College of Engineering

Offices: 100 Wallace Hall
Zulma Toro-Ramos, dean

Departments
Aerospace, (316) 978-3410—L. Scott Miller, 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 Cheraghli, chairperson and graduate coordinator
Mechanical, (316) 978-3402—Behnam Bahr, chairperson; Ikram Ahmed, 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 3.000/4.000 for admission to full standing, 2.750/4.000 for admission on probation, and 2.500/4.000 for admission to nondegree, 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.

Examination
Before the MS degree is granted, candidates in the thesis option must pass an oral examination over the thesis. Candidates in the directed project option must give an oral presentation and submit a written report on their directed project. Candidates in the coursework option must pass a written exit exam. Details of the exit exam can 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 3.250 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.

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 adviso-
ry 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, L. Scott Miller (chair), Michael Papadakis, Kamran Rokhsaz (master's graduate coordinator), Bert L. Smith, Roy Y. Myose, James E. Steck, John S. Tomblin
Associate Professors: James E. Locke, M. Gawad Nagati, Charles Yang
Assistant Professors: Suresh Raju

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 acoustics, aeroelasticity, 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 five 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, Spirit Aerosystems, Cessna, Bombardier-Learojet, 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 specializations 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). Lump 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, AE 514, and AE 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. Prerequisites: AE 333, 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 tools 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.
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. Prerequisites: 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 airfoil 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 AE 521.

AE 712. Advanced Aerodynamics Laboratory (3). IR; 3L. Advanced topics in wind tunnel testing, including analysis and sensitivity, modeling techniques, flow visualization, calibration, control surface loads 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 reversal, flutter, buffet, dynamic response to rapidly applied periodic forces, aeroelastic effects on load distribution, and static and dynamic stability. Prerequisites: AE 333, 424, instructor's consent.


AE 715. Intermediate Space Dynamics (3). Advanced topics in orbital mechanics—vector mechanics perspective of the two-body problem; fast transfers; interplanetary missions including gravity assist maneuver and intercept problem; atmospheric entry. Prerequisites: AE 373, AE 415 or instructor's consent.

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. Prerequisites: AE 333, 625 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. Prerequisite: 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 330 and 373.

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 through 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 812. Aerodynamics of Viscous Fluids (3). Viscous fluids flow theory and boundary layers. Prerequisite: AE 424 or ME 521.


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; nozzle 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; SClRam 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 876. MS Thesis (1-6). Graded S/U only.

AE 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.

AE 890. 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 911. Airfoil Design (3). Historical development of airfoils, underlying theories and experiments; modern airfoil design philosophies and techniques; theories used in modern airfoil computation methods; application of computer programs for practical airfoil design problems including high lift and control devices. Prerequisites: AE 711, MATH 757.

AE 913. Aerodynamics of Aerostaticity (3). A study of thin airfoils and finite wings in steady flow and thin airfoils oscillating in incompressible flow. Includes extension to compressible and three-dimensional airfoils and modern methods for low aspect ratio lifting surfaces. Prerequisites: AE 711 and 777 or instructor’s consent.

AE 919. Advanced Computational Fluid Dynamics (3). A study of structured grid generation schemes, transformation of the governing equations of fluid motion, numerical algorithms for the solution of Euler equations, parabolized Navier-Stokes equations, and Navier-Stokes equations. Explore the fundamentals of unstructured grids and finite volume schemes. Prerequisite: AE 719 or ME 585.

AE 936. Theory of Plasticity (3). Includes criteria of yielding, plastic stress-strain relationships, and stress and deformation in thick-walled shells, rotating discs and cylinders, bending and torsion of prismatic bars for ideally plastic and strain-hardening materials. Includes two-dimension and axially symmetric problems of finite deformation and variational and extremum principles. Prerequisite: AE 731.

AE 960. Advanced Selected Topics (1-3). Prerequisite: instructor’s consent.


AE 990. Advanced Independent Studies (1-3). Prerequisite: instructor’s consent.

Electrical and Computer Engineering (ECE)

Graduate Faculty

Professors: Ward T. Jewell, Hyuck M. Kwon, Glyn Rimmerington, 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 544. Digital Design and Simulation with Verilog (3). Behavioral and structural modeling of digital systems using the Verilog Hardware Description Language. Students use a commercial computer-aided design tool. Modeling and simulation from register-transfer level through switch-level. Top-down modular design and test; introduction to verification and validation. Prerequisite: ECE 294. Corequisite: CS 300.

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 586. Introduction to Communication Systems (4). 3R, 1L. 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 383 and either STAT 471 or IME 254.

ECE 588. Advanced Electric Motors (3). Advanced electric motor applications and theories. Includes single-phase motors, adjustable speed ac drive applications, and stepper motors. Prerequisites: ECE 488 and 492.

ECE 594. 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 wide popularity of wireless communications. The level of the course will be adaptable to junior or senior undergraduates as well as beginning graduate students. Prerequisites: ECE 363, IE 254.
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 microprocessor. Prerequisite: ECE 492.

ECE 691. Integrated Electronics (3). A study of BJTs and MOS analog and digital integrated circuits. Includes BJTs, BiMOS, and MOS fabrication; application specific semi-custom VLSI arrays; device performance and characteristics; and integrated circuit design and applications. Prerequisites: ECE 194 and 493 or departmental consent.

ECE 697. Electric Power Systems Analysis II (3). Analysis, design, modeling, and simulation of high-voltage electric power transmission systems and rotating generators. Simulations include short circuit studies, economic dispatch, and transient stability. Prerequisite: ECE 598.

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, FSK, 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 communication systems review; packet communications; queueing theory; OSI, s25, and SN A 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. Prerequisite: 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 VHDL 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 IME 254.

ECE 764. Routing and Switching I (4). 3R; 3L. An introductory course which studies different hardware technologies, like ethernet and token ring. Discusses VLSM. 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 techniques, including SRB, BSRB, and DLLSW. 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 776. 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. Prerequisite: 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 791, Design of Analog Integrated Circuits (3). This course is concerned primarily with the design of analog integrated circuits, and detailed analysis. The design concentrates on MOS devices, but some attention will also be given to bipolar technology. Dynamic loads will dominate, as the need is to limit passive components such as resistors and capacitors as much as possible. Specific circuits include current sources, voltage references, differential amplifiers, with operational amplifiers receiving the emphasis. SPICE simulation will be extensively used, including parameter sweeps, temperature effects, and sensitivity analysis as well as frequency response and time-domain analysis. Prerequisite: ECE 691.


ECE 793. Electric Power Distribution (3). Analysis, design, modeling, and simulation of radial medium-voltage electric power distribution systems. Simulations include power flow and short circuit. 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 multiple access (MC-CDMA) communications. Prerequisite: ECE 726.

ECE 836. 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, queueing 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 phantom variables, and are subject to the same types of statistical analysis as data obtained from real systems. Prerequisite: ECE 754.

ECE 844. Advanced Computer Architecture I (3). Covers advanced architectural subjects—microprogramming, economics of chip design, instruction set performance, and pipelining. Prerequisite: 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 864. 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 886. Error Control Coding (3). Introduces error control codes, including Galois fields, linear block codes, cyclic codes, Hadamard 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 893. Optimal Control (3). Reviews mathematics relevant to optimization, including calculus of variations, dynamic programming, and other norm-based techniques. Formulates various performance measures to define optimality and robustness of control systems. Studies design methods for various classes of systems, including continuous-time, discrete-time, linear, nonlinear, deterministic, and stochastic systems. Prerequisite: ECE 792.

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

ECE 897. 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 898. Electric Power Quality (3). Measurement, analysis, modeling, simulation, and mitigation of electric power quality on the medium- and low-voltage distribution systems. Prerequisite: ECE 798.

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 3.000. S/U only.

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 individually, independent study in specialized content 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 and Manufacturing Engineering (IME)

Graduate Faculty

Professors: Don Malzahn, Hossein Cheraghi (chairperson), Abu Masud

Associate Professors: Krishna K. Krishnan (graduate coordinator), Viswanathan Madhavan, Janet M. Twomey, Jamal Shiek-Ahmad, Lawrence Whitman

Assistant Professors: Michael Jorgensen, Gamal Weheba, Bayram Yildirim, Haitao Liao

The industrial and manufacturing engineering (IME) department at WSU is committed to instruction and research in design, analysis, and operation of manufac-
turing 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 IME 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 seven graduate certificate programs in the following areas: advanced manufacturing analysis, composite manufacturing systems, CAD/CAM/CIM systems, measurement/inspection, supply chain management, manufacturing processes, and free-form surfaces manufacturing.

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

1. The Graphics Lab has 25 NT stations with CATIA, 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 Cesa 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.** Emphasizes 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.** Emphasizes 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.** Emphasizes 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; IME 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 3.00, on a 4.00 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: IME 549, Industrial Ergonomics; IME 550, Operations Research; IME 553, Production Systems; and IME 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 3.00 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 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 IME 255, Engineering Economy; and
5. have a minimum GPA of 3.00 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 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 a GRE score.
Certificate Programs

The IME 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: IME 258, ME 250, and AE 333. This program requires satisfactory completion of the following four courses (a total of 12 credit hours):

- IME 558, Manufacturing Methods & Materials I
- IME 758, Analysis of Manufacturing Processes
- IME 768, Metal Machining Theory & Applications
- IME 858, Non-Linear Finite Element Analysis of Metal 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 Technology
- AE 654, Manufacturing Composite Structures
- IME 778, 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: IME 558, IME 254/724, and graphics/programming experience. This program requires satisfactory completion of the following four courses (a total of 12 credit hours):

- IME 622, Computer-Aided Design & Manufacturing
- IME 775, Computer-Integrated Manufacturing
- IME 785, Tolerances in Design & Manufacturing
- IME 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 prerequisites: MATH 243, Calculus II. This program requires satisfactory completion of the following four courses (a total of 12 credit hours):

- IME 724, Statistical Methods for Engineers
- IME 854, Quality Engineering
- IME 554, Statistical Quality Control
- IME 755, Design of Experiments

Industrial and Manufacturing Engineering (IME)

Courses for Graduate/Undergraduate Credit

IME 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, principal gears design, gear 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: IME 254 and IME 258.

Degree Requirements

1. Completion with at least a 3.00 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: IME 550, Operations Research; IME 664, Engineering Management; IME 724, Statistical Methods for Engineers; IME 740, Analysis of Decision Processes; IME 764, Systems Engineering and Analysis; IME 854, Quality Engineering; MBA 800; 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.

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: IME 550 Operations Research. This program requires satisfactory completion of the following four courses (a total of 12 credit hours):

- IME 553, Production Systems
- IME 724, Statistical Methods for Engineers
- IME 783, Supply Chain Management
- IME 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 design, decision, and decision-making. Program prerequisites: MATH 243, Calculus II. This program requires satisfactory completion of the following four courses (a total of 12 credit hours):

- IME 664, Engineering Management
- IME 724, Statistical Methods for Engineers
- IME 740, Analysis of Decision Processes
- IME 764, Systems Engineering and Analysis.
IM 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: IME 254.


IM 553. Production Systems (3). Quantitative techniques used in the analysis and control of production systems. Includes forecasting, inventory models, operation planning and scheduling. Prerequisite: IME 254; Corequisite: IME 255.

IM 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: IME 254, or 724.

IM 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: IME 452 and ECE 138.


IM 558. Manufacturing Methods and Materials II (4). Introduction to 3-D computer graphics. Discusses concepts of CAD/CAM/CIM, design theory, 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: I EN 222 and I ME 258 or equivalent.

IM 559. 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. Prerequisites: complete at least two of the following courses (IME 549, 553, 563) and be within two semesters of graduation.

IM 562. Computer-Aided Design and Manufacturing (3). Introduction to 3-D computer graphics. Discusses concepts of CAD/CAM/CIM, design theory, 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: I EN 222 and I ME 229 or equivalent.

IM 564. 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: IME 558.


IM 568. 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: IME 258. Corequisite: AE 223.

IM 570. Post Cure Manufacturing of Composites (3). A study of the fabrication of fiber reinforced composite parts (FRPs), with particular relevance to the aircraft industry. These processes include trimming, drilling, countersinking, assembly and quality assessment. Major traditional and nontraditional machining processes are presented and the effect of process parameters, material parameters, and system parameters on the material removal rate, tool wear and the quality of the machined part are discussed. Participants will learn the advantages and disadvantages of each machining process, state of the art tools and tool materials, and how to select the most appropriate process for different materials and geometries. The course also contains hands on components emphasizing several key topics. Prerequisite: IME 258 or consent of instructor.

IM 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. Prerequisites: complete at least two of the following courses (IME 549, 553, 563) and be within two semesters of graduation.

IM 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: I EN 222 and I ME 229 or equivalent.

IM 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: IME 558.


IM 658. 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: IME 258. Corequisite: AE 223.

IM 659. Correlation and 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: IME 254, or 724.

IM 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: IME 254 and 255.

IM 670. Industrial Engineering Design II (3). Continuation of the design project initiated in IME 590 or the performance of a second industrial engineering design project. May not be counted toward a graduate industrial engineering major. Prerequisites: IME 590 and departmental consent.

IM 724. Statistical Methods for Engineers (3). For graduate students majoring in engineering. Studies 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.


IM 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: IME 254 and 255.

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

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

IM 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: IME 524, or 724.

IM 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: IME 524, or 724.

IM 758. Analysis of Manufacturing Processes (3). This course will introduce students to plasticity and build upon students’ knowledge of mechanics and heat transfer in order to analyze various manufacturing processes. Numerical techniques (mainly Finite Element Analysis) as well as theoretical methods will be introduced and applied to analysis of...
IME 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.

IME 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: IME 254 and IME 255.

IME 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: IME 553.

IME 768. Metal Machining: Theory and Applications (3). This course provides basic understanding of the various conventional metal machining processes and the nature of various phenomena that occur in it. The course includes fundamental treatments of the mechanics of chip formation under orthogonal and oblique conditions, temperatures in machining, tool materials, tool wear, surface roughness, and numerical and mechanistic modeling methods, and discusses current research trends and possible future developments. Prerequisites: AE 333 or ME 250.

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

IME 778. Machining of Composites (3). This course introduces students to a wide range of machining processes used in the secondary manufacturing of composites, focusing on scientific and engineering developments affecting the present and future of composites manufacturing. Major traditional and non-traditional machining processes are discussed. The effect of process parameters, material parameters, and system parameters on the material removal rate and the quality of the machined part are also discussed. Emphasis will be given to the application of non-traditional machining processes in the manufacture of fiber-reinforced polymers that are used in the aerospace and aviation industries. Students will learn the advantages and disadvantages of each machining process and how to select the most appropriate process for different materials and geometries. Prerequisites: AE 333, IME 578, or approval of instructor.

IME 780. Topics in Industrial Engineering (3). New or special courses are presented under this listing. Repeatable for credit when subject matter warrants.

IME 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 IME. Repeatable for credit. May not be used to satisfy degree requirements. Prerequisites: departmental consent and graduate GPA of 3.00 or above. Cr/Ncr only.

IME 783. Supply Chain Management (3). Quantitative and qualitative techniques used in the design and management of the supply chain. Includes distribution management, multi-plant coordination, optimal design of the logistics network, adequate safety stock levels and the risk pooling concept, and integrating decision support systems (DSS) in the management of the supply chain. Prerequisite: IME 553.

IME 785. 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: IME 254 or instructor’s consent.

Courses for Graduate Students Only

IME 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: IME 553.

IME 835. Applied Forecasting Methods (3). A study of the forecasting methods, including smoothing techniques, time series analysis, and Box-Jenkins models. Prerequisite: IME 524.

IME 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: IME 524.

IME 858. Non-Linear Finite Element Analysis of Metal Forming (3). The course will introduce the use of an LS-DYNA software package for metal forming simulations and discuss the theoretical foundation necessary to understand the physics and mechanics behind some of the options that need to be used to ensure solution accuracy in FEA of metal forming. Prerequisites: AE 722 or ME 650K or IME 780K.

IME 865. Modeling and Analysis of Discrete Systems (3). This course discusses analytical and experimental techniques for the modeling and analysis of discrete systems in general and manufacturing systems in particular. Students will utilize techniques such as simulation, Markov Chains, Queuing Theory, and Petri Nets to model manufacturing systems problems. Students will investigate issues related to the modeling and analysis of manufacturing systems through readings, lectures and projects. Prerequisite: IME 553 or instructor’s consent.


IME 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 modeling, economic analysis models, diagnostic models, combinatorial optimization, and machine vision.

IME 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.

IME 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.

IME 882. Free-Form Surfaces (3). The objective of this course is for manufacturing engineering students to learn design of free-form surfaces and their manufacturing using various traditional and non-traditional methods. Topics that will be investigated include: geometric modeling, algorithms for curves and splines, lofting, blending of surfaces, surfaces using Coons patches and manufacturing analysis of surfaces, including rapid prototyping. Prerequisites: ECE 138 or computer programming experience, IME 622 or instructor’s consent.

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

IME 930. 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: IME 550.
IME 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: ME 549.

IME 950. 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: ME 549 and AE 223.

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

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

IME 990. Advanced Independent Study (0-3). Arranged individual, independent study in specialized content areas. Repeatable toward the PhD degree. Prerequisites: advanced standing and departmental consent.

Mechanical Engineering (ME)

Graduate Faculty

Professors: Behnam Bahr (chairperson), Hamid M. Lankarani, Jorge E. Talia, Dennis Sigler

Associate Professors: David N. Koert, Bob Minaei, T.S. Ravigururajan

Assistant Professors: Ikram Ahmed (graduate coordinator), Brian Driessen, Kurt Soschinske

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). This association makes facilities of the NIAR available for research activities of these faculty and their graduate students. NIAR and departmental facilities include a computational fluid dynamics laboratory (CFD lab) with a Linux based network, a scanning electron microscope (SEM) located in the materials laboratory, the crash dynamics laboratory, the shock and vibration laboratory, the propulsion laboratory, the computer integrated manufacturing laboratory, and the mechatronics laboratory.

The department's programs and efforts are influenced by the concentration of technology-oriented industries in the Wichita area. Particular attention is given to scheduling coursework so that engineers employed by local industry may pursue a graduate degree in mechanical engineering.

Master of Science

Courses of study leading to the MS degree are available with specialization in any of the departmental faculty research areas described earlier. Details of the MS 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 those stated previously for the MS degree. Exact specialties 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.

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 psychrometry, 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 open conduits and over immersed bodies. Includes compressible flow, turbomachinery, 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 transfer by conduction, convection, and radiation. Steady and 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 experimental methods. Discusses related theory; the design of experiments; and the design of laboratory experiments. Analyzes the data obtained from various experiments set up and operated in the laboratory to demonstrate and reinforce fundamental concepts of engineering mechanics. Prerequisites: ECE 282 and AE 333, each with a grade of C or better. 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 with a grade of C or better.

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

ME 602. Engineering for the Environment (3). Engineering for the environment, air, water, and noise pollution, and handling of hazardous wastes. Covers pollution control, 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, ME 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 regenerators. 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 systems. 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 communications 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 engineering problems. Finite element solutions to one- and two-dimensional 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 ANSYS. Prerequisites: ME 439, 522 or equivalent, with a grade of C or better.
ME 641. Thermal Systems Design (3). Modeling, simulation, and optimization used as tools in the design of thermal systems. 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 662. Mechanical Engineering Practice (3). 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 project 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 211 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 758. Nonlinear controls of Electro-Mechanical Systems (3). The standard first nonlinear controls course: covers stability, feedback linearization (robotic, mechanical, electromechanical system applications); differentially-flat systems (with rotor-craft position-tracking applications); backstepping control-design methods (electro-mechanical, robotic, and rotor-craft applications); MIMO systems; normal form; zero dynamics; and adaptive control of robotic systems. ECE 729, Linear State Space Controls, while not a prerequisite, will be helpful.

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 250 and MATH 555, or equivalent, 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 3.00 or above. Offered Cr/NC only.

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 methods; 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 biofuidics. Prerequisite: ME 729 or instructor's 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 electro-mechanical 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 854. Two-Phase Flow Heat Transfer (3). Thermo-dynamic and mechanical 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 858. Computational Fluid Dynamics and Heat Transfer I (3). Basic finite difference/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 relaxation 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-plastic, 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 868. Advanced Fracture Mechanics (3). Covers the fracture mechanics of elastic-plastic, 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 869. 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 electro-mechanical 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 866. Advanced Fracture Mechanics (3). Covers the fracture mechanics of elastic-plastic, 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 900. Advanced Independent Study (1-16). Arranged individual, independent study in specialized content areas. Prerequisite: instructor's consent.

ME 901. Advanced X-Ray Diffraction Theory (3). First part concentrates on the fundamental X-ray diffraction theories including dynamical theory of X-ray and anomalous absorption, with which a serious student in this field must be thoroughly familiar. Second part emphasizes the general theory of X-ray diffraction in a concise and elegant form using Fourier transforms. The general theory is then applied to various atomic structures, ideal crystals, imperfect crystals, and amorphous bodies. Prerequisites: ME 767, MATH 757.

ME 960. Advanced Selected Topics (1-3). New or specialized advanced topics in mechanical engineering. Prerequisite: instructor's consent.

ME 962. Advanced Ceramics (3). Covers concepts in ceramics science and engineering essential to understanding and using advanced ceramic materials such as high temperature metal, ceramics. Expands coverage of fundamental concepts and physical properties presented in ME 860. Provides deeper understanding of crystalline solids and characteristic properties of ceramics. Incorporates many of the most recent advances in the area. Students are expected to have backgrounds in chemistry, physics, math, thermodynamics, mechanics of solids, and introduction to materials in undergraduate engineering courses.

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

ME 990. 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.