Joint Mechanical Engineering

Courses

J M ENGR 1413 Introduction to Engineering Design: CAD: 2 semester hours
Prerequisites: Civil Engineering or Mechanical Engineering major.
An introduction to engineering design in the context of mechanical engineering. Students learn the fundamentals of spatial reasoning and graphical representation. Freehand sketching, including pictorial and orthographic views, are applied to the design process. Computer modeling techniques provide accuracy, analysis, and visualization tools necessary for the design of devices and machines. Topics in detailing design for production, including fasteners, dimensioning, tolerancing, and creation of part and assembly drawings are also included.

J M ENGR 1414 Introduction to Engineering Design: Project: 2 semester hours
Prerequisites: Mechanical Engineering major. An introduction to engineering design in the context of mechanical engineering. Students complete a series of labs and assignments that introduce physical phenomena related to mechanical engineering. The course proceeds to a design contest in which the students design and build from a kit of parts a more significant machine that competes in a contest held at the end of the course. The students also get to complete an individual design project on a topic which they select.

J M ENGR 2110 Machine Shop, Fabrication, and Prototyping: 2 semester hours
Prerequisites: Mechanical Engineering major. Basic machine shop and mechanical fabrication skills, including blacksmithing and industrial electrical control. "Design and build" activities will emphasize appropriate design for fabrication. Students learn machine shop skills including precision measurement, work holding, sawing, drilling, turning, and milling. Completion of the course provides certification to use the Washington University engineering machine shop.

J M ENGR 2410 Mechanics of Deformable Bodies: 3 semester hours
Prerequisites: MATH 1900, ENGR 2310, and Civil Engineering or Mechanical Engineering major. Normal and shear stresses and strains. Stress-strain diagrams. Hooke's law and elastic energy. Thermal stresses. Stresses in beams, columns, torsional members, and pressure vessels. Elastic deflection of beams and shafts. Statically indeterminate structures. Mohr's circle of stress. Stability concepts.

J M ENGR 3010 Computer Aided Design: 3 semester hours
Prerequisites: J M ENGR 1413 and Mechanical Engineering major. Computer aided design, analysis and optimization of parts and assemblies; solid modeling of complex surfaces, creation of detail drawings, dimensioning and tolerancing; assembly modeling, assembly constraints, interference checking; motion constraints, force and acceleration analysis, thermal analysis; part optimization for weight, strength and thermal characteristics using SolidWorks software. Solid modeling for additive manufacturing and 3D printing topics included.

J M ENGR 3110 Mechanical Design and Machine Elements: 3 semester hours
Prerequisites: J M ENGR 2410 and Mechanical Engineering major. Provides a thorough overview of the steps in the engineering design process and introduces analytical/quantitative techniques applicable to each step. Topics include recognition of need, specification formulation, concept generation, concept selection, embodiment, and detail design. Includes an introduction to several classes of machine elements such as shafts, bearings, gears, brakes, and threaded fasteners. Underlying analytical models of the machine elements are presented along with guidelines about designing and choosing such elements for practical applications. Students complete a case study project to conclude the course.

J M ENGR 3200 Thermodynamics: 3 semester hours
Prerequisites: MATH 1900, CHEM 1111 and PHYSICS 2111, and Electrical Engineering or Mechanical Engineering major. Classical thermodynamics; thermodynamic properties; work and heat; first and second laws. Entropy, irreversibility, availability. Application to engineering systems.

J M ENGR 3250 Material Science for J M ENGR: 4 semester hours
Prerequisites: CHEM 1111 and Mechanical Engineering major. Introduces the chemistry and physics of engineering materials. Emphasis on atomic and molecular interpretation of physical and chemical properties, the relationships between physical and chemical properties, and performance of an engineering material.

J M ENGR 3360 Material Science for J C ENGR: 3 semester hours
Prerequisites: CHEM 1111 and Civil Engineering major. Introduces the chemistry and physics of engineering materials. Emphasis on atomic and molecular interpretation of physical a chemical properties, the relationships between physical and chemical properties, and performance of an engineering material.

J M ENGR 3700 Fluid Mechanics: 3 semester hours
Prerequisites: MATH 2020 and ENGR 2320, Civil Engineering major or Mechanical Engineering major. Fundamental concepts of fluids as continua. Viscosity. Flow field: velocity, vorticity, streamlines. Fluid statics: hydrostatic forces manometers. Conservation of mass and momentum. Incompressible inviscid flow. Dimensional analysis and similitude. Flow in pipes and ducts. Flow measurement. Boundary-layer concepts. Flow in open channels.

J M ENGR 3710 Principles of Heat Transfer: 3 semester hours
Prerequisites: J M ENGR 3200, J M ENGR 3700 and J E MATH 3170, and Mechanical Engineering major. Introductory treatment of the principles of heat transfer by conduction, convection, or radiation. Mathematical analysis of steady and unsteady conduction along with numerical methods. Analytical and semiempirical methods of forced and natural convection systems. Heat exchangers: LMTD and e-NTU analysis. Boiling and condensation heat transfer. Radiation between blackbody and real surfaces. Radiation network analysis.

J M ENGR 3721 Fluid Mechanics Laboratory: 1 semester hour
Prerequisites: J M ENGR 3700 and Civil Engineering or Mechanical Engineering major. Physical laboratory exercises focusing on fluid properties and flow phenomena covered in J M ENGR 3700. Calibration and use of a variety of equipment; acquisition, processing, and analysis of data by manual as well as automated methods.

J M ENGR 3722 Heat Transfer Laboratory: 1 semester hour
Prerequisites: J M ENGR 3721, J M ENGR 3710 and Mechanical Engineering major. Physical laboratory exercises, including some numerical simulations and computational exercises, focusing on heat-transfer phenomena covered in J M ENGR 3710. Calibration and use of variety of laboratory instrumentation; acquisition, processing, and analysis of data by manual as well as automated methods; training in formal report writing.

J M ENGR 4000 Independent Study: 1-3 semester hours
Prerequisites: Mechanical Engineering major and consent of instructor. Independent investigation of a mechanical engineering topic of special interest to a student performed under the direction of a faculty member.

J M ENGR 4110 Mechanical Engineering Design Project: 3 semester hours
Prerequisites: J M ENGR 3110 and Mechanical Engineering major. Small student teams complete design projects subject to various constraints (e.g. economic, safety, legal, environmental, ethical), and appropriate codes and standards. Teams first perform a background information study, which is followed by a specification and conceptual design study. Embodiment and fabrication plans are produced for the chosen concept. The results of an engineering analysis study influence the final design of a working prototype, which is built and demonstrated. This is "documented" in an appropriate manner (e.g. a CAD model) that allows others to reproduce a version, and it is "published" so that other interested parties learn of its existence.

J M ENGR 4120 Design of Thermal Systems: 3 semester hours
Prerequisites: J M ENGR 3200 and Mechanical Engineering major. Analysis and design of advanced thermo-fluid systems. Student teams participate in the design process which could involve research, design formulation, codes, standards, engineering economics, a design project report, and formal presentations. Topics include: thermal-fluid systems and components, such as power, heating, and refrigeration systems, pumps, fans, compressors, combustors, turbines, nozzles, coils, heat exchangers and piping.

J M ENGR 4170 Dynamic Response of Physical Systems: 2 semester hours
Prerequisites: ENGR 2320 and J E MATH 3170, and Mechanical Engineering major. Free and forced vibration of mechanical systems with lumped inertia, springs, and dampers. Methods of Laplace transform, complex harmonic balance, and Fourier series. Electrical analogs. Introduction to Lagrange's equations of motion and matrix formulations. Transient response of continuous systems by partial differential equations, by rayleigh methods, and by lumped parameters. Must be taken concurrently with J M ENGR 4180.

J M ENGR 4180 Dynamic Response Laboratory: 1 semester hour
Prerequisites: J M ENGR 4170 and J M ENGR 4180 must be taken during the same semester. Laboratory problems focusing on materials covered in J M ENGR 4170.

J M ENGR 4250 Material Selection in Engineering Design: 3 semester hours
Prerequisites: J M ENGR 3250 and Mechanical Engineering major. Analysis of the scientific bases of material behavior in the light of research contributions of the last 20 years. Development of a rational approach to the selection of materials to meet a wide range of design requirements for conventional and advanced applications. Although emphasis will be placed on mechanical properties, other properties of interest in design will be discussed, e.g., acoustical, optical and thermal.

J M ENGR 4310 Control Systems I: 3 semester hours
Same as J E ENGR 4410. Prerequisites: J E MATH 3170, J E ENGR 2300 and Electrical Engineering major or Mechanical Engineering major. Introduction to automatic control concepts. Block diagram representation of single and multiloop systems. Multi-input and multi-output systems. Control system components. Transient and steady-state performance; stability analysis; Routh, Nyquist, Bode, and root locus diagrams. Compensation using lead, lag and lead-lag networks. Synthesis by Bode plots and root-locus diagrams. Introduction to state-variable techniques, state-transition matrix, state-variable feedback.

J M ENGR 4360 Energy Alternatives: 3 semester hours
Same as J E ENGR 4360. Prerequisites: J E ENGR 2300 or J M ENGR 3200, and Electrical Engineering major or Mechanical Engineering major. This course introduces engineering analyses of the human uses of energy. Both non-renewable (e.g., oil, natural gas, coal, nuclear) and sustainable (e.g., hydropower, solar, wind, biomass) resources are covered. Topics include the engineer's role in harvesting, production, storage, conversion, delivery, and uses of energy. Students will learn system analysis, design, integration, optimization, and operational aspects of selected resources delivery systems, and end uses. Technical content will include site selection, conversion and delivery efficiency calculations, engineering economic analyses, control systems, and energy resource systematic classification. Students will be assessed based on homework, quizzes, tests, class participation, and projects.

J M ENGR 4630 Nanotechnology: Concepts and Applications: 3 semester hours
Prerequisites: Mechanical Engineering major. The aim of this course is to introduce to students the general meaning, terminology and ideas behind nanotechnology and its potential application in various industries. The topics covered will include nanoparticles - properties, synthesis and applications, carbon nanotubes - properties, synthesis and applications, ordered and disordered nanostructured materials and their applications, quantum wells, wires and dots, catalysis and self-assembly, polymers and biological materials, nanoelectronics and nanophotonics, nanomanufacturing and functional nano-devices, health effects and nanotoxicity etc.

J M ENGR 4700 Sustainable Environmental Building Systems: 3 semester hours
Prerequisites: Mechanical Engineering major. Sustainable design of building lighting and HVAC systems considering performance, life-cycle cost and downstream environmental impact. Criteria, codes and standards for comfort, air quality, noise/vibration and illumination. Life cycle and other investment methods to integrate energy consumption/conservation, utility rates, initial cost, system/component longevity, maintenance cost and building productivity. Direct and secondary contributions to acid rain, global warming and ozone depletion.

J M ENGR 4706 Aircraft Performance: 3 semester hours
Prerequisites: Mechanical Engineering major. This course introduces the principles and applications of aerodynamics to determine the performance of typical jet engine and propeller airplanes. The performance calculations include flight conditions of takeoff, climb, level flight, and landing. The topics covered also include range and endurance computation, turning flight, flight envelope, constraint analysis and design process. The knowledge and skill gained in this course can be readily applied in the preliminary design of an airplane.

J M ENGR 4730 Economic Decisions in Engineering: 3 semester hours
Same as J C ENGR 4740. Prerequisites: Civil Engineering major, Electrical Engineering major or Mechanical Engineering major. This course examines the principles of economics involved in engineering decisions. It looks at decisions between alternatives based on the efficient allocation of resources. Topics include the time element in economics, analytical techniques for economic studies and taxes.

J M ENGR 4810 HVAC Analysis and Design I: 3 semester hours
Prerequisites: Mechanical Engineering major. Moist air properties and the psychrometric chart. Classic moist air processes and design procedures for heating and cooling systems. Design of heating, ventilating, and air conditioning systems for indoor environmental comfort and health. Basics of heat transfer in building structures. Solar radiation effects on building heat transfer. Calculation procedures for the analysis of heating and cooling loads in buildings.

J M ENGR 4820 HVAC Analysis and Design II: 3 semester hours
Prerequisites: Mechanical Engineering major. Energy calculations to estimate the quantity of energy needed to heat and cool building structures. Fundamentals of incompressible flow, basics of centrifugal pump performance, and design procedures for water piping systems. Space air diffuser design to assure that temperatures, humidities, and air velocities within occupied spaces are acceptable. Air duct design and fan analysis for optimally distributing air through building air duct systems. Performance analysis of refrigeration systems, including the effects of pressure losses and heat transfer. Direct contact heat and mass transfer.

J M ENGR 4900 Engineering Project Management: 3 semester hours
Prerequisites: Electrical Engineering or Mechanical Engineering major. Basic fundamentals and advanced concepts of engineering project management applicable to projects and programs, both large and small. Project management skills, techniques, systems, software and application of management science principles will be covered and related to research, engineering, architectural, and construction projects from initial evaluations through approval, design, procurement, construction and startup.

J M ENGR 4950 Fundamentals of Mechanical Engineering Review: 1 semester hour
Prerequisites: Mechanical Engineering major. A review and preparation of the most recent NCEES Fundamentals of Engineering (FE) Exam specifications for Mechanical Engineering students is offered in a classroom setting. Exam strategies will be illustrated using examples.

J M ENGR 4990 Mechanical Engineering Senior Seminar: 1 semester hour
Prerequisites: Mechanical Engineering major. Personal and professional development to prepare graduates entering the mechanical engineering profession. Topics may include personality characteristics, diversity, team dynamics, professionalism, early career development, graduate study, effective presentations, and case histories of mechanical engineering projects. Performance is based on class participation, oral presentations, and written reports.