MECHANICAL ENGINEERING
MATERIALS SCIENCE AND ENGINEERING

GRADUATE COURSE INVENTORY 2017

Approved Courses for Students Seeking a Masters Degree

----------*Core Course Requirements*----------

Thermal-Fluids . . . . . .three courses from: ME7300, ME7330, ME7340, ME7500, ME7520, ME7550

Design . . . . . ME7100 and two courses from: ME7060, ME7080, ME7120, ME7160, ME7210, ME 7690

Materials . . . . . .three courses from: ME7500, ME7720, ME7730, ME7750, ME7760, ME7780

For future course offerings, see **Course Schedule Planning Guides** at (www.wright.edu/registrar/scheduling/course-schedule-planning-guides)

MATH COURSE (Required)

MTH 6050 Advanced Engineering Mathematics 3 credits
Topics include eigenvalues and eigenvectors, matrix factorizations, Fourier series, analytical and numerical solutions to the three classical partial differential equations, and complex functions, integration, and series and residues.
Prerequisites: MTH 2320 and (MTH 2350 or (MTH 2330 and MTH 2530))

ENGINEERING COURSE OPTIONS *(Please note---6xxx courses cannot be repeated for credit if 4xxx equivalent course was taken)*

ME 6010 Computational Methods for Mechanical Engineering 3 credits
Combines material learned in statics, dynamics, thermodynamics, fluid mechanics, and heat transfer and applies them to the design of mechanical systems using numerical methods. **Prerequisites**: ME 5360 and ME 5210

ME 6080 Design Optimization 3 credits
Graphic, analytical, numerical, and symbolic techniques are used in the kinematic and dynamic analysis of machines. Computer-aided design of mechanisms is introduced. Emphasis on the application of these techniques to planar mechanisms. **Prerequisites:** ME 2210 and MTH 2350 or (MTH 2530 and EE 2010 and EE 2011)
(Please note that if you take ME 4080/6080, you are not eligible to take EGR 7040 for credit)

ME 6120 Finite Element Analysis 3 credits
Fundamentals of finite element analysis as a general numerical method for the solution of boundary value problems in engineering, with an emphasis on structural and solid mechanics. **Prerequisites:** MTH 2350 or (MTH 2330 and MTH 2530) and ME 5120
Corequisite: ***ME 6120L Finite Element Analysis Laboratory O Credits***

ME 6140 Mechanical Design I 3 Credits
Fundamental concepts in design for both static and fatigue loading, with application to selected mechanical components and systems. **Prerequisite:** ME 5120

ME 6150 Mechanical Design II 3 Credits
Analysis and design of mechanical elements including screws, welds, springs, bearings, gears, clutches, brakes, flywheels, pulleys and shafts. Students conduct a group design project. **Prerequisite**: ME 6140

ME 6180 Additive Manufacturing 3 Credits
An introduction to additive manufacturing process. The course will address various additive manufacturing (AM) principles and concepts; Materials science for AM; Design for AM; Scope of additive manufacturing with application area; bio-manufacturing. **Prerequisite: None**

ME 6190 Introduction to Engineering Lubrication 3 Credits
Define various lubrication regimes where mechanical elements in automotive, aerospace, heavy machinery, wind turbine applications operate; introduce surface topography metrics & parameters; describe lubricant properties including viscosity & density dependences on pressure as well as temperature, non- & Newtonian behavior; derive Reynolds equation; solve governing equations for elasto & hydrodynamic lubrication; introduce egr approaches for lubrication performance assessment in machine elements. **Prerequisites:** ME 5350 and (MTH 2330 and MTH 2530) or (MTH 2350 and MTH 2320)

ME 6210 Mechanical Vibrations 3 Credits
Modeling and analysis of single and multi-degree freedom systems under free and forced vibration and impact. Lagrangian and matrix formulations, energy methods, and introduction to random vibrations. **Prerequisite:** ME 5210
Co-requisite: ***ME 6210L Mechanical Vibrations Laboratory O Credits***

ME 6220 Mechanical System Modeling & Design 3 Credits
Modeling of complex mechanical systems as a set of simple, linear or nonlinear components for the purpose of design. Introduces modern computational tools. **Prerequisite:** ME 5210

ME 6240 Vehicle Engineering 3 Credits
Develops students' abilities to derive and solve vehicle equations, and introduce dynamic analysis in vehicle design. Various performance criteria, control concepts, and HEVs will be studied. **Prerequisite:** ME 2210

ME 6250 Kinematics and Design of Mechanisms 3 credits
Graphic, analytical, numerical, and symbolic techniques are used in the kinematic and dynamic analysis of machines. Computer-aided design of mechanisms is introduced. Emphasis is on the application of these techniques to planar mechanisms. **Prerequisite:** ME 2210

ME 6260 Introduction to Robotics 3 Credits
(Also listed as CEG 6560 and EE 6560.) An introduction to the mathematics of robots. Topics covered include coordinate systems and transformations, manipulator kinematics and inverse kinematics, Jacobians, dynamic and trajectory planning. **Prerequisite:** MTH 2350 or MTH 2530
Co-requisite: ***ME 6260L Introduction to Robotics Laboratory O Credits***

ME 6330 Compressible Fluid Flow 3 Credits
Fundamentals of gas flow in the subsonic to supersonic flow regimes. Wave propagation in compressible medium, one-dimensional isentropic flow with area change, frictional effects, heat transfer effects and two-dimensional waves. **Prerequisite:** ME 5350

ME 6340 Simulation of Thermal-Fluids Problems with Advanced Engineering Software Computational Fluid Dynamics 3 Credits
Students will learn to use commercial computational fluid dynamics software to solve practical engineering problems, including fluid, heat and mass transfer. **Prerequisite:** ME 6010

ME 6350 Mechanics of Viscous Fluids 3 Credits
Fundamental equations of viscous flow for laminar and turbulent flows including the Navier Stokes equations. Boundary layer analysis. **Prerequisite:** ME 3350

ME 6360 Principles of Internal Combustion Engines 3 Credits
Thermodynamics of I.C. engines, combustion thermodynamics, friction, heat and mass losses, and computer control of the modern fuel-injected I.C. engine. **Prerequisite:** ME 5350 minimum "C" grade

ME 6430 Aeronautics 3 Credits
Aviation history. Standard atmosphere, basic aerodynamics, theory of lift, airplane performance, principles of stability and control, astronautics, and propulsion concepts. **Prerequisite:** ME 5350

ME 6440 Aerospace Propulsion 3 Credits
Engine cycle analysis; combustion fundamentals; reciprocating engines and propellers; applications to turbojet, turbofan, turboprop, ramjet, SCRAM jet, and rocket engines. **Prerequisite:** ME 5350

ME 6490 Aerospace Structures 3 Credits
Analysis and design of flight structures. Stress, deformation, and stability analysis of aerospace structures. Thin-walled members bending, torsion, shear stresses calculation in multi-cell structures and buckling of thin plates. **Prerequisite:** ME 5120

ME 6520 Hydropower 3 Credits
Topics covered are hydraulics of turbomachines for power generation, hydrologic analysis for hydropower development for run-of the river systems and reservoir systems, dams and environmental impacts, environmental impact assessment, operations of reservoir systems, and economics of hydropower generation. **Prerequisites:** ME 5350

ME 6530 Energy Conversion 3 Credits
This course will study the fundamentals of energy and energy conversion, the conversion of energy from mechanical, thermal, chemical, and nuclear will be discussed. To demonstrate these energy forms generators, wind, ocean, turbines, direct energy conversion, fossil fuels, biofuels, and nuclear power will be presented. **Prerequisite:** ME 5320

ME 6540 Solar Thermal Engineering 3 Credits
Fundamentals of solar radiation and how it can be utilized as a thermal energy source. Solar insolation on a surface, flat plate collectors, concentrating collectors, thermal energy storage, and solar hot water heating will be discussed.
Prerequisite: ME 5360

ME 6550 Geothermal Energy 3 Credits
Techniques for tapping the energy of the earth will be discussed. This will include hot and cold geothermal energy. Use of geothermal energy to produce electricity, for space and district heating and cooling, and for industrial applications will be presented. Geothermal energy's effect on the environment and its economics will be discussed. **Prerequisite:** ME 5360

ME 6560 Wind Power 3 Credits
Power in the wind, the wind turbine and its parts, performance of wind turbines, and economics of wind turbines will be presented. **Prerequisite:** ME 5350

ME 6570 Energy Materials 3 Credits
Students will understand the principles and the materials of advanced electrochemical energy storage systems including batteries, fuel cells, and super capacitors. In this course, students will gain an understanding of material structures, material composition, and material morphologies in relation to applicable properties for electrochemical energy storage and conversion systems. Students will also be introduced to state-of-the-art materials research and development in these systems. **Prerequisites:** ME 2700 minimum "C" grade and (ME 5310 minimum "C" or ME 5750 minimum "C")

ME 6580 Fuel Cell Science and Technology 3 Credits
This course will cover the fundamentals, technologies, and applications of various types of fuel cells. The fundamentals covered are thermodynamic prediction, electrolyte conduction, and electrode kinetics. The types of fuel cells covered are polymer electrolyte fuel cell, solid oxide fuel cell, and fuel cell stack. **Prerequisites:** ME 6700 minimum "B" grade and (ME 5310 minimum "B" or ME 5750 minimum "B")

ME 6585 Natural Gas Production Engineering 3 Credits
Students will be able to demonstrate a knowledge of natural gas production and the associated separation processes to extract gas from oil, recognize the properties of natural gas, perform design calculations involved in production, development and distribution of natural gas, demonstrate a knowledge of effluent treatments in natural gas production and demonstrate a knowledge of the environmental impacts of natural gas. **Prerequisites:** CHM 1210, PHY 2400 and ME 3350

ME 6590 Advances in Clean Coal Technology 3 Credits
Historical perspective on coal; sources of coal in the world; future dependence on coal for energy; power production using coal; general process description; principles of combustion, conventional combustion reactors, environmental impact; fluidized bed reactors, process improvements in minimizing emissions; and discussions on future innovations in for clean coal technology. **Prerequisite:** ME 5360

ME 6680 Experimental Nanotechnology 3 Credits
This course will provide a series of laboratory experiments similar to the state-of-the-art R&D in nanotechnology and nanoscience. The experiments include 1) fabrication of nanomaterials such as metal nanoparticles and graphene nano-platelets; 2) characterization of physical and chemical properties by using techniques such as Raman spectroscopy, atomic force microscopy, terahertz spectroscopy, electrochemical analyses etc; and 3) computational modeling of nanoscale physical phenomena. **Prerequisites:** CHM 1210 and CHM 1210L and PHY 2400 and PHY 2400L

ME 6700 Structure & Properties Materials II 3 Credits
Effect of microstructure, phase equilibrium, and processing on properties of structural materials including metallic alloys, polymers, and composites. **Prerequisite:** ME 2700, MTH 2350, MTH 2320

ME 6720 Engineering Polymers I 3 Credits
Introduces polymers as engineering materials and covers fundamental concepts in polymer science and engineering. Includes polymerization processes, morphology and crystallinity, thermal transitions, viscoelasticity, rubber elasticity, aging, and contemporary issues in polymers. **Prerequisite:** ME 2700

ME 6730 Introduction to Ceramics 3 Credits
Ceramic and refractory raw materials and products; processing techniques; atomic structure and bonding; structure of crystalline phases and glasses; structural imperfections; diffusion and kinetics in oxides; advanced ceramics. **Prerequisite:** ME 2700

ME 6740 Materials Selection and Failure Analysis 3 Credits
Engineered components are manufactured with materials and are designed to perform for a specified life, but they may fail in service. Using lectures and computer software, this course covers procedures for selecting the optimum materials and manufacturing processes under multiple constraints. Failure analysis to establish the root cause is addressed through lectures and case studies that relate factors such as design, material, manufacture and service conditions. **Prerequisites:** ME 2700 and ME 4620 and ME 5120. (ME 4620 only may be taken concurrently)

ME 6750 Materials Characterization 4 Credits
Survey of the principal techniques used to detect and evaluate flaws in material components such as castings, weldments, and composites. Includes liquid penetrant, ultrasonic, radiographic, eddy current, and magnetic test methods. **Prerequisites:** ME 2700 and ME 5610 **Co-requisite:** ***ME 6750L Materials Characterization Laboratory O Credits***

ME 6770 Mechanical Behavior of Materials 3 Credits
Crystal plasticity and single crystal behavior. Introduction to dislocation theory. Strengthening mechanisms in metals. Fracture, fatigue, and creep behavior of metals. **Prerequisites:** ME 2700 and ME 5120

ME 6820 Corrosion 3 Credits
Survey of the principles of corrosion processes with application to metallic and nonmetallic materials. Principles of electrochemistry are included. **Prerequisites:** ME 2700 and (ME 5310 or 5750)

ME 6830 Computational Materials Science 3 Credits
This course covers basic theories, methods and algorithms of atomsitic computer simulations of materials, using lectures and computer labs. Classical, semi-empirical, and ab initio quantum mechanical methods are explained. **Prerequisite:** ME 2700

ME 6840 Materials Selection for Mechanical Design 3 Credits
Principles of materials-limited design. Lectures, case histories, open-ended assignments and computer based materials selection tools. Procedures for selection of optimum material(s) under constraints resulting from functional, reliability, safety, cost and environmental issues. **Prerequisites:** ME 2700 and ME 5120

ME 6850 Nano-scale Science and Engineering 3 Credits
Students will be introduced to nano-scale science and engineering in terms of the nano-scale building blocks (emphasizing carbon based nano-species), the characterization techniques (emphasizing Raman Spectroscopy) and the nano-phenomena such as thermal, optical, electrical, chemical and mechanical phenomena observed on the nano-scale. **Prerequisites:** ME 2700 and ME 5750

ME 6860 Metal Forming 3 Credits
Fundamentals of principal deformation processing systems including forging, extrusion, rolling, and sheet forming; material response and formability; and mechanics and analysis of selected processes. **Prerequisites:** ME 2700 and 5120

ME 6870 Machining 3 Credits
Fundamentals of machining with emphasis on engineering models of machinability, chip formation, cutting forces, power, & lubrication. Introduction to numerical control machining. **Prerequisites:** ME 1020 & ME 2210
Co-requisite: ***ME 6870L Machining Lab O Credits***

ME 6880 Powder Processing of Materials 3 Credits
Fundamental metallurgy and ceramic science of powder processing techniques. Details of current powder processing technology and methods. Hands-on laboratory experience with both metal & ceramic materials. **Prerequisite:** ME 5750

ME 7060 Structural Reliability 3 Credits
Analyze the uncertainties associated with mechanical and structural design. Methods to model various uncertainties in a design using probabilistic analysis tools. Computation of safety index and structural reliability using efficient techniques for implicit functions. **Prerequisites:** ME 6120 and ME 7100

ME 7080 Multidisciplinary Structural Optimization 3 Credits
Structural optimization of large scale systems with constraint approximations, sensitivity analysis, and design variable linking methods. Primal, dual, and optimality criteria methods for shape and size optimization. **Prerequisite:** ME 6080 and ME 6120 and ME 7100

ME 7100 Advanced Mechanics of Solids 3 Credits
Introduction to solid mechanics at the graduate level. Topics include theory of elasticity, indicial notation and coordinate transformations, exact solutions to plane elasticity problems in Cartesian and polar coordinates, axisymmetric problems, torsion of noncircular sections and energy methods. **Prerequisite:** ME 6140

ME 7120 Finite Element Method Applications 3 Credits
Concepts of dynamic analysis using the finite element method (FEM). Application of various computational techniques to dynamic structures and thermal systems including vehicle dynamics. **Prerequisite:** ME 6120

ME 7140 Nonlinear Finite Element Analysis 3 Credits
Nonlinear finite element analysis of elastic, plastic, and viscoplastic deformation. Flow formulation and solid formulation. Analysis and simulation of structures and metal forming processes. **Prerequisites:** ME 6120 and ME 7100

ME 7160 Nonlinear Dynamics and Vibrations 3 Credits
The behavior of nonlinear mechanical systems is analyzed with numerical, symbolic, graphic, and analytical methods. Equal emphasis is placed on understanding nonlinear effects and methods of analysis. **Prerequisite:** ME 6210

ME 7200 Mechanics of Composites 3 Credits
The main objective of this course is to introduce composites as an engineering material and emphasize the basic concepts of their nature and mechanical properties. Micromechanics and macromechanics and lamination theory of composites will be emphasized. **Prerequisite:** ME 1020 and ME 5120

ME 7210 Computational Methods in Structural Dynamics 3 Credits
Vibration of discrete and continuous systems. Computational methods for the eigenvalue problem. Large-dimensional systems. Approximate methods for continuous systems. Substructure synthesis. Response of vibrating systems.
Prerequisite: ME 6210

ME 7250 Advanced Dynamics 3 Credits
Introduction to classical mechanics. Application of distributed and discretized approaches to dynamic systems with rigid and deformable members. Emphasis on the understanding of fundamental theory of mechanics and applications of different techniques to dynamics. **Prerequisite:** ME 5210

ME 7300 Advanced Fluid Dynamics 3 Credits
Theory and application of conservation equations for fluid mechanics. Develops boundary layer equations for laminar and turbulent flows. Topics include incompressible, viscous, supersonic, and hypersonic flows. **Prerequisite:** ME 5350

ME 7330 Convective Heat and Mass Transfer 3 Credits
Heat and mass transfer analysis within conductors and over submerged objects for laminar and turbulent flows. Film condensation and boiling. **Prerequisite:** ME 5360

ME 7340 Advanced Computational Fluid Dynamics 3 Credits
Introduction to modern computational fluid dynamic (CFD) methods. Survey of current numerical procedures to solve fluid dynamic problems from incompressible to hypersonic flows. 3 hours lecture, 2 hours lab.
Prerequisites: ME 6010 minimum "C" grade

ME 7350 Radiation Heat Transfer 3 Credits
Fundamentals and application of radiation heat transfer, radiation between gray and non-gray bodies, network techniques, radiation through absorbing media, and radiation between gases and surrounding surfaces. Finite difference solution for radiation problem. **Prerequisite:** ME 5360

ME 7390 Fundamentals of Plasma Science 3 Credits
Properties, characteristics, and use of ionized gases. Fundamentals of gaseous electronics including kinetic theory, excitation, ionization, equilibrium, non-equilibrium, and local thermodynamic equilibrium. Plasma generation, glow discharge, rf-discharges, plasma torches, and free-burning arcs. **Prerequisite:** ME 7500

ME 7400 Hypersonic Flows 3 Credits
Hypersonic flow is studied from the viewpoint of its unique fluid dynamic attributes with emphasis on classic inviscid theories, chemical kinetics, and state-of-the-art development. **Prerequisite:** ME 6330

ME 7500 Advanced Thermodynamics 3 Credits
Thermodynamics is studied from both the classical (macroscopic) and statistical (microscopic) viewpoints with emphasis on statistical thermodynamics. Property relationships, Maxwell relations, partition functions, distribution functions, kinetic theory and the Boltzmann transport equation are discussed. **Prerequisites:** ME 5320 and ME 5750

ME 7520 Hydrogen Energy 3 Credits
This course focuses on hydrogen as a renewable and clean means of energy storage, and discusses hydrogen production and storage, as well as an overview of hydrogen energy conversion. **Prerequisites:** ME 5310 or ME 5750

ME 7550 Photovoltaics 3 Credits
Basic principles of solar cells will be covered including semiconductors, electronics and holes, and p-n junctions. Different types of solar cell materials including crystalline and amorphous cells as well as techniques for increasing their efficiency will be presented. **Prerequisite:** ME 7500

ME 7690 Vibration Testing and Machine Health Monitoring 3 Credits
Advanced theoretical and practical aspects of vibration testing including: signal analysis, windowing, transducers, exciters, modal identification techniques, rotor dynamics, and machine health monitoring. Includes extensive independent lab study. **Prerequisite:** ME 6210

ME 7720 Engineering Polymers II 3 Credits
Polymer physics including phase diagrams, phase separation, amorphous and crystalline states, liquid crystals, thermal transitions, viscoelasticity and rheology, as well as deformation and fracture. **Prerequisites:** ME 6720 and ME 5750

ME 7730 Advanced Physical Properties 3 Credits
Focuses on some of the advanced physical properties of solid-state materials including thermoelectric energy conversion, optoelectronics, principles of lasers, high-k dielectrics, magnetoresistance, negative differential resistance and superconductivity. **Prerequisite:** ME 6700

ME 7740 Quantitative Microscopy 3 Credits
Deals with quantifying microstructural features, such as volume fraction, grain size, shape, and orientation of phases. The course covers stereology, the science of relating 2-dimensional images to 3-dimensional structure, and image analysis. **Prerequisites:** Prior experience in microstructural characterization and calculus

ME 7750 Advanced Engineering Materials 3 Credits
This course will focus on the different types of engineering materials: how their composition and structure determine their properties, with special emphasis on how they can be modified for advanced applications. Engineering applications stressed will be structural, chemical/electrochemical, thermal, electronic, dielectric, magnetic, and optical. **Prerequisite:** ME 6700

ME 7760 Transformations in Solids I 3 Credits
Focus is on the scientific principles behind processing and transformation of materials. Topics include: Thermodynamics of phases, diffusion, interfaces and microstructure, nucleation, growth, solidification, precipitation, diffusional and diffusion-less transformations, reaction pathways and emerging technologies. **Prerequisite:** ME 5760

ME 7780 Ceramics for Advanced Applications 3 Credits
Science and technology of ceramics and glasses and their use in modern technologies; atomic structure; bonding; defect-microstructure-property relations; thermal and structural ceramics; electronic, optical, dielectric and magnetic ceramics; and special applications. **Prerequisite:** ME 6730

ME 7950 Thesis 1 – 5 Credits
Research on the Master's thesis topic. Instructor and Department approval required.

ME 7990 Independent Study in Mech Egr, Mat Science & Egr, Renewable & Clean Energy 1 - 5 Credits
Independent study in Mechanical Engineering, Materials Science and Engineering, and Renewable and Clean Energy. Topics vary. Instructor and Department approval required.

ME 8950 PhD Dissertation Research 1 – 10 Credits
Research on the Ph.D. dissertation topic. Instructor and Program/Department approval required.

RELATED ENGINEERING COURSES

EGR 7010 Applied Linear Techniques 3 Credits
Graduate level linear engineering methods in finite and infinite dimensions.

EGR 7020 Systems Engineering and Analysis 3 Credits
Exposes students to the design of systems and tools for the analysis of complex technological systems. **Prerequisites:** MTH 2310 and (STT 3630 or IHE 6120)

EGR 7030 Computational Engineering Analysis 3 Credits
Students will learn practical and efficient computational techniques that are routinely encountered in modeling, simulation and analysis of engineering problems.

EGR 7040 Design Optimization 3 Credits
Concepts of minima and maxima; linear, dynamic, integer and nonlinear programming; variational methods. Interdisciplinary engineering applications are emphasized.
***** Please note--if you have taken ME 4080 or ME 6080, you are not eligible to take EGR 7040 for credit.***

EGR 7050 Design and Analysis of Engineering Experiments 3 Credits
Introduction to planning and analysis of engineering experiments. Topics include basic statistics review, linear models, regression, analysis of variance, experiment designs, response surface methods, and engineering applications. **Prerequisites:** MTH 2350 and (STT 3630 or IHE 6020)

RELATED COURSES IN ELECTRICAL SYSTEMS ENGINEERING

EE 6130 Continuous Control Systems 3 Credits
Introductory course providing students with a general control background. Major topics include block diagrams and signal-flow graphs, electromechanical modeling, time response, root locus, and design of PID controllers.
Co-requisite: *EE 6130L Continuous Control Systems Laboratory 1 Credit*

EE 6170 Digital Control Systems 3 Credits
Samples spectra and aliasing, analysis and design of digital control systems using root locus and transform techniques, discrete equivalents of continuous controller and quantization effects.
Co-requisite: EE 6170L Digital Control Systems Laboratory 1 Credit

EE 7010 Applied Linear Techniques 3 Credits
(Also listed as EGR 701 and BMS 705) Graduate level linear engineering methods in finite and infinite dimensions.

EE 7020 Modern Control I 3 Credits
State variable representations of continuous and discrete systems. Linear vector spaces and similarity transformations; elgen-analysis, time and transform domain solutions of linear state equations; controllability, observability, and stability of linear systems.