12) (CR/NC)**

Full-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. A more fully developed formal report and evaluation by work supervisor required. Credit/No Credit grading only. No major credit allowed; total credit limited to 24 units. Prerequisite: Sophomore standing and consent of instructor.

**ME 500 Individual Study (1-3)**

Advanced study planned and completed under the direction of a member of the department faculty. Open only to graduate students who have demonstrated ability to do independent work. Enrollment by petition. Prerequisite: Consent of department head, graduate advisor and supervising faculty member.

**ME 501 Continuum Mechanics and Linear Elasticity (4)**

Introduction to continuum mechanics. Kinematics, stress, and balance laws. Constitutive theory for isotropic and anisotropic solids and viscous fluids. Applications including design of beams and pressure vessels, stress concentrations, fiber-reinforced composites, and non-homogeneous biological materials. 4 lectures. Prerequisite: ME 401 or CE 401 or consent of instructor. *Crosslisted as CE 511/ME 501.*

**ME 503 Inelastic Stress Analysis (4)**

Perfectly plastic and work hardening materials; von Mises and Tresca yield, isotropic and kinematic hardening flow rules, boundary-value problems. Finite elasticity: kinematics, Cauchy- and Green-elasticity, invariance, constraints, Neo-Hookean and Mooney-Rivlin materials, experimental approaches, non-uniqueness, anisotropy, residual stress, thermoelasticity, boundary-value problems. 4 lectures. Prerequisite: ME 501 or CE 511. *Crosslisted as CE 513/ME 503.*

**ME 504 Finite Element Analysis I (4)**

Linear finite element theory and analysis. Strong, weak and variational formulations. Physical and isoparametric spaces. Error estimates and numerical integration. Development of finite element algorithms. Use of commercial finite element codes to illustrate course concepts including modeling issues and limitations. 3 lectures, 1 laboratory. Prerequisite: CE/ME 404 and CE 511 or ME 501 or consent of instructor. *Crosslisted as CE/ME 504. Formerly ME 502.*

**ME 505 Finite Element Analysis II (4)**

Nonlinear and dynamic finite element theory and analysis. Variational formulations and their significance. Isoparametric formulation and numerical integration. Development of two and three-dimensional finite element algorithms. The limitations of FEA. 3 lectures, 1 laboratory. Prerequisite: CE/ME 504. *Crosslisted as CE/ME 505.*

**ME 506 System Dynamics (4)**

Unified approach for mathematical modeling and analysis of dynamic physical systems which may store energy in multiple energy domains. Emphasis on developing lumped-parameter linear system models from a set of primitive elements in a systematic manner. 4 lectures. Prerequisite: Graduate standing or consent of instructor.

**ME 507 Mechanical Control System Design (4)**

Application of principles of high-level design to mechanical control system implementation. Use of modified state transition logic in conjunction with object-oriented programming as design methodology. Real-time programming using above techniques for control of mechanical systems. 3 lectures, 1 laboratory. Prerequisite: Graduate standing or consent of instructor.

**ME 517 Advanced Vibrations (4)**

Vibration of complex engineering systems. Inertia and stiffness matrices. Natural frequencies and normal modes. Approximate solutions and computer techniques. Response to transient and periodic inputs. 3 lectures, 1 laboratory. Prerequisite: ME 318, graduate standing or consent of instructor.

**ME 518 Machinery Vibration and Rotor Dynamics (4)**

Vibrations relating to rotating machinery. Modeling of structural rotordynamic phenomena induced by shaft flexibility, bearings, and seals. Laboratory measurement of rotor system dynamic response and interpretation of machinery

diagnostic information. Research project on a related topic. 3 lectures, 1 laboratory. Prerequisite: ME 318, graduate standing or consent of instructor.

**ME 531 Acoustics and Noise Control (4)**

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 acoustic enclosures, room enclosures, room acoustics. Design of quiet machinery and transducers. 3 lectures, 1 laboratory. Prerequisite: ME 318, MATH 344.

**ME 540 Viscous Flow (4)**

Introduction to tensor calculus and indicial notation. Development of Reynolds' Transport Theory. Special forms of the governing equations of fluid motion. Internal flows and other classical solutions to the Navier-Stokes equations. 4 lectures. Prerequisite: ME 347, MATH 344 and graduate standing or consent of instructor.

**ME 541 Advanced Thermodynamics (4)**

Selected modern applications of thermodynamics which may include topics from: 1) equilibrium and kinetics as applied to combustion and air pollution, analysis and evaluation of techniques used to predict properties of gases and liquids, and 2) improvement of modern thermodynamic cycles by second law analysis. 4 lectures. Prerequisite: ME 303, ME 343, ME 347 and graduate standing or consent of instructor.

**ME 542 Dynamics and Thermodynamics of Compressible Flow (4)**

Control volume analysis of fluid-thermo equations for one-dimensional, compressible flow involving area change, normal shocks, friction, and heat transfer. Two-dimensional supersonic flow including linearization, method of characteristics, and oblique shocks. One-dimensional constant area, unsteady flow, 4 lectures. Prerequisite: ME 303, ME 343, ME 347, MATH 244, and graduate standing or consent of instructor.

**ME 551 Mechanical Systems Analysis (4)**

Various system modeling methods applied to mechanical systems. System stability studies and system optimization methods. 3 lectures, 1 laboratory. Prerequisite: Graduate standing or consent of instructor.

**ME 552 Advanced Heat Transfer I (4)**

Advanced principles of heat transfer. Classical solution techniques to problems in conduction and/or radiation. 4 lectures. Prerequisite: ME 343, ME 347, MATH 344, and graduate standing or consent of instructor.

**ME 553 Advanced Heat Transfer II (4)**

Advanced principles of heat transfer. Classical solution techniques to problems in convection. 4 lectures. Prerequisite: ME 343, ME 347, MATH 344, and graduate standing or consent of instructor.

**ME 554 Computational Heat Transfer (4)**

Numerical solutions of classical, industrial, and experimental problems in conduction, convection, and radiation heat transfer. 3 lectures, 1 laboratory. Prerequisite: ME 343, ME 347, MATH 418, graduate standing or consent of instructor.

**ME 555 Micro Systems Laboratory (2)**

Design, fabrication, and testing of a microfluidic device. Utilization of a rapid prototype soft lithography processing technique to create micro channels, valves, mixing chambers, etc. for controlling fluid flow dynamics. 2 laboratories. Prerequisite: Senior or graduate standing or consent of instructor. Corequisite: MATE 550. *Crosslisted as MATE/ME 555.*

**ME 563 Graduate Seminar (1)**

Current developments in mechanical engineering. Participation by graduate students, faculty and guests. 1 seminar. Prerequisite: Graduate standing in mechanical engineering program.

**ME 570 Selected Advanced Topics (1-4)**

Directed group study of selected topics for advanced students. The Schedule of Classes will list title selected. Total credit limited to 8 units; may be repeated in same term. 1-4 seminars. Prerequisite: Graduate standing or consent of instructor.

**ME 571 Selected Advanced Laboratory (1-4)**

Directed group laboratory study of selected topics for advanced students. The Schedule of Classes will list title selected. Total credit limited to 8 units; may be repeated in same term. 1-4 laboratories. Prerequisite: Graduate standing or consent of instructor.

**ME 579 Fluid Power Control (4)**

Design, analysis, and control of fluid power systems. Analysis of fluid power system components such as valves, actuators, pumps and motors. System response and stability. Dynamic modeling and computer simulation 3 lectures, 1 laboratory. Prerequisite: ME 422.

**ME 593 Cooperative Education Experience (2) (CR/NC)**

Advanced study analysis and part-time work experience in student's career field; current innovations, practices, and problems in administration, supervision, and organization of business, industry, and government. Must have demonstrated ability to do independent work and research in career field. Credit/No Credit grading only. Prerequisite: Graduate standing and consent of instructor.

**ME 594 Cooperative Education Experience (6) (CR/NC)**

Advanced study analysis and full-time work experience in student's career field; current innovations, practices, and problems in administration, supervision, and organization of business, industry, and government. Must have demonstrated ability to do independent work and research in career field. Credit/No Credit grading only. Prerequisite: Graduate standing and consent of instructor.

**ME 595 Cooperative Education Experience (12) (CR/NC)**

Advanced study analysis and full-time work experience in student's career field; current innovations, practices, and problems in administration, supervision, and organization of business, industry, and government. Must have demonstrated ability to do independent work and research in career field. A fully-developed formal report and evaluation by work supervisor required. Credit/No Credit grading only. Prerequisite: Graduate standing and consent of instructor.

**ME 599 Design Project (Thesis) (1-9)**

Each individual or group will be assigned a project for solution under faculty supervision as a requirement for the master's degree, culminating in a written report/thesis. Prerequisite: Graduate standing.