College of Engineering

Offices: 100 Wallace Hall
Walter J. Horn, interim dean

Departments
Aerospace, (316) 978-3410—L. Scott Miller, interim chairperson; Kamran Rokhsaz, master’s graduate coordinator; Klaus Hoffmann, doctoral graduate coordinator.

Electrical and Computer, (316) 978-3415—M. Ed Sawan, chairperson and graduate coordinator

Industrial and Manufacturing, (316) 978-3425—Hossein Cherughi, chairperson and graduate coordinator

Mechanical, (316) 978-3402—Hamid Lankorani, chairperson; Behnam Bahr, graduate coordinator

The College of Engineering offers graduate programs leading to a Master of Science (MS) and a Doctor of Philosophy (PhD) in aerospace engineering, electrical engineering, industrial engineering, and mechanical engineering. Areas of specialization can be found in the individual departmental sections. A Master of Engineering Management (MEM) is also offered; details can be found in the Industrial and Manufacturing Engineering Department section. The graduate programs are enhanced by the presence of the industrial complex in Wichita and of the National Institute for Aviation Research on the Wichita State campus.

Master of Science Admission Requirements
To be admitted to the MS program, students must have completed the equivalent of an undergraduate degree in an engineering or related field. Students with deficiency in certain areas may be required to take additional courses. Master’s engineering programs require a minimum GPA of 3.00/4.00 for admission to full standing, 2.75/4.00 for admission on probation, and 2.50/4.00 for admission to non-degree, category B. All GPAs are based on the last two years or approximately 60 credit hours of coursework. These standards may be waived at the discretion of the individual department based on an applicant’s other qualifications. Scores for the general test of the Graduate Record Examination (GRE) are recommended for all students applying from non-U.S. institutions. The GRE scores will help in the admission decisions for those students with marginal grades.

Degree Requirements
The MS degree requires the completion of a Plan of Study approved by the student’s advisor and the department graduate coordinator, which must be filed within the first 12 credit hours of graduate coursework.

Three options are available:

1. the thesis option requires a minimum of 24 hours of coursework plus a minimum of 6 hours of thesis,
2. the directed project option requires a minimum of 30 hours of coursework plus a minimum of 3 hours of directed project, and
3. the coursework option requires a minimum of 33 hours of coursework.

At least 60 percent of the hours in the Plan of Study must be 700-level or above. Additional details of the MS degree may be obtained from the department graduate coordinator.

Doctor of Philosophy
PhD programs are offered by the four departments of engineering at WSU. A grade point average of at least 3.25 in the last 60 hours or nearest two years is required for admission. Typical fields of specialization can be found in the individual departmental sections. These fields will be used in determining testing areas for the comprehensive examination in the major and minor fields.

Admission Requirements
Admission to any PhD program in engineering requires that the student has completed (or nearly completed) a master’s degree in engineering or physical science. Scores for the general test of the Graduate Record Examination (GRE) must be submitted. Some students may find it necessary to take prerequisite courses to be able to meet the course breadth requirements. The student is recommended to the graduate dean for admission by the department chairperson in consultation with the graduate coordinator of the department where the graduate student will be housed.

Plan of Study and Advisory Committee
Within the first 12 hours of PhD coursework, the department chairperson, in consultation with the graduate coordinator and the student, recommend to the graduate dean an advisory committee for each student. The committee will be composed of a minimum of five graduate faculty, with at least four having full membership including the chairperson who also must have authorization to chair doctoral committees. A majority of the advisory committee members must be from the major department and at least one member must be outside the student’s major department. The chairperson of the advisory committee should be the student’s dissertation advisor. The student and advisory committee chairperson will formulate a Plan of Study and a tentative dissertation topic for approval by the advisory committee, the department chairperson or graduate coordinator, and the graduate dean. The Plan of Study will include designation of major and minor fields and all graduate-level coursework which is applicable to the degree.

Course Breadth Requirements: To ensure proper breadth of coursework, the Plan of Study must include at least 15 hours in the student’s major field and 18 hours outside the major area. The 18 hours must include a minimum of 6 hours in a minor area (defined by the advisory committee) and a minimum of 6 hours of mathematics/statistics. A Plan of Study normally contains about 60 hours of coursework, including courses from the master’s degree, and should have a minimum of 60 percent of the hours (24 dissertation hours included) beyond the master’s work at the 800-900 level or equivalent.

Comprehensive Examination
After the PhD Plan of Study has been approved and after sufficient coursework has been completed, the student must take the comprehensive examination given by the advisory committee. The comprehensive examination will cover the major and minor fields and any course that the advisory committee deems necessary. The student’s advisory committee is responsible for ensuring that the student takes the comprehensive examination at the appropriate time. No part of the comprehensive examination may be attempted more than twice. Upon passing the comprehensive examination, a student is known as an aspirant for the PhD.

Time Limits and Residency Requirement
From the time the student is admitted to the program, no more than six years may elapse until requirements for the degree have been completed. However, the student may petition the advisory committee for a leave of absence to pursue full-time professional activities related to his/her doctoral program and long-range professional goals. At least two semesters shall be spent in residency on the WSU campus involved in full-time academic pursuits. This may include up to half-time teaching and research. Well-designed plans for obtaining dissertation research experience under the supervision of the student’s advisor will be considered in lieu of the residency requirement.

Dissertation Approval Examination (DAE)
When the PhD aspirant has completed the major portion of the coursework, the advisory committee can
petition for permission to administer the DAE. The aspirant will submit a written dissertation proposal to the advisory committee. After reading the proposal and receiving permission of the graduate dean, the advisory committee will conduct an oral examination to determine the aspirant’s ability to carry out the proposed research and whether or not this research qualifies as a PhD dissertation. Any essential change in the project requires committee approval.

After passing the DAE, the student is known as a candidate for the PhD degree. A candidate must be continuously enrolled in PhD Dissertation for a minimum of 6 hours each semester and 2 hours in the Summer Session until completion of the dissertation or 24 hours of PhD Dissertation have been taken. After this, 2 hours per semester and 1 hour per summer are required. In any case, no less than 24 hours of enrollment for PhD Dissertation will be required. The dissertation may be performed in absentia with the approval of the advisory committee.

Final Dissertation Examination

The student must defend the dissertation before the advisory committee. At least five months must elapse between the DAE and the final examination. The final examination will be open to the public. Invited guests or external examiners may be invited if the committee desires.

Aerospace Engineering (AE)

Graduate Faculty

Professors: Klaus A. Hoffmann (doctoral graduate coordinator), Walter J. Horn (interim dean), L. Scott Miller (interim chair), Michael Papadakis, Kamran Rokhsaz (master’s graduate coordinator), Bert L. Smith

Associate Professors: James E. Locke, Roy Y. Myose, M. Gawad Nagati, James E. Steck, John S. Tomblin

The Department of Aerospace Engineering offers programs leading to Master of Science (MS) and Doctor of Philosophy (PhD) degrees. Faculty research provides valuable educational opportunities for graduate students. Current research topics include aeroacoustics, aerelasticity, aerothermodynamics, aircraft dynamic loads, aircraft flight dynamics, aircraft icing, airfoil design and rotor aerodynamics, artificial neural networks, composite materials, computational fluid dynamics, computational solid mechanics, continuum damage and fracture mechanics, damage tolerance, design, experimental aerodynamics, finite element analysis, flight dynamics and control, flight mechanics, hypersonics, intelligent control, laser velocimetry, solid mechanics, structural dynamics, and theoretical and applied aerodynamics.

The department's research and instructional facilities are among the finest in the nation. They include six wind tunnels, a water tunnel, and a structural testing laboratory. Graduate students have opportunities to use the equipment in all laboratories for their research projects. Students also may use the research facilities in the University’s National Institute for Aviation Research, including a composite materials lab and a crash dynamics lab. Computer facilities for students include mainframe terminals, high performance workstations, and various personal computers.

The department’s programs are enhanced by Wichita’s aviation heritage and the presence of major aerospace companies in the city, including Airbus, Boeing, Cessna, Bombardier-Learjet, and Raytheon.

Graduate coursework is scheduled so that engineers employed in the local industry may conveniently pursue graduate degrees.

Master of Science

Courses of study leading to the MS degree are available with specialization in any of the following four fields: (1) aerodynamics and fluid mechanics; (2) structures and solid mechanics; (3) flight dynamics and control; and (4) multidisciplinary analysis and design. Details of the MS program requirements can be found under the College of Engineering heading.

Doctor of Philosophy

Courses of study leading to the Doctor of Philosophy (PhD) degree are available with specializations in the same fields as listed above for the MS degree. Details of the PhD program requirements can be found under the College of Engineering heading.

Graduate Courses

All graduate courses must be approved in advance of enrollment by a student's graduate advisor.

Courses for Graduate/Undergraduate Credit


AE 508. Systems Dynamics (3). Lumped parameter modeling; classical, numerical, transform, and state model methods of solution; introduction to systems with feedback; analogies of various physical systems. Prerequisites: AE 373 and MATH 555.


AE 528. Aerospace Design I (4). 2R; 2L. Methodology of flight vehicle design; mission objectives, regulations, and standards; use of hand and computer methods for configuration development and component sizing; ethics; and liability in design. Prerequisites: AE 502, 514, and 525.


AE 625. Flight Structures II (3). Strength analysis and design of flight vehicle components. Introduction to energy methods and variational principles. Application of finite element method to the analysis of flight vehicle structures. Special projects in structural analysis and design. Prerequisite: AE 525.

AE 628. Aerospace Design II (4). 2R; 2L. Preliminary design of flight vehicles, design iteration, sensitivity studies, optimization, economic considerations, and introduction to project management. Prerequisite: AE 528.

AE 653. Basic Composite Material Technologies (3). Introduces basic composite material technologies, including mechanical behavior, material classification, testing for mechanical properties, manufacturing methods, nondestructive inspection, and design. Prerequisite: AE 333.

AE 654. Manufacturing Composite Structures (1-2). Manufacturing methods and tooling for fiber-reinforced polymer structures and structural components. Prerequisites: both ME 250 and AE 653 are recommended.

AE 660. Selected Topics (1-3). New or special topics presented on sufficient demand. Repeatable for credit when subject material warrants. Prerequisite: instructor's consent.

AE 690. Independent Study (1-3). Arranged individual independent study in specialized areas of aerospace engineering under the supervision of a faculty member. Repeatable for credit. Prerequisite: consent of supervising faculty member.
AE 702. Aerospace Propulsion II (3). In-depth study of rocket and jet propulsion. Turbojet and rocket engine components. Effect of operating variables on turbojet cycles and rocket performance. Prerequisite: AE 502 or instructor’s consent.

AE 703. Rotor Aerodynamics (3). Aerodynamics of rotors, including propellers, wind turbines and helicopters; momentum, blade element, and potential flow analysis methods; helicopter dynamics, control, and performance. Prerequisite: AE 424.

AE 707. Modern Flight Control System Design I (3). Modern multi-loop design methods for stability and control augmentation and guidance systems, specifically for aerospace vehicles. State variable model. Optimal state feedback gains and Riccati’s equation, tracking systems, sensors and actuator, discretization of continuous dynamic systems, optimal design for digital controls, and effect of non-linearities and trim conditions on design considerations. Prerequisite: AE 514 or AE 714, and AE 607 or ECE 684 or ME 659.

AE 711. Intermediate Aerodynamics (3). A study of potential flow equations of motion, singularity solutions, principle of superposition, conformal mapping, thin aerofoil theory, finite wing theory, effects of fluid inertia, three-dimensional singularities, swept wing theory, delta wing theory, introduction to panel methods, and an introduction to automobile aerodynamics. Prerequisite: AE 424 or ME 521.

AE 712. Advanced Aerodynamics Laboratory (3). IR: 3L. Advanced topics in wind tunnel testing, including analysis and sensitivity; modeling techniques, flexure design and calibration, control surface shapes and moments, laser velocimetry, hot film anemometry, dynamic signal processing, flow measurement probes, flow visualization using smoke tunnels and water tunnel. Prerequisite: AE 512 or instructor’s consent.

AE 713. Introduction to Aeroelasticity (3). Studies phenomena involving interactions among aerodynamic, inertial, and elastic forces. Explores influence of these interactions on aircraft design. Includes such specific cases as divergence, control effectiveness, control reversal, flutter, buffet, dynamic response to rapidly applied periodic forces, aeroelastic effects on load distribution, and static and dynamic stability. Prerequisites: AE 333, 424 or equivalent.


AE 716. Compressible Fluid Flow (3). Analysis of compressible fluid flow for one- and two-dimensional cases, moving shock waves, one-dimensional flow with friction and heat addition, linearized potential equation, method of characteristics, conical shocks, and subsonic similarity laws. Prerequisites: AE 424, ME 521 or equivalent.

AE 719. Introduction to Computational Fluid Dynamics (3). Classification of partial differential equations, numerical solution of parabolic, elliptic, and hyperbolic differential equations, stability analysis, boundary conditions, scalar representation of the Navier-Stokes equations, incompressible Navier-Stokes equations. Prerequisite: AE 424 or ME 521.

AE 722. Finite Element Analysis of Structures I (3). Advanced treatment of the theoretical concepts and principles necessary for the application of the finite element method in the solution of differential equations in engineering. Prerequisite: AE 629 or equivalent or instructor’s consent.

AE 731. Theory of Elasticity (3). Develops the equations of the theory of elasticity and uses them to determine stress and displacement fields in linear elastic isotropic bodies; uses Airy stress functions to obtain solutions; and introduces energy principles and variational methods. Prerequisite: instructor’s consent.


AE 759. Neural Networks for System Modeling and Control (3). Introduces specific Neural Network architectures used for dynamic system modeling and intelligent control. Includes theory of feed-forward, recurrent, and Hopfield networks; applications in robotics, aircraft and vehicle guidance, chemical processes, and optimal control. Prerequisites: AE 607 or ME 659 or ECE 684 or instructor’s consent.

AE 760. Selected Topics (1-3). Prerequisite: instructor’s consent.


AE 777. Vibration Analysis (3). A study of free, forced, damped, and undamped vibrations for one and two degrees of freedom, as well as classical, numerical, and energy solutions of multi-degree freedom systems. Introduces continuous systems. Prerequisites: MATH 555, AE 373 and 333.

Courses for Graduate Students Only


AE 807. Modern Flight Control Systems Design II (3). Continuation of AE 707, emphasizing the effects of atmospheric turbulence and corrupted measurements; state estimation using the Kalman filter; output feedback design methods for flight controls; robustness requirements in the design; and extension to digital systems. Prerequisites: AE 707 and 714.

AE 811. Panel Methods in Aerodynamics (3). An introduction to panel method theory and application for inviscid incompressible attached flows. Utilization of some two- and three-dimensional computer codes. Prerequisites: AE 711 and MATH 757 or equivalent.


AE 817. Transonic Aerodynamics (3). Experimental and analytical difficulties in flow and flight near Mach one; basic equations and solution methods; linearized potential equation; shock occurrence criteria on wings; Transonic Area Rule; noz- zle throat design; detached shock wave computations; computational methods. Prerequisites: AE 424 or equivalent; and AE 711 or 716.

AE 818. Hypersonic Aerodynamics (3). Classical hypersonic theory and approximations; Newtonian flow; flight corridors and trajectories; hot gas effects; experimental difficulties; short time test facilities; computational techniques; propulsion methods; airframe-engine integration; SCRam jets. Prerequisites: AE 711 and 716 or equivalent.

AE 822. Finite Element Analysis of Structures II (3). Formulation of the finite element equations by variational methods; the use of isoparametric and higher order elements for analyzing two- and three-dimensional problems in solid mechanics; introduction to solutions of nonlinear problems. Prerequisites: AE 722 and 731.

AE 831. Continuum Mechanics (3). Introductory treatment of the fundamental, unifying concepts of the mechanics of continua with applications to classical solid and fluid mechanics. Prerequisite: consent of the instructor.

AE 832. Theory of Plates and Shells (3). Small deflections of thin elastic plates; classical solutions for rectangular and circular plates; approximate solutions for plates of various shapes; introduction to the analysis of thin shells. Prerequisite: AE 731.


AE 860. Selected Topics (1-3). Prerequisite: instructor's consent.


AE 900. Advanced Independent Studies (1-3). Prerequisite: instructor's consent.

**Electrical and Computer Engineering (ECE)**

Graduate Faculty

Professors: Ward T. Jewell, Hyuck M. Kwon, Glynn Rimmington, M. Ed Sawan (chairperson and graduate coordinator)

Associate Professors: Larry D. Paarmann, Ravindra Pendse, Steven R. Skinner, Asrat Teshome, John M. Watkins

Assistant Professors: Coskun Cetinkaya, Sudharman Jayaweera, Fred J. Meyer, Kameswara R. Namuduri

The Department of Electrical and Computer Engineering offers courses of study leading to the Master of Science (MS) and Doctor of Philosophy (PhD) degrees.

**Master of Science**

Courses of study leading to the MS degree are available with specializations in any of the following five fields: (1) control systems, (2) communications, (3) signal processing, (4) computers and digital systems, and (5) energy and power systems. Details of the MS program can be found under the College of Engineering heading.

**Doctor of Philosophy**

Courses of study leading to the Doctor of Philosophy (PhD) degree are available with specializations in control theory, communications/signal processing, digital systems, and energy and power systems. Details of the PhD program can be found under the College of Engineering heading.

**Facilities**

Modern electrical engineering laboratories contain facilities for experimental work in areas of instrumentation, control systems, computers and digital systems, electronics, circuits, energy conversion, power electronics, and power quality.

**Courses for Graduate/Undergraduate Credit**


ECE 577. Special Topics in Electrical and Computer Engineering (1-4). New or special courses presented on sufficient demand. Repeatable for credit. Prerequisite: departmental consent.

ECE 585. Electrical Design Project I (2). 3L. A design project under faculty supervision chosen according to the student's interest. Prerequisites: COMM 111 and departmental consent. May not be counted toward a graduate electrical major.

ECE 590. Introduction to Communication Systems (4). 3R; 3L. Fundamentals of communication systems; models and analysis of source, modulation, channel, and demodulation in both analog and digital form. Reviews Fourier Series, Fourier Transform, DFT, Probability, and Random Variables. Studies in Sampling, Multiplexing, AM and FM analog systems, and additive white Gaussian noise channel. Additional topics such as PSK and FSK digital communication systems covered as time permits. Prerequisites: ECE 303 and either STAT 471 or IENG 254.

ECE 598. Advanced Electric Motors (3). Advanced electric motor applications and theory. Includes single-phase motors, adjustable speed ac drive applications, and stepper motors. Prerequisites: ECE 488 and 492.

ECE 599. Microprocessor Based System Design (4). 3R; 1L. Presents development of microprocessor based systems. Studies interfacing the address bus, data bus, and control bus to the processor chip. Memory systems and I/O devices interfaced to the appropriate busses. Vendor-supplied, special-purpose chips, such as interrupt controllers, programmable I/O devices, and DMA controllers, integrated into systems designed in class. Lab gives hands-on experience. Prerequisites: ECE 394, or 238 and 294.

ECE 595. Electrical Design Project II (2). 3L. A continuation of ECE 585. Prerequisite: ECE 585. Will not count toward a graduate electrical engineering degree.

ECE 598. Electric Power Systems Analysis (3). Analysis of electric utility power systems. Topics include analysis and modeling of power transmission lines and transformers, power flow analysis and software, and an introduction to symmetrical components. Prerequisite: ECE 282.

ECE 616. Introduction to Wireless Communications (3). Introduces students to the basic principles and issues related to wireless communications. We will consider not only the basic technical aspects of the wireless communications, but also the market issues, social and cultural impact of the wireless communications, deregulation issues as well as political issues relating to the development and widespread popularity of wireless communications. The level of the course will be applicable to junior or senior undergraduates as well as beginning graduate students. Prerequisites: ECE 383, IE 254.

ECE 636. Telecommunications (3). Topics in circuit and packet switching, layered communication architectures, state dependent queues, traffic engineering, call processing, software organization, routing, and common channel signaling. Prerequisite: ECE 586 or departmental consent.

ECE 664. Advanced Digital Lab (2). An open laboratory experience for computer engineering students. Gives the stu-
ECE 666. Computer Forensics (3). Computer crimes include security violations and unauthorized access and theft of sensitive information. In this course, we discuss procedures for the identification, preservation, and extraction of electronic evidence that can be legally used when a computer crime is committed. From the network perspective, we discuss auditing and investigation of network and host intrusions. Forensic tools and resources for system administrators and information system security officers will also be covered. Legal issues related to computer and network forensics will be discussed. There will be about eight programming-related laboratory exercises in this class. This course is intended for senior undergraduate students and graduate students majoring in ECE and computer science. Prerequisites: ECE 138 and CS 540. In addition, good programming skills in one of the languages (C, C++, or Java), familiarity with the operating systems (UNIX/Windows) are required.

ECE 684. Introductory Control System Concepts (3). An introduction to system modeling and simulation, dynamic response, feedback theory, stability criteria, and compensation design. Prerequisite: ECE 383.

ECE 688. Power Electronics (4). 3R; 3L. Deals with the applications of solid-state electronics for the control and conversion of electric power. Gives an overview of the role of the thyristor in power electronics application and establishes the theory, characteristics and protection of the thyristor. Presents controlled rectification, static frequency conversion by means of the DC link-converter and the cyclo converter, emphasizing frequency, and voltage control and harmonic reduction techniques. Also presents requirements of forced commutation methods as applied to DC-DC control and firing circuit requirement and methods. Introduces applications of power electronics to control AC and DC motors using new methods such as microprocessors. Prerequisite: ECE 492.

ECE 691. Integrated Electronics (3). A study of BJT and MOS analog and digital integrated circuits. Includes BJT, BiMOS, and MOS fabrication; application specific semi-custom VLSI arrays; device performance and characteristics; and integrated circuit design and applications. Prerequisites: ECE 194 and 495 or departmental consent.

ECE 694. Principles of Power Distribution (3). The distribution system is a vital contributor to the overall power system function of providing quality electrical service. Provides an overall view of the engineering fundamentals of distribution system. Discusses distribution system planning and automation, primary and secondary distribution networks. Presents voltage regulation, protection, and reliability. Prerequisite: ECE 598 or departmental consent.

ECE 726. Digital Communication Systems I (3). Presents the theoretical and practical aspects of digital and data communication systems. Includes the modeling and analysis of information sources as discrete processes; basic source and channel coding; multiplexing and framing; spectral and time domain considerations related to ASK, PSK, DPSK, QPSK, FSK, MSK, and other techniques appropriate for communicating digital information in both base-band and band-pass systems; intersymbol interference; effects of noise on system performance; optimum systems; and general M-ary digital systems in signal-space. Prerequisites: ECE 586 and 754.

ECE 736. Data Communication Networks (3). Presents a quantitative performance evaluation of telecommunication networks and systems. Includes fundamental digital communications system review; packet communications; queuing theory; OSI, 802.3, and SNA layered architectures; stop-and-wait protocol, go-back-N protocol, and high-level data link layer; network layer flow and congestion control; routing; polling and random access; local area networks (LAN); integrated services digital networks (ISDN); and broadband networks. Prerequisites: ECE 383 or departmental consent.

ECE 737. Wireless Networking (3). Covers topics ranging from physical layer to application layer in the wireless and mobile networking fields. Explores physical layer issues of wireless communications, wireless cellular telephony, ad-hoc networks, mobile IP and multicast, wireless LAN (IEEE 802.11), security, Bluetooth and WAP, etc. Imparts general knowledge about wireless communication technologies and ongoing research activities. Prerequisite: ECE 736.

ECE 738. Embedded Systems Programming (3). A study of the requirements and design of embedded software systems. Application of the C programming language in the implementation of embedded systems emphasizing real-time operating systems, interfacing to assembly and high-level languages, control of external devices, task control, and interrupt processing. Prerequisite: ECE 594 or equivalent.

ECE 744. Introduction to VHDL (3). An introduction to VHSCIC hardware description language. Includes different types of modeling techniques using state-of-the-art CAD tools. Covers extensively behavioral modeling, structural modeling, and data-flow modeling. Design assignments include design and simulation of both combinational and sequential circuits using VHDL. Prerequisites: ECE 138 and 394.

ECE 754. Probabilistic Methods in Systems (3). A course in random processes designed to prepare the student for work in communications controls, computer systems information theory, and signal processing. Covers basic concepts and useful analytical tools for engineering problems involving discrete and continuous-time random processes Discusses applications to system analysis and identification, analog and digital signal processing, data compression parameter estimation, and related disciplines. Prerequisites: ECE 383 and either STAT 471 or IEN 254.

ECE 764. Routing and Switching I (4). 3R; 3L. An introductory course which studies different hardware technologies, like ethernet and token ring. Discusses VLSI. Introduces different routing protocols. Includes hands-on experience in the ECE department's routing and switching lab. Prerequisite: ECE 736 or departmental consent.

ECE 765. Routing and Switching II (4). 3R; 3L. Discusses different bridging technologies, including SRB, RSRB, and DLSW. Also includes advanced routing protocols, like OSPF and EIGRP, and route redistribution. Includes hands-on experience in the ECE department's routing and switching lab. Prerequisite: ECE 764 or departmental consent.

ECE 766. Information Assurance and Security (3). Provides basic concepts in information assurance and security including encryption, digital certificates, security in networks, operating systems, and databases. Topics in intrusion detection, legal and ethical issues in security administration will also be discussed. Prerequisites: ECE 736 or 764, or departmental consent.

ECE 777. Selected Topics in Electrical Engineering (1-4). New or special courses presented on sufficient demand. Repeatable for credit. Prerequisite: departmental consent.

ECE 781. Analog Filters (3). A detailed study of analog filter design methods. Includes both passive and active filters. Discusses analog filter approximations; covers sensitivity and noise analyses. Prerequisite: ECE 383 and 492.

ECE 782. Digital Signal Processing (3). Presents the fundamental concepts and techniques of digital signal processing. Time domain operations and techniques include difference equations and convolution summation. Covers Z-transform methods, frequency-domain analysis of discrete-time signals and systems, discrete Fourier transform, and fast Fourier transform. Emphasizes the frequency response of discrete-time systems and the relationship to analog systems. Prerequisite: ECE 383 or departmental consent.

ECE 790. Independent Study in Electrical Engineering (1-3). Arranged individual, independent study in specialized content areas in electrical engineering under the supervision of a faculty member. Repeatable for credit. Prerequisite: departmental consent.


ECE 797. Computer Application to Power System Analysis (3). Describes the use of power system component models and efficient computational techniques in the development of a new generation of computer programs representing the steady and dynamic states of electric power systems and informs of methods currently employed in the electric utility industry. Emphasizes algorithms suitable for computer solution of power systems problems such as power flows and system voltages during normal and emergency conditions and
transient behavior of the system resulting from fault conditions and switching operations. Prerequisite: ECE 598.

ECE 798. Advanced Electric Power Systems Analysis (3). Advanced topics in analysis and operation of electric utility power systems. Topics include faulted system analysis, economic dispatch, generator modeling, power system stability, and system protection. Prerequisite: ECE 598.

Courses for Graduate Students Only

ECE 810. Optical Networks (3). A comprehensive study of fiber optic communication systems, components, and networks. Subjects include modulation, wavelength division multiplexing, dispersion, single mode and multimode fibers, fiber optic components, optical cross-connects, and SONET rings. Prerequisite: ECE 510.

ECE 816. Advanced Signal Processing for Wireless Communications (3). Introduces the role of statistical signal processing in wireless communications and studies various signal processing techniques. Begins with an overview of the fundamentals of wireless communications and physical properties of the wireless channel. Covers topics such as adaptive filtering, interference suppression, space-time processing and MIMO techniques. Corequisites: ECE 726 and 754.

ECE 817. Theory of Detection and Estimation (3). Introduces students to the fundamental ideas of detection and estimation theory. Some of the topics covered will include binary hypothesis testing, potimal signal detection, performance analysis of optimum detectors, elements of parameter estimation and signal estimation. These ideas are basic to statistical signal processing and communications transceiver design. Prerequisite: ECE 754.

ECE 826. Digital Communication Systems II (3). Studies modern digital communication systems. Discusses topics such as carrier and symbol synchronization techniques; fading multipath channels; frequency-hopped spread spectrum systems; smart antenna array systems; space time codes (STC); space-time block codes (STBC); multi-input multi-output (MIMO); orthogonal frequency division multiplexing (OFDM) systems; and multi-carrier code division multiplex access (MC-CDMA) communications. Prerequisite: ECE 726.

ECE 828. Computer Performance Analysis (3). Teaches the basic concepts in stochastic modeling of systems for analysis and for simulation. Analytic modeling techniques include discrete- and continuous-time Markov chains, queuing theory, and queuing networks, as well as approximate methods based on these techniques. Operational analysis presents a non-stochastic, measurement-based perspective to the analysis of computer systems. Also emphasizes discrete-event simulation, a widely-used technique in many areas of performance evaluation. Performance metrics taken from stochastic simulations are random variables, and are subject to the same types of statistical analysis as data obtained from real systems. Prerequisites: ECE 754.

ECE 844. Advanced Computer Architecture I (3). Covers advanced architectural subjects—microprogramming, economics of chip design, instruction set performance, and pipelining. Prerequisites: ECE 594 or equivalent.

ECE 845. Adaptive Filters (3). Concerned with estimating a signal of interest or the state of a system in the presence of additive noise, but without making use of prior statistical characteristics of the signal nor the noise. Concerned with the design, analysis, and application of recursive filtering algorithms that operate in an environment of unknown statistics. Content includes least mean-square (LMS) filters, recursive least-square (RLS) filters, and recursive least-squares lattice (LSL) filters. All are adaptive and self-designing. Includes concepts of convergence, tracking ability, and robustness. Prerequisite: ECE 754.

ECE 846. Multi-Service Over IP (4). 3R; 1L. Advanced networking course; deals with challenges and solutions associated with sending voice, video, and data (multi-service) over IP. Includes Telephony signaling, call routing and dial plans, measuring voice quality, voice digitization and coding, quality of service issues, and current research. Hands-on lab allows students to design, troubleshoot, and test different VOIP scenarios. Prerequisites: ECE 764 and graduate standing in ECE.

ECE 876. MS Thesis (1-6). Graded S/U only. Repeatable for credit toward the MS thesis option up to 6 hours. Prerequisite: prior consent of MS thesis advisor.

ECE 877. Special Topics in Electrical Engineering (3). New or special courses are presented under this listing on sufficient demand. Repeatable for credit. Prerequisite: departmental consent.

ECE 878. MS Directed Project (1-3). A project conducted under the supervision of an academic advisor for the directed project option. Requires a written report and an oral presentation on the project. Graded S/U only. Prerequisite: consent of academic advisor.

ECE 882. Speech Digital Signal Processing (3). An introductory study in speech signal generation and digital speech signal processing. Includes speech generation and perception, acoustic phonetics, models of speech signals and speech production, analysis methods of digital speech signals, digital representations of speech signals, short-time Fourier transforms and the application to spectrograms, pitch and formant estimation, parametric and nonparametric methods of signal representation, linear prediction methods, speech data compression, some methods of speech synthesis and recognition, and speech signals in the presence of noise. Prerequisites: ECE 754.

ECE 883. Digital Filters (3). A study of digital filter design methods. Includes both IIR and FIR filters. Discusses software and hardware implementations; introduces two-dimensional digital filters. Prerequisite: ECE 782 or departmental consent.

ECE 884. Error Control Coding (3). Introduces error control codes, including Galois fields, linear block codes, cyclic codes, Hamming codes, Golay codes, BCH codes, Reed-Solomon codes, convolutional codes, Viterbi decoding algorithm, Turbo codes, and ARQ protocols. Applies to digital 3G and 4G cellular and satellite communications systems. Prerequisite: ECE 726.

ECE 892. Speech Recognition (3). Reviews topics of speech signal processing and analysis as necessary for a study of speech recognition such as speech signal production and perception; acoustic-phonetic characterization of speech signals; representing speech signals in time and frequency; and linear prediction of speech signals. Studies topics such as vector quantization, pattern comparison and template matching methods, dynamic time alignment or warping, stochastic methods such as hidden Markov models, linear prediction or phonetics as two methods of segmenting speech signals, language or context-dependent models, and small vs. large vocabulary models. Prerequisite: ECE 882 or departmental consent.

ECE 894. Advanced Computer Architecture II (3). Vector processors, memory-hierarchy design, input, and output. Prerequisite: ECE 844.

ECE 895. Operation and Control of Power Systems (3). Acquaints electric power engineering students with power generation systems, their operation in economic mode, and their control. Introduces mathematical optimization methods and applies them to practical operating problems. Introduces methods used in modern control systems for power generation systems. Prerequisite: ECE 598.

ECE 900. Advanced Selected Topics in Electrical Engineering (1-3). Presents new or specialized advanced topics in engineering. Repeatable for credit. Prerequisite: instructor's consent.

ECE 976. PhD Dissertation (1-16). Graded S/U only. Repeatable for credit. Prerequisite: admission to doctoral aspirant status.

ECE 981. Co-op (1). A work-related placement with a supervised professional experience to complement and enhance the academic program. Intended for master's-level or doctoral students in Electrical Engineering. Repeatable for up to 8 hours. May not be used to satisfy degree requirements. Prerequisites: departmental consent and a graduate GPA of at least 3.0. S/U only.

ECE 982. Speech Recognition (3). Reviews topics of speech signal processing and analysis as necessary for a study of speech recognition such as speech signal production and perception; acoustic-phonetic characterization of speech signals; representing speech signals in time and frequency; and linear prediction of speech signals. Studies topics such as vector quantization, pattern comparison and template matching methods, dynamic time alignment or warping, stochastic methods such as hidden Markov models, linear prediction or phonetics as two methods of segmenting speech signals, language or context-dependent models, and small vs. large vocabulary models. Prerequisite: ECE 882 or departmental consent.

ECE 986. Wireless Spread Spectrum Communications (3). Explains what spread-spectrum communications is and why
direct-sequence code-division multiple access (DS-CDMA) spread-spectrum is used for wireless communications. Studies the block diagrams of the IS-95 forward and reverse wireless communication links under multi-path mobile fading environment using analysis techniques and simulation. Analyzes pseudo-noise (PN) signal generation, the band-limited waveform shaping filter, convolutional coding, interleaver, Walsh code orthogonal modulation, Rake finger receivers, non-coherent Walsh orthogonal sub-optimal demodulation, other simultaneously supportable subscribers, and third generation CDMA. Prerequisite: ECE 726.

ECE 990. Advanced Independent Study (1-3). Arranged individual, independent study in specialized areas in engineering under the supervision of a faculty advisor. Repeatable toward the PhD degree. Prerequisites: advanced standing and departmental consent.

ECE 993. Large Scale Control Systems (3). Sensitivity analysis of deterministic and stochastic systems; sources of uncertainty in control systems, e.g., plant parameter variation, time delays, small nonlinearities, noise disturbances, and model reduction; quantitative study of the effects of uncertainties on system performance; low-sensitivity design strategies, state and output feedback design; sensitivity function approach, singular perturbation, and model education techniques; adaptive systems; and near-optimal control. Prerequisite: ECE 893.

Industrial (I EN) and Manufacturing (MFGE) Engineering

Graduate Faculty

Professors: Don Malzahn, Hossein Cheraghi (Chairperson), Abu Masud (Associate Dean of Engineering)

Associate Professors: Krishna K. Krishnan (Graduate Coordinator), Viswanathan Madhavan, Janet M. Twomey, Jamal Sheik-Ahmad, Lawrence Whitman

Assistant Professors: Michael Jorgensen, Gamal Wehba, Bayram Yildirim

The industrial and manufacturing engineering (IMfGE) department at WSU is committed to instruction and research in design, analysis, and operation of manufacturing and other integrated systems of people, material, equipment, and capital. The graduate programs are directed toward both full-time and part-time students with a special emphasis on providing training and experience in performing independent research on topics with theoretical as well as applied interest. Students are encouraged to conduct research or take courses on topics that overlap several disciplines.

The IMfGE department offers Master of Engineering Management (MEM), Master of Science, and Doctor of Philosophy degree programs in industrial engineering (MSIE and PhDIE, respectively). Fields of specialization for the MSIE and PhDIE programs include engineering systems, ergonomics/human factors, and manufacturing systems engineering. The department also offers graduate certificate programs in five topical areas: computer-aided design and manufacturing, industrial ergonomics and safety, systems engineering and management, production systems, and quality engineering management.

Facilities

The following facilities used in teaching and research are available for graduate students.

1. The Graphics Lab has 25 NT stations with Pro-Engineer, ARENA, and NeuralWare software.
2. The Manufacturing Metrology Lab has a Mitutoyo CMM, an optical comparator, and a host of metrology tools.
3. The CIM Lab has a CNC vertical machining center, a CNC lathe and a CNC Router.
4. The Cessna Manufacturing Processes Lab has several engine lathes, drill presses, and facilities for arc/gas welding, casting, and thermo-forming.
5. The Non-Traditional Machining Lab currently has an EDM machine.
6. The Rapid Prototyping Lab has a state-of-the-art rapid prototyping machine. It also has a portable CMM and laser-scanning machine which, along with the Rhino Software, can be used for reverse engineering applications.
7. The Virtual Reality Development Lab has head-mounted displays, a motion tracking system, computers, and a variety of software.
8. The Ergonomics/Human Factors Lab has a 3-D motion analysis system, EKG system, treadmill, bicycle ergometer, metabolic cart, load cells, audiometric chamber, and other measurement devices.
9. The Graduate Computing Lab, available only to IE/MEM students, has a number of PCs, all on engineering LAN.
10. The Open Computing Lab has several state-of-the-art PCs, laser printers, and a plotter all connected to the engineering LAN.

Curriculum and Research Tracks

The industrial and manufacturing engineering teaching and research tracks are clustered around the following three areas.

Engineering Systems. Emphases include optimization; multi-criteria decision making; modeling and analysis of manufacturing/service systems; management of engineering enterprises; decision analysis; total quality management; application of intelligent systems and simulation in manufacturing; and activity-based costing.

Ergonomics/Human Factors. Emphases include industrial ergonomics; bio-mechanics; human-machine systems; occupational safety and other industrial hygiene issues; and ergonomics and human factors issues in aviation/space systems. Another area of continued research involvement is rehabilitation engineering, especially dealing with persons with severe physiological disabilities.

Manufacturing Systems Engineering. Emphases include planning, design, and control of manufacturing systems; CAD/CAM/CIM systems; measurement/inspection; GD&T; supply chain management; manufacturing processes; forming; composites manufacturing; and free-form surfaces manufacturing.

Master of Science in Industrial Engineering

The Master of Science in Industrial Engineering (MSIE) degree program offers tracks in all of the three areas described above. Students can complete the degree requirements through any of the following options: thesis, directed project, or all coursework.

Admission Requirements

In order to be admitted in the MSIE program, applicants must:

1. possess an undergraduate degree in engineering, science, business, or other related discipline;
2. have satisfactorily completed: MATH 344, Calculus III; IEN 255, Engineering Economy; a natural science course equivalent to that of the undergraduate engineering requirement;
3. have programming competence in C, C++, Visual Basic, or FORTRAN;
4. have a minimum GPA of 3.000, on a 4.000 scale, in the last 60 hours of undergraduate courses and in all graduate courses (students with lower GPA may be considered only for probationary or nondegree admission); and
5. indicate one of the following as a concentration area: engineering systems, ergonomics/human factors, or manufacturing systems engineering.

In addition,

6. students with English as a second language must have a minimum score of 213 on the computer-based or 580 on the paper-based TOEFL; students requesting financial assistance are encouraged to submit a TSE score (minimum acceptable score is 50); and
7. students with an undergraduate degree from a program not accredited by ABET are encouraged to submit GRE scores.

Degree Requirements

1. Core courses: IEN 549, Industrial Ergonomics; IEN 550, Operations Research; IEN 553, Production Systems; and IEN 724, Statistical Methods for Engineers;
2. CESP 750D, Engineering Research Writing (1 credit hour);
3. Major area courses: at least 9 hours from a selected list of area courses;
4. Technical electives: from an approved list of courses (no more than 6 hours from another department);
5. Up to 12 hours may be transferred from another accredited graduate school;
6. Completion with at least 3.000 GPA the minimum required graduate credit hours:

Thesis Option—a minimum of 24 hours of
coursework plus 6 hours of thesis, Directed Project Option—a minimum of 30 hours of coursework plus 3 hours of directed project, All Coursework Option—a minimum of 33 hours of coursework plus a written core competency exam; and
7. An approved Plan of Study

Master of Engineering Management
The Master of Engineering Management (MEM) degree program is geared toward helping engineers/technologists develop planning, decision making, and managerial skills while receiving advanced technical knowledge. Students should consider the MEM program if they find that they need to use (or develop) skills in decision making and management of teams, projects, and organizations. The MEM program is structured for practicing technical professionals.

Admission Requirements
To be admitted to the MEM program, applicants must:
1. possess an undergraduate degree in engineering, technology, science, mathematics, or computer science (some additional courses may be needed to make up background deficiency, if any);
2. have at least two years of acceptable professional work experience (enclose a resume with admission application to provide experience information);
3. have familiarity with and experience in using a personal computer and spreadsheet and database software (such as, MS Excel, MS Access);
4. have satisfactorily completed or have credit in MATH 243, Calculus II, and IEN 255, Engineering Economy; and
5. have a minimum GPA of 3.000 in the last 60 hours of undergraduate courses and in all graduate work.

In addition,
6. students with English as a second language must have a minimum score of 213 on the computer-based or 550 on the paper-based TOEFL; students requesting financial assistance are encouraged to submit a TSE score (minimum acceptable score is 50); and
7. students with an undergraduate degree from a program not accredited by ABET are encouraged to submit a GRE score.

Degree Requirements
1. Completion with at least a 3.000 GPA the minimum required graduate credit hours:
   Directed Project Option—a minimum of 30 hours of coursework plus 3 hours of directed project,
   All Coursework Option—a minimum of 33 hours of coursework plus a written core competency exam. The graduate coursework consists of 25 hours of core courses plus 5-8 hours of engineering electives;
2. Core courses: IEN 550, Operations Research; IEN 664, Engineering Management; IEN 724, Statistical Methods for Engineers; IEN 740, Analysis of Decision Processes; IEN 764, Systems Engineering and Analysis; IEN 854, Quality Engineering; MBA 801; MBA 801; and CESP 750D, Engineering Research Writing;
3. Electives: Two related engineering courses, one industrial and manufacturing engineering or business course (from a selected list);
4. An approved Plan of Study.
   Up to 12 hours may be transferred from another accredited graduate school.

Doctor of Philosophy
Courses of study leading to the Doctor of Philosophy (PhD) degree are available with specialization in any of the three areas discussed earlier. Details of the PhD program can be found under the College of Engineering heading.

Certificate Programs
The IMfgE department offers graduate certificate programs in the topical areas described below. Students seeking any of these certificates must be admitted to the Graduate School (1) in one of the degree programs offered by the department or (2) in a nondegree A status. All Graduate School policies relative to admissions apply. International students will not be issued an I-20 for pursuing a certificate program only. They may obtain a certificate only while concurrently pursuing a graduate degree. Students may apply certificate coursework toward a degree program. A cumulative graduate grade point average of at least 3.00 must be maintained for all courses comprising the certificate program with no grades below C.

Advanced Manufacturing Analysis
The courses in this certificate provide extensive information about the behavior of metals before, during, and after various processing operations; the mechanics and physics of operations; finite element-based analysis and design of processes; application of advanced finite-element technologies; and issues affecting the accuracy of finite-element simulations. Program prerequisites: MFGE 258, ME 250, and AE 333. This program requires satisfactory completion of the following four courses (a total of 12 credit hours):
- MFGE 258, Manufacturing Methods & Materials I
- IEN 780K, Analysis of Manufacturing Processes
- IEN 780M, Metal Cutting Theory & Applications
- IEN 880E, Finite Element Analysis in Forming

Composite Materials & their Processing
The courses in this certificate provide extensive information about technologies analysis involving composite materials and their processing. Program prerequisites: MATH 555, AE 333, and ME 250. This program requires satisfactory completion of the following four courses (a total of 12 credit hours):
- AE 653, Basic Composite Materials Technologies
- AE 654, Manufacturing Composite Structures
- IEN 7800, Machining of Composites
- ME 762, Polymeric Composite Materials

Design for Manufacturing
This program allows practicing Engineers to enhance their design skills by selecting a sequence of complimentary courses that include knowledge of the product realization process and the impact of design considerations on manufacturing costs. Program prerequisites: MFGE 558, IEN 254/724, and graphics/programming experience. This program requires satisfactory completion of the following four courses (a total of 12 credit hours):
- MFGE 622, Computer-Aided Design & Manufacturing
- IEN 775, Computer-Integrated Manufacturing
- IEN 785, Tolerances in Design & Manufacturing
- MFGE 502, Manufacturing Measurement

Foundations of Six-Sigma and Quality Improvement
This certificate program is primarily intended for individuals with industrial affiliation who may be interested in enhancing their skills in Quality Engineering and Six-Sigma Methodology. The program includes most of the Six-Sigma Black Belt (CSSBB) certification requirements outlined by the American Society for Quality (ASQ). Includes detailed coverage of applied statistical and managerial techniques most useful for process improvement, resource management, and design optimization. Program prerequisite: MATH 243, Calculus II. This program requires satisfactory completion of the following four courses (a total of 12 credit hours):
- IEN 724, Statistical Methods for Engineers
- IEN 854, Quality Engineering
- IEN 554, Statistical Quality Control
- IEN 755, Design of Experiments

Industrial Ergonomics and Safety
This program provides advanced knowledge and methodology of ergonomics and safety engineering for practitioners in industry who are responsible for the design and evaluation of work systems (tasks, materials, tools, equipment, workstations, and environments) for better usability, health, safety, and performance of workers in the workplace.

The curriculum focuses on the essential knowledge, analytical techniques, guidelines, regulations, and contemporary issues of ergonomics and safety engineering for the design and evaluation of various work systems in industry. Program prerequisite: MATH 243, Calculus II. This program requires satisfactory completion of the following four courses (a total of 12 credit hours):
- IEN 549, Industrial Ergonomics
- IEN 557, Safety Engineering
- IEN 724, Statistical Methods for Engineers
- IEN 760, Ergonomics Topics

Lean Systems
This program provides advanced knowledge and methodology of lean systems design, evaluation, and operation for practitioners in industry who are responsible for the development and management of production systems in the workplace. Curriculum
focuses on the essential knowledge, analytical techniques, guidelines, and contemporary issues in the design, evaluation, and management of lean systems in industry. Program prerequisite: IEN 550 Operations Research. This program requires satisfactory completion of the following four courses (a total of 12 credit hours):

IEN 553, Production Systems
IEN 724, Statistical Methods for Engineers
IEN 783, Supply Chain Management
IEN 767, Lean Manufacturing.

Systems Engineering and Management
Students completing this program will be able to apply systems concepts and techniques to the understanding, description, design, and management of large-scale systems requiring the integration of information and human activity.

The curriculum focuses on the essential knowledge, analytical techniques, and contemporary issues in complex systems definition, design, and decision-making. Program prerequisite: MATH 243, Calculus II. This program requires satisfactory completion of the following four courses (a total of 12 credit hours):

IEN 664, Engineering Management
IEN 724, Statistical Methods for Engineers
IEN 740, Analysis of Decision Processes
IEN 764, Systems Engineering and Analysis.

Industrial Engineering (IEN)

Courses for Graduate/Undergraduate Credit

IEN 524, Engineering Probability and Statistics II (3). A study of hypothesis testing, regression analysis, analysis of variance, correlation analysis, and design of experiments emphasizing applications to engineering. Prerequisite: IEN 254 or STAT 471.


IEN 553, Production Systems (3). Cross-listed as MFG E 545. Quantitative techniques used in the analysis and control of production systems. Includes forecasting, inventory models, operation planning and scheduling. Prerequisites: IEN 254 and 500.

IEN 554, Statistical Quality Control (3). A study of the measurement and control of product quality using statistical methods. Includes acceptance sampling, statistical process control, and total quality management. Prerequisite: IEN 524.

IEN 556, Information Systems (3). Provides a basic understanding of information systems in a modern enterprise, including database design, information technology, and ethics using hands-on activities and directed classroom discussion. Prerequisites: IEN 452 and ECE 138.

IEN 557, Safety Engineering (3). Environmental aspects of accident prevention, industrial compensation, and safety legislation. Fundamental concepts of occupational health and hygiene. Prerequisite: IEN 254 or STAT 471.

IEN 563, Facilities Planning and Design (2). Quantitative and qualitative approaches to problems in facilities planning and design, emphasizing activity relationships, space requirements, materials handling and storage, and plant layout. Prerequisites: IEN 452 and 550, MFG E 258.


IEN 590, Industrial Engineering Design I (3). An industry-based team design project utilizing industrial engineering principles; performed under faculty supervision. May not be counted toward graduate credit. May not get credit in both IEN 590 and MFG E 590. Prerequisites: completion of at least two of the following courses (IEN 549, 553, 563) and be within two semesters of graduation.

IEN 664, Engineering Management (3). An introduction to the design and control of technologically based projects. Considers both the theoretical and practical aspects of systems models, organizational development, project planning and control, resource allocation, team development, and personal skill assessment. Prerequisites: IEN 254 and 255.

IEN 690, Industrial Engineering Design II (3). Continuation of the design project initiated in IEN 590 or the performance of a second industrial engineering design project. May not be counted toward a graduate industrial engineering major. May not get credit in both IEN 690 and MFG E 690. Prerequisites: IEN 590 and departmental consent.

IEN 724, Statistical Methods for Engineers (3). For graduate students majoring in engineering. Students study and model real-life engineering problems and draw reliable conclusions through applications of probability theory and statistical techniques. Cannot be used to fulfill degree requirements for the BS degree in industrial and manufacturing engineering. Prerequisite: MATH 243.


IEN 740, Analysis of Decision Processes (3). Decision analysis as it applies to capital equipment selection and replacement, process design, and policy development. Explicit consideration of risk, uncertainty, and multiple attributes is developed and applied using modern computer-aided analysis techniques. Prerequisites: IEN 254 and 255.

IEN 749, Advanced Ergonomics (3). A continuation of IEN 549. Includes principles and application of human factors to the design of the workplace, displays, control systems, hand tools, and video display terminals. Prerequisite: IEN 549.

IEN 750, Industrial Engineering Workshops (1-4). Various topics in industrial engineering. Prerequisite: departmental consent.

IEN 754, Reliability and Maintainability Engineering (3). Studies problems of quantifying, assessing, and verifying reliability. Presents various factors that determine the capabilities of components emphasizing practical applications. Examples and problems cover a broad range of engineering fields. Prerequisite: IEN 524.

IEN 755, Design of Experiments (3). Application of analysis of variance and experimental design for engineering studies. Includes general design methodology, single-factor designs, randomized blocks, factorial designs, fractional replication, and confounding. Prerequisite: IEN 524 or instructor's consent.

IEN 757, Modern Techniques in Safety Engineering (3). An advanced study of the principles and quantitative measures of industrial safety and the Occupational Safety and Health Act. Prerequisite: IEN 557.

IEN 760, Ergonomics Topics (3). New or special courses on topics in ergonomics and human factors engineering. May be repeated for different topics. Prerequisite: departmental consent.

IEN 764, Systems Engineering and Analysis (3). Presentation of system design process from the identification of a need through conceptual design, preliminary design, detail design and development, and system test and evaluation. Studies operational feasibility, reliability, maintainability, supportability, and economic feasibility. Prerequisites: IEN 254 and 255.

IEN 767, Lean Manufacturing (3). Introduces lean concepts as applied to the manufacturing environment. The course deals with the concepts of value, value stream, flow, pull, and perfection. Includes waste identification, value stream mapping, visual controls, and lean metrics. Prerequisite: IEN 553.

IEN 775, Computer Integrated Manufacturing (3). A study of the concepts, components, and technologies of CIM systems; enterprise modeling for CIM; local area networks; CAD/CAD interfaces; information flow for CIM; shop floor control; and justification of CIM systems. Prerequisite: ECE 138 or knowledge of a programming language, MFG E 558.

IEN 780, Topics in Industrial Engineering (3). New or special courses are presented under this listing. Repeatable for credit when subject matter warrants.
A study of advanced IEN 835. Applied Forecasting Methods (3). Prerequisite: IE 553. Includes business process re-engineering, graphical operation of all elements associated with an enterprise. Tools to more effectively achieve its goals and objectives. The management of the supply chain. Prerequisite: IEN 553.

IEN 878. Tolerancing in Design and Manufacturing (3). Provides a basic understanding of the theory and application of tolerancing in design, manufacturing, and inspection. Reviews current literature in the area of tolerancing and inspection. Includes detailed discussion of the ASME standards on geometric dimensioning and tolerancing (GD&T), GD&T verification procedures, tolerance analysis and allocation, statistical tolerancing, and Taguchi’s approach to tolerancing. Prerequisite: IEN 254 or instructor’s consent.

Courses for Graduate Students Only

IEN 825. Enterprise Engineering (3). How to design and improve all elements associated with the total enterprise through the use of engineering and analysis methods and tools to more effectively achieve its goals and objectives. The course deals with the analysis, design, implementation and operation of all elements associated with an enterprise. Includes business process re-engineering, graphical enterprise modeling tools and architectures, and enterprise transformation. Prerequisite: IE 553.

IEN 853. Applied Forecasting Methods (3). A study of the forecasting methods, including smoothing techniques, time series analysis, and Box-Jenkins models. Prerequisite: IEN 524.

IEN 842. Advanced Simulation (3). A study of advanced techniques and methods for statistically selecting input distributions for and analyzing output from simulation models. Also studies variance reduction and model validation techniques. Prerequisites: IEN 565 and 524.

IEN 854. Quality Engineering (3). A broad view of quality tools and their integration into a comprehensive quality management and improvement system. Covers the theory and approaches of the major quality leaders such as Deming, Juran, and Crosby. Explores off-line and on-line quality engineering techniques, including cost of quality, the seven “old” and seven “new” tools, Quality Function Deployment, and statistical process control methods. Explores design of engineering experiments, including Taguchi’s methods. Prerequisite: IEN 524.

IEN 857. Environmental Hygiene Engineering (3). Evaluation and control of mechanical, physical, and chemical environments. Environmental factors considered include heat, cold, noise, vibration, light, pressure, acceleration, radiation, and air contaminants. Prerequisite: IEN 549.


IEN 877. Foundations of Neural Networks (3). For students from a variety of disciplines. Introduces the theory and practical applications of artificial neural networks. Covers several network paradigms, emphasizing the use of neural networks as a solution tool for industrial problems which require pattern recognition, predictive and interpretive models, pattern classification, optimization, and clustering. Presents examples and discusses them from a variety of areas including quality control, process monitoring and control, robotics control, simulation metamodeling, economic analysis models, diagnostic models, combinatorial optimization, and machine vision.

IEN 878. MS Directed Project (1-3). A project conducted under the supervision of an academic advisor for the directed project option. Requires a written report and an oral presentation on the project. Graded S/U only. Prerequisite: consent of academic advisor.

IEN 880. Topics in Industrial Engineering (3). New or special courses are presented under this listing on sufficient demand. Repeatable for credit when subject matter warrants.

IEN 890. Independent Study in Industrial Engineering (3). Analysis, research, and solution of a selected problem. Prerequisite: instructor’s consent.

IEN 910. Multiple Criteria Decision-Making (3). An extensive treatment of techniques for decision-making where the multiple criteria nature of the problem must be recognized explicitly. Prerequisite: IEN 550.

IEN 949. Work Physiology (3). The study of cardiovascular, pulmonary, and muscular responses to industrial work including aspects of endurance, strength, fatigue, recovery, and the energy cost of work. Utilization of physical work capacity and job demand for task design, personnel assignment, and assessment of work-rest scheduling. Prerequisite: IEN 549.

IEN 900. Occupational Biomechanics (3). Theoretical fundamentals of the link system of the body and kinetic aspects of body movement. Includes application of biomechanics to work systems. Prerequisites: IEN 549 and AE 223.

IEN 956. Knowledge-Based Systems (3). Introduction to the concepts and techniques in knowledge-based systems or expert systems. Includes design and development of knowledge-based systems using microcomputer-based software. Prerequisite: ECE 229 or AE 227 or departmental consent.

IEN 960. Advanced Selected Topics (1-3). New or special courses on advanced topics presented under this listing on sufficient demand. Prerequisite: instructor’s consent.

IEN 976. PhD Dissertation (1-6). Graded S/U only. Repeatable for credit. Prerequisite: admission to doctoral aspirant status.

IEN 990. Advanced Independent Study (1-3). Arranged individual, independent study in specialized content areas. Repeatable toward the PhD degree. Prerequisites: advanced standing and departmental consent.

Manufacturing Engineering (MFGE)

Courses for Graduate/Undergraduate Credit

MFGE 502. Manufacturing Measurement Analysis (3). 2R; 3L. Covers methods for measurement and analysis of variables in the production of industrial parts. Topics include basic principles of measurement, data acquisition, data analysis, dimensional measurement techniques, basic understanding and evaluation of GD&T, force, temperature, surface finish, measurement, principals of gage design, gage capability studies, process capability studies, and sampling techniques. Includes a laboratory component to familiarize students with different kinds of measurement devices such as CMM, non-contact optical measurement devices, surface profilometer, optical flats, and automatic data collection. Prerequisites: IEN 254 and MFGE 258.

MFGE 545. Manufacturing Systems (3). Cross-listed as IEN 553. A study of the design, planning, implementation, and control of manufacturing systems. Discusses types of manufacturing systems, material requirement planning, capacity planning, facilities planning, scheduling, and an introduction to computer-aided process planning. Prerequisite: MFGE 558.

MFGE 554. Manufacturing Tools (3). Introduces the principles behind the design and fabrication of machine tools and production tooling. Discusses tool materials; machine tool kinematics; accuracy, instrumentation, and control; and designing fixtures and jigs. Includes an introduction to design of inspection tools, machining and press working tools, and modular fixtureing. Application of theories to labs and design problems. Prerequisite: MFGE 258. Corequisite: AE 223.

MFGE 558. Manufacturing Methods and Materials II (4). 3R; 3L. Covers theoretical and practical aspects of manufacturing processes, including material properties and behavior as influenced by the manufacturing process. In-depth study of such manufacturing processes as casting heat treatment, bulk forming, sheet metal forming, metal cutting, non-traditional machining, and process monitoring through measurement of manufacturing process variables. Also includes laboratory experience and plant tours. Prerequisites: MFGE 258 and ME 250.

MFGE 622. Computer-Aided Design and Manufacturing (3). Introduction to 3-D computer graphics. Discusses concepts of CAD/CAM/CIM, design theory, automation, and knowledge-based CAD systems. Examines the basic principles of computer-aided manufacturing, NC programming, and CAD/CAM integration. Describes the design interchange standards and the interface between CAD and CAM. Prerequisites: 1 EN 222 and ECE 229 or equivalent.
MEGE 654. Nontraditional Machining Processes (3). A study of the role and economics of nontraditional processes; use of laser and electron beams in inspection and measurement; heat treatment; material removal; material joining; and coating. Also covers the fundamentals of electro-discharge machining, electro-chemical machining, chemical milling, and water-jet machining. Prerequisite: MGE 558.


Mechanical Engineering (ME)

Graduate Faculty

Professors: Behnam Bahr (graduate coordinator), Jharna Chaudhuri (chairperson), Hamid M. Lankarani, Dennis Sigener, Jorge E. Talia

Associate Professors: David N. Koert, T.S. Ravigururajan, C. Charles Yang

Assistant Professors: Ikramuddin Ahmed, Kurt Soschinsky

The Department of Mechanical Engineering offers courses of study leading to the Master of Science (MS) and Doctor of Philosophy (PhD) degrees. Departmental faculty have developed research activities in several areas of specialization, including engineering materials properties and failure modes; intelligent controls, robotics, and automation; multibody and impact dynamics; mechanical engineering design and manufacturing; thermal/fluid sciences and computational fluid dynamics and heat transfer (CFD); combustion; and heating, ventilating, and air-conditioning (HVAC) and energy conservation.

Many departmental faculty members are associates of Wichita State's National Institute for Aviation Research (NIAR), which makes faculty of the NIAR available for research activities of these faculty and their graduate students. NIAR and departmental faculty have developed research activities in several courses of study leading to the Master of Science (MS) degree. Each specialization will depend upon the student's dissertation advisor and graduate committee. Other details of the Doctor of Philosophy (PhD) program can be found under the College of Engineering heading. Additional information can be obtained at http://www.engr.wichita.edu/me/grad/grad.htm.

Doctor of Philosophy

Areas of research specialization for the Doctor of Philosophy (PhD) program are within the bedside previously for the MS degree. Exact specialties will depend upon the student's dissertation advisor and graduate commit- tee. Other details of the Doctor of Philosophy (PhD) program can be found under the College of Engineering heading. Additional information can be obtained at http://www.engr.wichita.edu/me/grad/grad.htm.

Courses for Graduate/Undergraduate Credit

The courses numbered 502 through 760 are not automatically applicable toward an advanced degree in engineering. They must be approved by the student's advisor, the graduate coordinator, and the chairperson of the department. Courses required for the BS degree normally are not permitted for use toward the graduate degree in mechanical engineering.

ME 502. Thermodynamics II (3).* Continuation of ME 398, emphasizing cycle analysis, thermodynamic property relationships, and psychometrics, with an introduction to combustion processes and chemical thermodynamics. Prerequisite: ME 398 with a grade of C or better.

ME 521. Fluid Mechanics (3).* Fluid statics. Basic equations of fluid mechanics. Study of flow in closed conduits and over immersed bodies. Includes compressible flow, turbomachin- ery, and measurements in fluid mechanics. Prerequisites: ME 398 with C or better and MATH 555 and AE 373.

ME 522. Heat Transfer (3).* Temperature fields and heat trans- fer by convection, conduction, and radiation. Study of transient multidimensional conduction, free and forced convection, and combined heat transfer. Discusses various analytical methods, analogies, numerical methods, and approximate solutions. Prerequisite: ME 521.

ME 533. Mechanical Engineering Laboratory (3). 2R; 3L.Introduces the basics of mechanical engineering measurements. Discusses related theory, followed by applications in such areas as strain, sound, temperature, and pressure measurements. Format includes lectures, recitation (which presents the concept of the experiment to be performed and the required data analysis), and laboratories. Analyzes the data obtained from measuring systems set up and operated in the laboratory to demonstrate and reinforce fundamental concepts of engineering mechanics. Prerequisites: ECE 282 and AE 333. Corequisite: ME 522.

ME 541. Mechanical Engineering Design II (3). Applications of engineering design principles to the creative design of mechanical equipment. Problem definition, conceptual design, feasibility studies, design calculations to obtain creative solutions of current real engineering problems. Introduction to human factors, economics, and reliability theory. Group and individual design projects. Prerequisite: ME 439.

ME 542. Structural Analysis I (3). Introduction to structural analysis. Methods of equilibrium, trusses, and frames. Prerequisite: MATH 398 with C or better and MATH 555 and AE 373.

ME 543. Structural Analysis II (3). Continuation of ME 542. Introduction to finite element analysis. Prerequisite: ME 542.

ME 544. Design of HVAC Systems (3). Analysis and design of heating, ventilating, and air-conditioning systems based on psychrometrics, thermodynamics, and heat transfer funda- mentals. Focuses on design procedures for space air-conditioning and heating and cooling loads in buildings. Prerequisites: ME 521 and 522 or equivalent.

ME 550. Selected Topics in Mechanical Engineering (1-3). New or special topics are presented on sufficient demand. Repeatable for credit when subject material warrants. Prereq- usite: departmental consent.

ME 602. Engineering for the Environment (3). Engineering for the environment, air, water, and noise pollution, and handling of hazardous wastes. Covers briefly the major pollutants, their major sources, their effects, and their attainment levels set by the U.S. Environmental Protection Agency. Emphasizes engineering systems for pollution control. Prerequisites: ME 398; AE 223, IEN 255; or departmental consent.

ME 631. Heat Exchanger Design (3). Covers analytical models for forced convection through tubes and over surfaces, experimental correlations for the Nusselt number and pressure drop, design of single and multiple pass shell and tube heat exchangers; compact baffled, direct contact, plat, and fluidized bed heat exchangers, radiators, recuperators, and regenera- tors. Prerequisites: ME 521 and 522, or equivalent.

ME 633. Mechanical Engineering Systems Laboratory (3). 2R; 3L.* Selected experiments illustrate the methodology of experimentation as applied to mechanical and thermal sys- tems. Experiments include the measurement of performance of typical systems and evaluation of physical properties and parameters of systems. Group design and construction of an experiment is an important part of the course. Team and individual efforts are stressed as are written and oral communica- tion skills. Prerequisites: ME 533, ENGL 102.

ME 637. Computer-Aided Engineering (3). 2R; 3L. Integrates computer-aided design, finite element analysis, kinematics analysis, heat transfer analysis, and other considerations for design of mechanical components and systems. Provides a blend of theory and practice. Corequisite: ME 439 or equivalent.

ME 639. Applications of Finite Element Methods in Mechanical Engineering (3). 2R; 3L. Introduces the finite element method (FEM) as a powerful and general tool for solving differential equations, arising from modeling practical engineer- ing problems. Finite element solutions to one- and two-dimen- sional mechanical engineering problems in fluid mechanics, heat transfer, solid mechanics, and vibrations. Includes Galerkin's and variational finite element models. Introduces commercial finite element computer tools such as ALGOR and ANSYS. Prerequisites: ME 439, 522 or equivalent.

ME 641. Thermal Systems Design (3). Modeling, simulation, and optimization used as tools in the design of thermal sys- tems. Engineering design principles, characteristics of thermal equipment, and economic considerations. Studies open-ended problems, including work on design projects in small groups. Prerequisites: ME 502 and 521.
ME 650. Selected Topics in Mechanical Engineering (1-3). New or special topics are presented on sufficient demand. Repeatable for credit when subject material warrants. Prerequisite: departmental consent.

ME 653. Internal Combustion Engines (3). A broad coverage of the basics of internal combustion engines emphasizing spark ignition and diesel engines. Definition of engine types and configurations and important variables used to evaluate performance and efficiency. Fundamentals learned in thermodynamics, chemistry, and mechanical design are used to understand engine design, performance, and control. Applications discussed are focused primarily on automotive use and involve power output, fuel consumption, and exhaust emissions. Prerequisite: ME 398.

ME 659. Mechanical Control Systems (3). Modeling and simulation of dynamic systems. Theory and analysis of the dynamic behavior of control systems, based upon the laws of physics and linear mathematics. Concerns classical methods of feedback control systems and design. Prerequisites: either a) ME 533, ECE 282, and MATH 555 or b) ECE 282.

ME 662. Mechanical Engineering Practice (3). 1R; 6L. An exercise in the practice of mechanical engineering: students engage in a comprehensive design project requiring the integration of knowledge gained in prerequisite engineering science and design courses. Team effort and both oral and written presentations are a part of the experience. Prerequisite: mechanical engineering students in their last semester of study.

ME 664. Introduction to Fatigue and Fracture (3). Deals with the primary analytical methods used to quantify fatigue damage. These are the stress life approach, strain life approach, and the fracture mechanics approach. Prerequisite: ME 250.

ME 665. Selection of Materials for Design and Manufacturing (3). Focuses on the selection of engineering materials to meet product and manufacturing requirements. Solution to various product and manufacturing problems by appropriate selection of materials is illustrated through the use of numerous examples and case studies. Prerequisites: ME 250, AE 333.

ME 666. Materials in Manufacturing Processes (3). Deals with fundamental principles of materials and their applications to manufacturing processes. Prerequisite: ME 250.

ME 667. Mechanical Properties of Materials I (3). Major focus on deformation mechanisms and on crystal defects that significantly affect mechanical properties. Also covers plasticity theory, yield criteria for multi-axial states of stress, fracture mechanics, and fracture toughness. Includes some review of basic mechanics of materials and elasticity as needed. Prerequisite: ME 250 or departmental consent.

ME 669. Acoustics (3). Fundamentals of acoustics including the study of simple harmonic systems, acoustic waves, transmission phenomena, and environmental and architectural acoustics. Prerequisites: MATH 555, AE 373.

ME 678. Studies in Mechanical Engineering (1-3). Arranged individual, independent study in specialized content areas in mechanical engineering under the supervision of a faculty member. Requires written report or other suitable documentation of work for departmental records. Three (3) hours maximum technical elective credit. Not for graduate credit. Prerequisite: departmental consent.

ME 719. Basic Combustion Theory (3). Introduction to the fundamental principles of combustion processes. Examines the chemistry and physics of combustion phenomena, that is, detonation and flames, explosion and ignition processes. Prerequisites: CHEM 111Q and ME 502.

ME 729. Computer-Aided Analysis of Mechanical Systems (3). Modeling and analysis of planar motion for multibody mechanical systems including automatic generation of governing equations for kinematic and dynamic analysis, as well as computational methods and numerical solutions of governing equations. Open-ended student projects on engineering applications such as vehicle ride stability simulations for different terrains. Prerequisites: ME 339, AE 373, and MATH 555.

ME 737. Robotics and Control (3). A systems engineering approach to robotic science and technology: Fundamentals of manipulators, sensors, actuators, end-effectors, and product design for automation. Includes kinematics, trajectory planning, control, programming of manipulator, and simulation, along with introduction to artificial intelligence and computer vision. Prerequisite: ME 659 or equivalent.

ME 739. Advanced Machine Design (3). A broad coverage of principles of mechanical analysis and design of machine elements. Emphasizes dynamic system modeling, prediction of natural frequencies and forced response, effect of support flexibility, failure theories used in design, and fatigue life prediction. Typical mechanical systems studied are gears, bearings, shafts, rotating machinery, and many types of spring-mass systems. Uses fundamentals learned in mechanics, strength of materials, and thermal sciences to understand mechanical system modeling, analysis, and design. Prerequisite: ME 541 or instructor's consent.

ME 747. Microcomputer-Based Mechanical Systems (3). 2R; 3L. Microcomputer-based real-time control of mechanical systems. Familiarizes students with design and methodology of software for real-time control. Includes an introduction to the C programming language which is most relevant to interfacing and implementation of control theory in computer-based systems. Laboratory sessions involve interfacing microcomputers to mechanical systems and software development for control methods such as PID. Prerequisite: ME 659 or instructor's consent.

ME 750. Special Topics in Mechanical Engineering (1-3). New or special topics are presented on sufficient demand. Repeatable for credit when subject material warrants. Prerequisite: departmental consent.

ME 755. Intermediate Thermodynamics (3). Laws of thermodynamics, introduction to statistical concepts of thermodynamics, thermodynamic properties, chemical thermodynamics, Maxwell’s relations. Prerequisite: ME 502 or departmental consent.

ME 759. Neural Networks for Control (3). Introduces specific neural network architectures used for dynamic system modeling and intelligent control. Includes theory of feed-forward, recurrent, and Hopfield networks; applications in robotics, aircraft and vehicle guidance, chemical processes, and optimal control. Prerequisite: ME 659 or departmental consent.

ME 760. Fracture Mechanics (3). Covers fracture mechanics in metals, ceramics, polymers and composites. Suitable for graduate and undergraduate study in metallurgy and materials, mechanical engineering, civil engineering, and aerospace engineering where a combined materials-fracture mechanics approach is stressed. Prerequisite: ME 250 or departmental consent.

ME 762. Polymeric Composite Materials (3). A basic understanding and knowledge about the structure and mechanical properties of polymeric composite materials in detail. Discusses both short fiber and continuum fiber composites. Emphasizes special design considerations for composite materials including fracture mechanics and performance of composites under adverse conditions (fatigue and impact). Prerequisite: ME 50 or equivalent or departmental consent.

ME 764. Thermodynamics of Solids (3). Presents basic thermodynamic concepts which will form the working tools throughout the course. Emphasizes the interpretation of certain types of phase diagrams—not upon the use of thermodynamics to assist phase diagram construction but upon the use of phase diagrams to obtain thermodynamic quantities. Also, the thermodynamics of defects and defect interactions in metals, ceramics, polymers, elemental semiconductors, and compounds. Prerequisites: ME 250 and 398 or departmental consent.

ME 766. SEM and EDAX (3). Introduces Scanning Electron Microscopy (SEM), a powerful tool in materials science and engineering which can be used to analyze structural defects in materials. Discusses both the theory and experimental methods, as well as the application of these methods. Prerequisite: ME 250 or departmental consent.

ME 767. X-Ray Diffraction (3). Theory of X-ray diffraction, experimental methods, and their applications which can include determination of the crystal structure of materials, chemical analysis, stress and strain measurements, study of phase equilibria, measurement of particle size, and determination of the orientation of a single crystal. Prerequisites: ME 250 and AE 333 or departmental consent.

ME 781. Cooperative Education (1-8). A work-related placement with a supervised professional experience to complement and enhance the student's academic program. Intended for master's level or doctoral students in mechanical engineering. Repeatable for credit. May not be used to satisfy degree requirements. Prerequisite: graduate standing, department's consent, and graduate GPA of 3.000 or above. Offered Cr/NCr only.

* Normally not permitted for use toward the graduate degree in mechanical engineering.
Courses for Graduate Students Only

ME 801. Boundary Layer Theory (3). Development of the Navier-Stokes equation, laminar boundary layers, transition to turbulence, turbulent boundary layers, and an introduction to homogeneous turbulence. Prerequisite: ME 521 or departmental consent.

ME 802. Turbulence (3). An overview of the theory, practical significance, and computation of turbulent fluid flow. Prerequisites: ME 521 and 801.

ME 829. Advanced Computer-Aided Analysis of Mechanical Systems (3). Computational methods in modeling and analysis of spatial multibody mechanical systems. Includes Euler parameters; automatic generation of governing equations of kinematics and dynamics; numerical techniques and computational methods; computer-oriented projects on ground vehicles with suspension and steering mechanisms, crashworthiness, and biodynamics. Prerequisite: ME 729 or instructor’s consent.

ME 832. Failure Analysis Applications in Mechanical Design (3). Application of engineering fundamentals to the study of mechanical failure brought about by the stresses, strains, and energy transfers in machine elements that result from the forces, deflections, and energy inputs applied. Emphasizes recognition, identification, prediction, and prevention of failure modes that are prevalent in machine-element design. Prerequisite: ME 439 or departmental consent.

ME 847. Applied Automation and Control Systems (3). 2R; 3L. Control theory condensed to engineering practice with the analysis, design, and construction of operating control systems. Experiments with pneumatic, hydraulic, and electromechanical servo-systems. Implementation of feedback and feed forward control schemes for various industrial systems and machine tools. The experiments are project-oriented and intended to be representative of the current state-of-the-art in classical and modern control practice. Prerequisite: ME 659 or equivalent.

ME 850. Special Topics in Mechanical Engineering (3). New or special topics are presented on sufficient demand. Repeatable for credit when subject material warrants. Prerequisite: departmental consent.

ME 851. Principles and Applications of Conduction Heat Transfer (3). Theory and measurement, Fourier’s equation, steady and unsteady state with and without heat sources, and sinks and numerical methods. Prerequisites: ME 522, MATH 757, or departmental consent.

ME 852. Principles and Applications of Convective Heat Transfer (3). Free and forced convection in laminar and turbulent flow. Includes analysis and synthesis of heat transfer equipment. Prerequisite: ME 522 or departmental consent.

ME 853. Principles and Applications of Radiative Heat Transfer (3). Radiative properties of real surfaces, configuration factor analysis, radiative transfer in participating media, exchange factor analysis, Monte Carlo methods. Prerequisite: ME 522 or departmental consent.

ME 854. Two-Phase Flow Heat Transfer (3). Thermo-dynamic mechanical and thermal aspects of interfacial phenomena, boiling, and condensation near immersed surface; pool boiling, internal flow convective boiling, and condensation. Prerequisites: ME 522, MATH 555, or departmental consent.

ME 855. Computational Fluid Dynamics and Heat Transfer I (3). Basic finite difference/finite volume methods; finite difference/volume representation of partial differential equations; stability analysis; finite difference/volume methods for solution of heat and fluid flow equations; grid generation and use of modern computer codes/software for analysis and visualization. Prerequisites: ME 521 and 522 or equivalent.

ME 860. Introduction to Ceramics (3). Introduces the fundamental principles of ceramic science and engineering with application on ceramics processes and fabrications. Presents the concepts and properties utilizing the crystal structure background. Discusses nonequilibrium aspect of phase relation in ceramics systems and their influence on processing parameters. Covers the microstructure form by liquid, liquid-solid, and solid-state reaction with some detail in combination with heat treatment. Students are expected to have backgrounds in chemistry, physics, math, thermodynamics, mechanics of solids, and introduction to materials in undergraduate engineering courses.

ME 864. Physical Metallurgy (3). Covers a range of basic concepts in physical metallurgy essential for further study in materials engineering. Topics include structure and diffraction, dislocations, defects and thermal processes, solid solution and hardening, diffusion, and phase diagrams and transformations. Prerequisites: ME 250 and 398, AE 333, or departmental consent.

ME 866. Advanced Fracture Mechanics (3). Covers the fracture mechanics of elastic-brittle, ductile, time dependent, and heterogeneous materials at an advanced level. The material is suitable for graduate study only in metallurgy and materials, mechanical engineering, and aerospace engineering where a combined materials-fracture mechanics approach is stressed. Prerequisites: ME 250, AE 333, or departmental consent.

ME 867. Mechanical Properties of Materials II (3). After a brief review of pertinent concepts of the macro-mechanical behavior of deformable bodies, course focuses on deformation mechanisms and on crystal defects that significantly affect mechanical properties and strengthening mechanisms. This includes point, line, and planar crystalline defects; dislocation dynamics; and various hardening and strengthening mechanisms. Concludes with discussion of physical properties and testing methods to measure these properties. Prerequisite: ME 667 or departmental consent.


ME 976. PhD Dissertation (1-16). Graded S/U only. Repeatable for credit. Prerequisite: admission to doctoral aspirant status.

ME 980. Advanced Independent Study (1-16). Arranged individual, independent study in specialized content areas. Repeatable toward the PhD degree. Prerequisites: advanced standing and instructor’s consent.

The following abbreviations are used in the course descriptions: R stands for lecture and L for laboratory. For example, 4R; 2L means 4 hours of lecture and 2 hours of lab.