INTRODUCTION

The mechanical engineering program at CSUF provides a foundation for professional engineering careers in private industry and government. Mechanical engineers are employed in a wide range of industries, such as manufacturing, transportation, energy, food, biomedical and others. In general, mechanical engineers are involved with the design, research, development, manufacture, testing, distribution, support, maintenance and recycling of devices and products. Automobiles, airplanes, home appliances, robots, rockets, space capsules, printers and computer hardware are some of the various products that have been customarily designed and developed by mechanical engineers. Mechanical engineers possess a firm understanding of science, mathematics and engineering needed to carry out these complex tasks which are so important to a modern technological society.

The Bachelor of Science in Mechanical Engineering is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org.

The graduate curriculum is designed to provide a specialized education for career advancement or further work towards a doctoral degree.

LEARNING GOALS AND STUDENT LEARNING OUTCOMES

The following learning goals and outcomes have been established for students pursuing a degree in Mechanical Engineering:

Program Educational Objectives

A. Technical Growth – Graduates will be successful in modern engineering practice, integrate into the local and global workforce, and contribute to the economy of California and the nation

B. Professional Skills – Graduates will continue to demonstrate the professional skills necessary to be competent employees, assume leadership roles, and enjoy career success and satisfaction

C. Professional Attitude and Citizenship – Graduates will become productive citizens with high ethical and professional standards, make sound engineering or managerial decisions, and have enthusiasm for the profession and professional growth

Student Outcomes

(a) An ability to apply knowledge of mathematics, science, and engineering

(b) An ability to design and conduct experiments, as well as to analyze and interpret data

(c) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

(d) An ability to function on multi-disciplinary teams

(e) An ability to identify, formulate, and solve engineering problems
An understanding of professional and ethical responsibility
An ability to communicate effectively
The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context
A recognition of the need for and an ability to engage in life-long learning
A knowledge of contemporary issues
An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

2 + 2 Articulated Programs with Community Colleges
The Mechanical Engineering Department has developed 2+2 articulation agreements with community colleges to provide students seamless transfer to CSUF’s Mechanical Engineering program. This allows the full-time students taking the courses specified by the department adviser to graduate in two years following transfer to CSUF.

BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING (132 UNITS)

The requirements for the degree comprise four major segments: foundation courses in mathematics and physical sciences; basic engineering courses; general education courses in the arts, humanities, social sciences, biological sciences and other related areas; and a sequence of courses to fulfill the requirements of the Mechanical Engineering degree or the emphasis in Manufacturing Engineering.

Students are required to meet with their academic adviser every semester during the first year and at least once a year thereafter. Students are strongly encouraged to see their academic advisers frequently to obtain guidance in pursuit of their careers. All courses taken in fulfillment of the requirements for the bachelor’s degree must be taken for a letter grade, i.e., under grade Option 1. All mathematics and physical science courses required for the degree must be completed with at least a “C” (2.0) to count as prerequisite courses to engineering courses or as credit towards the degree. Graduate courses are not open to undergraduate students without approval of the program coordinator.

Mathematics and Science Courses (32)
BIOL 101 Elements of Biology (3)
MATH 150A Calculus (4)
MATH 150B Calculus (4)
MATH 250A Multivariate Calculus (4)
MATH 250B Introduction to Linear Algebra and Differential Equations (4)
CHEM 120A General Chemistry (5)
PHYS 225, 225L Fundamental Physics: Mechanics and Lab (4)
PHYS 226, 226L Fundamental Physics: Electricity and Magnetism and Lab (4)

Engineering Core Courses (23)
EGME 102 Engineering Graphics (2)
EGCE 201 Statics (3)
EGEE 203 Electric Circuits (3)
EGME 205 Digital Computation (3)
EGCE 302 Dynamics (3)
EGME 304 Thermodynamics (3)
EGME 306A Unified Laboratory (1)
EGME 308 Engineering Analysis (3)
EGME 314 Engineering Economy (2)

General Education Courses
Area A: Core Competencies (9 Units)
1. Oral Communication (3)
   HONR 101B, HCOM 100, 102
2. Written Communication (3)
   ENGL 101
3. Critical Thinking (3)
   HONR 101A, HCOM 235, PHIL 105, 106, PSYC 110, READ 290

Area B: Scientific Inquiry and Quantitative Reasoning (16 Units)
1. Physical Science (8)
   CHEM 120A and PHYS 225
2. Life Science (3)
   BIOL 101
3. Laboratory Experience (1)
   PHYS 225L
4. Mathematics/Quantitative Reasoning (4)
   MATH 150A
5. Implications and Explorations in Mathematics and Natural Sciences
   Not applicable for engineering majors

Area C: Arts and Humanities (12 Units)
1. Introduction to Arts (3)
   ART 101, 201A, 201B, 311, 312, DANC 101, MUS 100, 101
2. Introduction to the Humanities (3)
   Any lower division course in this category listed in the current class schedule
3. Explorations in the Arts and Humanities (3)
   Any upper-division course in this category listed in the current class schedule
4. Origins of the World Civilizations (3)
   HIST 110A or 110B, 210A, 210B
**Area D: Social Sciences (12 Units)**

1. Introduction to the Social Sciences (3)
   EGME 314 and EGME 490

2. World Civilizations and Cultures
   Not applicable for engineering majors

3. American History, Institutions and Values (3)
   AFAM 190, AMST 201, CHIC 190, HIST 180, 190, HONR 201A

4. American Government (3)
   HONR 201B, POSC 100

5. Explorations in Social Sciences (3)
   Any upper-division course in this category listed in the current class schedule

**Area E: Lifelong Learning and Self Development (3 Units)**
Not applicable for engineering majors

**Area Z: Cultural (3 Units)**
Take at least one star (*) course in Sections C.3 and D.5

**Upper-Division Writing Requirement**
The following courses are required by all mechanical engineering majors: EGME 306A, 306B, 476A and 476B. Written work for these courses must meet professional standards and requires completion with a grade of "C" (2.0) or better.

**Required Courses (36 units)**

EGEE 203L Electric Circuits Laboratory (1)

EGEE 303 Electronics (3)

EGME 306B Fluids and Thermal Laboratory (1)

EGME 322L Introduction to Computer-Aided Design (3)

EGME 331 Mechanical Behavior of Materials (3)

EGME 333 Fluid Mechanics & Aerodynamics (3)

EGME 335 Introduction to Mechanical Design (3)

EGME 407 Heat Transfer (3)

EGME 414 Design Project I (3)

EGME 419 Design Project II (2)

EGME 421 Mechanical Design (3)

EGME 431 Mechanical Vibrations (3)

EGME 476A Dynamic Systems and Controls Lab (2)

EGME 476B Energy and Power Lab (2)

EGME 490 Seminar in Engineering (1)

**Technical Electives (11 units)**
Before enrolling in any elective course, approval of the adviser must be obtained.

**Power and Energy**

EGME 417, 424, 447, 451, 452, 454

**Design and Materials for Manufacturing**

EGGN 403

EGME 315, 410, 411, 418, 422, 438, 454, 456, 457L, 459, 460, 461, 462, 463, 475, 480, 483, 486, 487

**Thermal and Fluids Engineering**

EGME 410, 417, 422, 424, 426, 447, 451, 452, 454, 486, 487

**Robotics, Controls and Automated Manufacturing**

EGGN 403

EGME 315, 410, 411, 422, 424, 454, 456, 457L, 461, 463, 483, 486, 488

**MANUFACTURING ENGINEERING EMPHASIS**
See the Bachelor of Science in Mechanical Engineering section of this catalog for requirements in mathematics and science foundation courses (32 units), engineering core courses (23 units) and general education coursework.

**Required Courses (40 units)**

EGEE 203L Electric Circuits Laboratory (1)

EGEE 303 Electronics (3)

EGME 306B Fluids and Thermal Laboratory (1)

EGME 322L Introduction to Computer-Aided Design (3)

EGME 331 Mechanical Behavior of Materials (3)

EGME 333 Fluid Mechanics and Aerodynamics (3)

EGME 335 Introduction to Mechanical Design (3)

EGME 476A Dynamic Systems and Controls Lab (2)

EGME 407 Heat Transfer (3)

EGME 414 Design Project I (3)

EGME 419 Design Project II (2)

EGME 421 Mechanical Design (3)

EGME 461 Fabrication Methods (3)

EGME 463 Introduction to Robotics (3)

EGME 483 Computer-Aided Manufacturing (3)

EGME 490 Seminar in Engineering (1)

**Technical Electives (9 units)**
Approval of the adviser must be obtained before enrolling in any elective course.

EGME 315, 410, 411, 422, 426, 454, 459, 460, 462, 480

EGEE 323, 404, 404L, 445, 445L
MASTER OF SCIENCE IN MECHANICAL ENGINEERING
(30 UNITS)

To qualify for admission to a conditionally classified standing, students must meet the CSU requirements for admission to a master's degree program. Please consult the Graduate Admissions section in this catalog for complete information. In addition, applicants must meet the following departmental requirements:

- Bachelor’s degree from a regionally accredited institution, e.g., Western Association of Schools and Colleges (WASC)
- Bachelor’s degree in mechanical engineering from an institution accredited by the Engineering Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012, telephone 410-347-7700

Students not meeting the above requirements may be admitted at the discretion of the graduate adviser and may be required to take additional units of adviser-approved prerequisite coursework. The student must demonstrate potential for graduate study by earning a grade point average of 3.0 or higher in these courses.

Application Deadlines
Reference fullerton.edu/ecs for application information.

Classified Standing
Students meeting the following additional requirements will be advanced to classified standing and are eligible to take graduate courses for which they are qualified:

1. complete all deficiency work, specified by the mechanical engineering graduate program adviser, with a “B” (3.0) or better;
2. meet with an adviser prior to completing nine units toward the M.S. degree at CSUF to develop a study plan, which must also be approved by the student’s graduate adviser, department chair and Office of Graduate Studies; and
3. fulfill the university writing requirement prior to completing nine units at CSUF toward the M.S. degree (Please refer to the “Graduate Regulations” section of this catalog and also the class schedule for further information on how this requirement can be met).

Study Plan
The study plan consists of adviser-approved upper-division or graduate-level coursework that must be completed with an overall grade-point average of at least 3.0. At least half the units required for the degree must be in approved graduate (500-level) courses.

Required Courses (3 units)
Adviser-approved math-oriented course (3)

Concentration Courses (15 units)
A student is required to select a minimum of 15 units in mechanical engineering. These units may be 400- and 500-level courses and are selected according to the student’s area of special interest. Coursework is designed to meet the student’s professional career goals and may focus on the following areas: Power and Energy, Design and Materials for Manufacturing, Thermal and Fluids Engineering, Robotics, Controls and Automated Manufacturing.

Other Courses (12 units)
Elective units should be taken in mechanical engineering or a related field and are subject to adviser approval. A maximum of three units of non-engineering courses can be approved on the study plan.

Exam/Thesis/Project Option (0-6 units)
Subject to approval by the adviser, students may select one of the following three options for final review by a department committee:

- Comprehensive oral examination over selected coursework (five courses, at least three of which are 500-level)
- EGME 597 Project (3-6 units)
- EGME 598 Thesis (3-6 units)

Students enrolling in less than six units of Thesis/Project will be required to take a comprehensive oral exam. Students enrolling in six units of thesis or project may defend their thesis or project work with an oral exam, limited to their project work, instead of taking a comprehensive oral exam.

MECHANICAL ENGINEERING COURSES
Courses are designated as EGME in the class schedule.

102 Engineering Graphics (2)
Graphics as a fundamental means of communication in design. Sketching, visualization, geometry, CAD principles and applications. Orthographic projections, pictorials. Multiview drawing, including auxiliary, section and detail views. Standards and conventions. Dimensioning, tolerances, GDT. Design processes, cost analysis and freshman project. (1 hour lecture, 3 hours laboratory)

205 Digital Computation (3)
Prerequisites: college algebra or three years of high school math, including a second course in algebra. Computers and their numerical applications. Programming languages, MathCAD spreadsheet, digital computation methods in statistics and solving algebraic equations. Applications of general purpose software for engineering analysis. (Same as EGGN 205)
214 Basic Machine Shop Practice and Safety (2)
Prerequisites: MATH 115, 125 or equivalents. Introduction to machine shop practices and drill press, grinding wheel, lathe, vertical mill and band saw. Thorough safety procedures instruction on each machine. Demonstrate safe practices on each machine. Introduction to measurement and tolerancing. Discussion and laboratory practice. (1 hour lecture, 3 hours laboratory.) Does not count toward fulfilling degree requirements. Credit/No Credit only.

304 Thermodynamics (3)
Prerequisites: CHEM 120A, MATH 150B, PHYS 225. Energy and its transformation; heat and work; conservation of mass and energy; system properties, irreversibility and availability. Ideal gases, heat engines and refrigeration (both ideal and actual), equipment selection and sizing.

306A Unified Laboratory (1)
Prerequisites: PHYS 225 and EGME 102. Corequisite: EGME 205, 331. Static and dynamic measurements (tension and strain test on beams, columns, charpy, gyroscopes) using mechanical and electrical transducers. Use of computers in data acquisition, reduction and analysis. Each student must write a complete set of reports and pass with a "C" (2.0) or better. (3 hours laboratory)

306B Fluids and Thermal Laboratory (1)
Prerequisites: EGME 306A and 333. Corequisite: EGME 407. Continuation of EGME 306A. Flow, temperature and pressure measurement. Experimental studies of fluid friction and heat exchanger performance. Use of computers in data acquisition, reduction and analysis. Each student must write a complete set of technical reports and pass with a "C" (2.0) or better. (3 hours laboratory)

308 Engineering Analysis and Statistics (3)
As EGCE/EGEE/EGGN 308

314 Engineering Economy (2)
Prerequisite: junior or senior standing in engineering. Development, evaluation and presentation of alternatives for engineering systems and projects using principles of engineering economy and cost benefit analysis. (Same as EGGN 314)

315 Basic Fabrication Techniques and Manufacturing Practices (3)
Prerequisite: EGME 102. Conventional fabrication techniques, measuring, referencing and tolerances applied to manufacturing such as tooling, computer numerical control machining and process indices. Safety instruction for use of campus machine shop equipment. (2 hours discussion and 2 hours laboratory)

322L Introduction to Computer-Aided Design (3)
Prerequisites: EGME 331, EGCE 302. Introduction to modeling, assembly, design documentation and analysis using typical commercial CAD/CAE software. Use of online resources in the collaborative design process. Design file transfer protocols. Design project using a technology based team environment. CAD/CAE system selection criteria. (1 hour discussion, 6 hours laboratory). (Same as CPSC 322L)

331 Mechanical Behavior of Materials (3)

333 Fluid Mechanics and Aerodynamics (3)
Corequisites: EGME 205, 304. Principles of fluid mechanics and their applications; fluid properties; fluid statics; one-dimensional incompressible flow; concepts of multi-dimensional flows including conservation principles; similitude and dimensional analysis; internal and external viscous flow; elements of compressible flow; design considerations in fluid mechanics.

335 Introduction to Mechanical Design (3)
Prerequisites: EGME 102, 205, EGCE 302. Kinematics and dynamics of mechanisms; design and analysis of linkages, gears and shafts through the use of analytical, graphical and computer-aided techniques.

350 Living and Working in Space (3)

407 Heat Transfer (3)
Prerequisites: MATH 250B and EGME 333. Principles of heat transfer and their applications: introduction to conductive, convective and radiation heat transfer; one-dimensional heat conduction; concepts of multi-dimensional conduction; convective heat transfer for internal and external viscous flows; cross-flow and shell and tube heat exchangers; thermal system design.

410 Introduction to the Finite Element Method and Applications (3)
Prerequisite: approved study plan. Basic concepts of integral and matrix formulation of boundary value problems. One dimensional finite element formulation of heat transfer, truss beam and vibration problems. Applications of commercial finite element programs. Selection criteria for code, element and hardware. CAD system interfaces.
411 Mechanical Control Systems (3)
Prerequisites: EGME 205, 308, EGCE 302. Mechanical control system design and analysis. Pneumatic, hydraulic, electromechanical actuators and devices. Stability criteria, root locus plots, frequency response analysis and design, transfer functions, introduction to feedback control and microprocessor applications.

414 Design Project I (3)
Prerequisites: EGME 322L, 421. Corequisite: EGME 426. Design methodology, CAD/CAE philosophy, optimization, product liability, probability/statistical principles, ASME codes, safety, human factors, material selection, legal aspects of design, professional ethics. Design project to be constructed in EGME 419, but feasibility study, preliminary design, assembly drawings, interim and final written project reports, interim and final oral presentations are required for 414. (1 hour lecture and 6 hours laboratory)

417 Computational Heat Transfer (3)

418 Space and Rocket Engineering (3)

419 Design Project II (2)
Prerequisite: EGME 414. Completion of the design project initiated in EGME 414. Construction of prototype, model or components. Test proposed design, and prepare a written final design report. Teamwork and communications skills are emphasized. Interim and final oral presentations are required. (6 hours laboratory)

421 Mechanical Design (3)
Prerequisites: EGME 331, 335. Design and application of machine components such as brakes, clutches, gears, springs, fasteners, pulleys and belting lubrication of machine elements, bearings, gaskets, seals, "O" rings, methods for study of impact, dynamic loading and fatigue; comprehensive treatment of failure, safety and reliability.

422 Mechanical Design Using Pro/ENGINEER (3)
Prerequisite: EGME 322L or equivalent. Modeling, assembly and design documentation using Pro/ENGINEER. Design of mechanical components and assemblies using Advanced Pro/ENGINEER features such as blends, drafts, user defined features, relations, family tables and assembly management. Collaborative design project, utilizing online resources. May be repeated for one credit.

424 Data Acquisition and Instrumentation Using LabVIEW (3)
Prerequisite: EGME 306A or equivalent. Graphical programming; design and development of virtual instruments using LabVIEW programming environment; building applications for data acquisition and data reduction, measurement, testing and control of engineering systems; collaborative term project. (2 hours discussion, 3 hours laboratory)

426 Design of Thermal and Fluid Systems (3)
Prerequisite: EGME 407. Integration of fundamental principles of thermodynamics, fluid mechanics, heat transfer and related subjects in the design of thermal and fluid systems. Design process and economics are applied to pumps, fans, turbines, boilers, piping systems, cross-flow and shell and tube heat exchangers.

431 Mechanical Vibrations (3)

438 Analytical Methods in Engineering (3)
Prerequisite: EGME 308. Ordinary and partial differential equations with constant and variable coefficients; orthogonal functions; conformal mapping; potential theory; engineering applications.

447 Piping Selection and Piping Network Design (3)
Prerequisites: EGME 333 and EGCE 301 or EGME 331. Pressure losses in piping networks; selection of piping based upon fluid, temperature, pressure and economic considerations; piping connections, fittings and components; stress analysis; review of national piping codes.

451 Heating, Ventilating and Air Conditioning Systems (3)
Prerequisites: EGME 304, 407. The fundamentals of controlling heating, ventilating and air conditioning systems. Theory and analysis of fundamental thermodynamics relating to these systems. Laboratory demonstrations of actual systems.

452 Fluid Machinery (3)
Prerequisites: EGME 304, 333. Thermal and hydraulic design and analysis of pumps, fans, turbines and compressors. Component selection, system design and performance evaluations.

454 Optimization of Engineering Design (3)
Prerequisite: EGME 308. Application of analytical and computer optimization techniques to engineering design problems. Presentation of design as an optimization task. One dimensional minimization. Unconstrained and constrained nonlinear programming. Approximation concepts. Duality. Computer applications to design problems using a general purpose optimization program.
456 Introduction to Mechatronics for Engineers (3)

457L Intelligent Systems Laboratory (2)
Prerequisite: EGME 456. Design and assembly of microprocessor-based mechanisms. Lab experiments encompass machine/high level programming and interfacing of microcontrollers with sensors and actuators. Design project. (1 hour lecture, 3 hours laboratory)

459 Plastics and Other Non-Metals (3)

460 Failure of Engineering Materials (3)
Prerequisite: EGME 331. Imperfections in solids; fracture initiation and crack propagation; dislocations; yield point phenomenon; fatigue; creep; ultrasonic effects; radiation damage; stress corrosion; hydrogen embrittlement; failure of composite materials.

461 Fabrication Methods (3)
Prerequisite: EGME 331. Manufacturing processes. Metal joining processes. Casting, forging, powder metallurgy, machining and machining tools, finishing, coating, plating, non-metallic materials inspection and gaging and tolerances.

462 Composite Materials (3)
Prerequisite: EGCE 301 or EGME 331. Application, mechanical properties and fabrication studies of fiber reinforced composite materials, stress analysis of laminated anisotropic composite structures. Studies of special problems unique to composites.

463 Introduction to Robotics (3)
Prerequisite: EGME 335. Corequisite: EGME 476A. Kinematic, dynamic, control and programming fundamentals associated with industrial robots and programmable manipulators. Trajectory planning, application of robotics in manufacturing and integration of robots into flexible manufacturing systems.

475 Acoustics and Noise Control (3)
Prerequisite: PHYS 227. Basic phenomena on the propagation, absorption and generation of acoustic waves, specification and measurement of noise, effects of noise on speech and behavior, legal aspects of industrial and building noise, principles and application of noise control.

476A Dynamic Systems and Controls Laboratory (2)
Prerequisites: EGME 431, 306B. Dynamic systems, vibration, acoustics and other mechanical components; computer simulation of dynamic systems (Simulink and computer-aided data acquisition); robotics, computer-controlled machining and automatic data acquisition. Computers in data acquisition, reduction and analysis. Each student must write a complete set of individual engineering laboratory reports. Must pass with a “C” (2.0) or better to count towards the upper-division writing requirement. Not available for graduate degree credit. (6 hours laboratory)

476B Energy and Power Laboratory (2)
Prerequisites: EGME 304, 306B, 407. Mass transfer, heat transfer and thermodynamic phenomena and their interaction with mechanical systems. Team experiment. Use of computers in data acquisition, reduction and analysis. Each student must write a complete set of individual engineering laboratory reports. Must pass with a “C” (2.0) or better to count towards the upper-division writing requirement. Not available for graduate degree credit. (6 hours laboratory)

480 Human Factors in Engineering (3)
Prerequisite: junior standing. Principles of design for making products and systems faster, easier and more effective to use. Design project using these principles that consider human capabilities and limitation of senses and responses to sensory stimuli. Physiological, psychological and work factors are evaluated for design of equipment, work methods, environments and standards.

483 Computer-Aided Manufacturing (3)
Prerequisite: EGME 476A or equivalent. Introduction to computer-aided manufacturing processes. CNC machines, robot and PLC programming. Design for CIM. Fixed and flexible manufacturing systems. Process planning and scheduling. Simulation software for manufacturing systems. Laboratory experiments. (1 hour discussion, 4 hours laboratory)

486 Introduction to Electronics Packaging (3)
Prerequisites: EGEE 303, EGME 306A. Electronic components and devices. The chip carrier, packaging and production of printed circuit boards. First, second and third level packaging. Introduction to thermal analysis and vibration of electronic equipment.

487 Thermal Control of Electronics Packaging (3)
Prerequisites: EGME 308, 407. Fluid mechanics and heat transfer as related to the thermal control of electronic packages of varying sizes. Analysis of individual components, complete boards and complete systems is considered. Liquid and gas cooling mediums.

490 Seminar in Engineering (1)
Prerequisite: senior standing in engineering. Engineering profession, professional ethics and related topics. May be repeated once for credit with the approval of the department.
497 Senior Project (1-3)  
Prerequisites: consent of instructor, adviser and department head. Directed independent design project.

499 Independent Study (1-3)  
Prerequisite: approval of study plan by adviser and department head. Specialized topics in engineering, selected in consultation with and completed under the supervision of the instructor. May be repeated for credit.

508 Advanced Inviscid Fluid Flow (3)  
Prerequisites: EGME 205, 308, 333. Two- and three-dimensional potential flow theory. Sources, sinks, vortices, Rankine bodies, free jets, channel flow, air foils. Introduction to computational fluid dynamics. Complex potential and various transformation techniques are used.

511 Advanced Mechanical Vibrations (3)  
Prerequisite: EGME 431. Vibrations in rotating and reciprocating machines; noise and vibration in fluid machinery; continuous systems; random vibrations; transient and nonlinear vibration, computer applications.

512 Advanced Mechanical Design and Management (3)  
Prerequisite: EGME 421 or equivalent. Advanced modern mechanisms. Analysis and synthesis of mechanisms. Advanced topics in computer-aided design of mechanical, thermal and fluid systems. Methodology of modern design. Optimization in design.

516 Advanced Radiation Heat Transfer (3)  
Prerequisite: EGME 407. Radiation heat transfer, including study of the geometric shape factors, ideal (black) and real systems, and energy transfer in absorbing, scattering and emitting media, and radiation combined with other modes of energy transfer.

520 Advanced Viscous Fluid Flow (3)  

526 Advanced Convective Heat Transfer (3)  
Prerequisite: EGME 407. Convective heat transfer; heat transfer in external and internal flow fields for both laminar and turbulent fluid flow, applications.

530 Advanced Strength of Materials (3)  
Prerequisite: EGME 421. Energy methods. Castilian’s theorem. Curved beams, beams on elastic supports, thick wall cylinders, shrink fits, localized stress, column instability, failure theories, bearings.

536 Advanced Conduction Heat Transfer (3)  
Prerequisite: EGME 407. Conduction heat transfer; Bessel and Legendre functions, Laplace transforms, eigenfunctions, Fourier series solutions, heat sources and sinks, multidimensional problems, transient systems and numerical methods (finite difference and finite element methods).

538 Advanced Engineering Analysis (3)  
Prerequisite: EGME 438. Partial differential equations in engineering, numerical techniques, integral equations, engineering applications.

540 Computer Applications in Engineering Design (3)  

541 Finite Element Method for Mechanical Engineers (3)  

554 Applied Optimal Mechanical Design (3)  
Prerequisite: EGME 454 or equivalent. Formulation of design optimization problems in mechanical engineering. Mathematical programming methods. Practical aspects of optimization. Design of complex mechanical systems. Individual projects will be assigned to apply optimization techniques to an engineering system or component.

576 Advanced Dynamics and Control of Mechanical Systems (3)  
Prerequisite: EGME 411. Advanced study of the dynamics and control of mechanical systems including: state space modeling, Lyapunov stability, modern design techniques and case studies.

597 Project (1-6)  
Prerequisite: consent of graduate program adviser.

598 Thesis (1-6)  
Prerequisite: consent of graduate program adviser.

599 Independent Graduate Research (1-3)  
Prerequisite: classified graduate status. Open to graduate students only by consent of Mechanical Engineering graduate program adviser. May be repeated for credit only upon approval by the graduate program adviser.