

SCHOOL OF MECHANICAL, INDUSTRIAL, AND MANUFACTURING ENGINEERING

The School of Mechanical, Industrial, and Manufacturing Engineering (MIME) at OSU offers undergraduate degrees in Mechanical Engineering, Industrial Engineering, and Manufacturing Engineering at the Corvallis campus and Energy Systems Engineering at the OSU-Cascades campus.

The Bachelor of Science and Honors Bachelor of Science degrees in Mechanical Engineering are accredited by the Engineering Accreditation Commission of ABET, <http://www.ABET.org>.

The Bachelor of Science and Honors Bachelor of Science degrees in Industrial Engineering are accredited by the Engineering Accreditation Commission of ABET, <http://www.ABET.org>.

The Bachelor of Science and Honors Bachelor of Science degrees in Manufacturing Engineering are accredited by the Engineering Accreditation Commission of ABET, <http://www.ABET.org>.

The Bachelor of Science and Honors Bachelor of Science degrees in Energy Systems Engineering are accredited by the Engineering Accreditation Commission of ABET, <http://www.ABET.org>.

The mission of the School of MIME is two-fold:

- To prepare our students as entrepreneurial, team-oriented, work-ready graduates and lifelong learners in mechanical, industrial and manufacturing engineering, and
- To engage in collaborative, cutting-edge research whose applications lead to greater prosperity and a sustainable future for Oregon and the world.

MIME Program Objectives

ABET (<http://www.ABET.org>) requires that each program establishes educational objectives defined as 'broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve.' While each program has specific objectives, all MIME programs' program objectives may be summarized by the following statements in three broad areas of student participation and graduate achievement:

1. **Our graduates will be systems thinkers.** MIME graduates will be able to analyze, evaluate, improve, and design engineered systems and processes using modern engineering tools (hardware and software) and approaches. They will demonstrate in-depth knowledge of mechanical, industrial and/or manufacturing systems.
2. **Our graduates will be global collaborators.** MIME graduates will be able to communicate effectively across disciplines and cultures. They will provide management and leadership skills within their organizations and work effectively in diverse environments.
3. **Our graduates will be innovative designers and problem solvers.** MIME graduates will use both structured and unstructured methodologies to innovate systems and processes. They will apply

technical knowledge and creativity in solving real-world problems. They will demonstrate a sound understanding of engineering and project management fundamentals and breadth of experience with engineering design and problem-solving processes.

Mechanical Engineering

Mechanical engineers design and develop small devices, large equipment, and processes for society. They play major roles in the design, testing and operation of mechanisms, machines, and systems, including processes for energy conversion and equipment used in households, businesses, transportation, and manufacturing.

In addition to the university baccalaureate core, the mechanical engineering curriculum has its base in mathematics, science, engineering science, and design. Mathematics and science courses occur primarily in the first two years. Engineering science is a major component, which is treated from the sophomore year to graduation in a combination of required and technical elective sources.

OSU's Mechanical Engineering Program has all the attributes needed for the best learning environment: ABET accredited curriculum, excellent faculty, modern facilities, quality students, and strong industrial interaction.

Engineering design is an integral element of the program. The philosophy is to 'plant the seed' for design at the freshman level and grow it throughout the program. Most of the skills are developed at the junior and senior levels when students have achieved proficiency in the basic technical requirements. At the junior level, the design process is extensively developed in three courses. At the senior year, design experiences occur in several areas, culminating in the two-term senior project in which students in small teams carry out the design of some product or process under the supervision of a faculty advisor. Attention to hands-on activity adds a very desirable 'feel' for many aspects of the design process.

A good choice of senior electives enables students to achieve a degree of specialization and depth to match their interests. The areas include applied stress analysis; design, dynamics, and analysis of mechanical and thermal/fluid systems; concurrent engineering; control system design; mechatronics; heat transfer; and metallurgy and materials.

The faculty encourages a vibrant extracurricular program for professional and leadership experiences. Students are encouraged to obtain at least three months of work experience through an industrial or research internship or to participate in a foreign exchange program. The school's goal is to have more than 95 percent of its students graduate with such experience. In addition to students having general internships, many of the professional-level students participate in the industry-driven Multiple Engineering Cooperative Program (MECOP). This program provides two paid six-month internships at over 60 Pacific Northwest companies where interns work with a company mentor and improve their capabilities for the work environment.

Mechanical engineers can be found in a wide variety of industries including aerospace, electronics, biomedical, transportation, manufacturing, energy, automotive, and government labs. Because of the increasing complexity of mechanical engineering, graduate study for the MS and PhD degrees is advisable for students who wish to specialize in depth in any of the above areas. The undergraduate curriculum provides an excellent foundation for graduate study.

Industrial Engineering

Industrial engineers (IEs) apply science, mathematics, and engineering methods to complex system integration and operation. Because the systems with which they work are often large and complex, IEs utilize knowledge and skills in a wide variety of disciplines, have the ability to work well with people, and take a broad, systems perspective. The Industrial Engineering degree is a very flexible degree that allows students to tailor their program of study to meet their individual career goals. A large number of restricted elective credits allows students to pursue the Business Engineering option or to customize their program to a field of interest.

IEs are key players in the integration and operation of systems in all sectors of industry and government including the following (with examples):

- aerospace (NASA space shuttle pre-launch processing systems)
- automotive (automobile final assembly plants)
- communications (telephone services)
- computers (factory information systems)
- electronics/semiconductors (silicon wafer fabrication facilities)
- food (canneries and fast food restaurant chains)
- government (department of motor vehicles service centers)
- health care (hospital central stores and operating rooms)
- manufacturing (circuit board fabrication facilities)
- retail (product distribution centers)
- transportation (airlines, overnight delivery services)

In their role as system integrators, IEs analyze and design systems. For example:

- facilities layout,
- material handling systems,
- manufacturing and other production systems,
- information systems,
- individual and group workplaces.

In the operations realm, IEs analyze, design and manage processes. For example:

- manufacturing processes-service processes,
- production system planning and control,
- resource allocation and scheduling,

- personnel assignment and scheduling,
- quality assurance,
- inventory control,
- system and personnel safety.

Energy Systems Engineering

Energy systems engineers oversee complex energy conversion and distribution systems, work to improve energy storage systems, and manage the efficient use of energy in building, manufacturing, and processing systems. ESE professionals also study the secondary effects of energy usage from a local environmental impact, regional and national economic impact, and global climate change perspective.

Energy systems engineers pursue a variety of jobs and occupations. For example, they might be hired to do any of the following:

- Manage operations of a wind turbine farm
- Analyze efficiency of hydroelectric power systems
- Oversee production of innovative fuel-cell technologies
- Evaluate the economic viability of new solar power installations
- Assess the environmental impact of alternative energy systems

Manufacturing Engineering

The Manufacturing Engineering degree is a more specialized degree, focusing on both high-tech manufacturing and traditional manufacturing. In particular, it is a specialization of industrial engineering that focuses on the making of physical products. The Manufacturing Engineering degree offers a hands-on education, and manufacturing engineering students are encouraged to participate in the college's MECOP program, a nationally recognized industrial cooperative education program.

Students who complete the requirements for the Manufacturing Engineering degree plus 32 additional credits (at least 16 of these credits must be from the list of industrial engineering restricted electives) can earn two separate degrees, one in manufacturing engineering and the other in industrial engineering. The additional 32 credits typically take two additional quarters to complete.

Undergraduate Programs

Majors

- Energy Systems Engineering (<http://catalog.oregonstate.edu/college-departments/engineering/school-mechanical-industrial-manufacturing-engineering/energy-systems-engineering-bs-hbs/>)
- Industrial Engineering (<http://catalog.oregonstate.edu/college-departments/engineering/school-mechanical-industrial-manufacturing-engineering/industrial-engineering-bs-hbs/>)

Option:

- *Business Engineering*

- Manufacturing Engineering (<http://catalog.oregonstate.edu/college-departments/engineering/school-mechanical-industrial-manufacturing-engineering/manufacturing-engineering-bs-hbs/>)

Options:

- *Manufacturing Systems*
- *Product Development*
- Mechanical Engineering (<http://catalog.oregonstate.edu/college-departments/engineering/school-mechanical-industrial-manufacturing-engineering/mechanical-engineering-bs-hbs/>)

Minor

- Aerospace Engineering (<http://catalog.oregonstate.edu/college-departments/engineering/school-mechanical-industrial-manufacturing-engineering/aerospace-engineering-minor/>)
- Humanitarian Engineering (<http://catalog.oregonstate.edu/college-departments/engineering/other-degrees-programs/humanitarian-engineering-minor/>)
- Materials Science (<http://catalog.oregonstate.edu/college-departments/engineering/school-mechanical-industrial-manufacturing-engineering/materials-science-minor/>)

Graduate Programs

Majors

- Industrial Engineering (<http://catalog.oregonstate.edu/college-departments/engineering/school-mechanical-industrial-manufacturing-engineering/industrial-engineering-meng-ms-phd/>)
 - Options:**
 - *Advanced Manufacturing*
 - *Engineering Management*
 - *Human Systems Engineering*
 - *Information Systems Engineering*
 - *Manufacturing Systems Engineering*
- Materials Science (<http://catalog.oregonstate.edu/college-departments/engineering/school-mechanical-industrial-manufacturing-engineering/materials-science-ms-phd/>)
- Mechanical Engineering (<http://catalog.oregonstate.edu/college-departments/engineering/school-mechanical-industrial-manufacturing-engineering/mechanical-engineering-meng-ms-phd/>)
 - Options:**
 - *Advanced Manufacturing*
 - *Design*
 - *Engineering Management*
 - *Materials Mechanics*
 - *Renewable Energy*
 - *Dynamics and Controls*
 - *Thermal Fluids*
- Robotics (<http://catalog.oregonstate.edu/college-departments/engineering/school-mechanical-industrial-manufacturing-engineering/robotics-meng-ms-phd/>)

Minors

- Industrial Engineering (<http://catalog.oregonstate.edu/college-departments/engineering/school-mechanical-industrial-manufacturing-engineering/industrial-engineering-graduate-minor/>)
- Materials Science (<http://catalog.oregonstate.edu/college-departments/engineering/school-mechanical-industrial-manufacturing-engineering/materials-science-graduate-minor/>)
- Mechanical Engineering (<http://catalog.oregonstate.edu/college-departments/engineering/school-mechanical-industrial-manufacturing-engineering/mechanical-engineering-graduate-minor/>)

- Robotics (<http://catalog.oregonstate.edu/college-departments/engineering/school-mechanical-industrial-manufacturing-engineering/robotics-graduate-minor/>)

Certificate

- Engineering Management (<http://catalog.oregonstate.edu/college-departments/engineering/school-mechanical-industrial-manufacturing-engineering/engineering-management-graduate-certificate/>)

Harriet Nembhard, *Head*

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Faculty

Professors: Apte, Batten, M. Campbell, Cann, Dong, Doolen, Gibbons, Kim, Liburdy, D. Nembhard, Paasch, B. Paul, Pence, Porter, Sharp, Smart, Stone, I. Tumer, K. Tumer

Associate Professors: Albertani, Balasubramanian, Bay, Blunck, Calvo-Amodio, DuPont, Grimm, Haapala, Hagen, Hatton, Hollinger, Hoyle, Hurst, Kawasaki, Parmigiani, Tucker, Vergara

Assistant Professors: Abbasi, Agor, Camburn, Davidson, Demirel, Eseonu, Fan, Fronk, Gess, MacCarty, Fitter, Ng, Niemeyer, Pasebani, Santala, Sencer, Tabei, Xu, Zhu

Instructors: S. Campbell, De Szoeko, Greene, Hoffman, Squires, Worley

Professional Faculty

Barber, Brakke, Ekstedt, Grigar, Jensen, Huffman, Leeds, L. Paul, Pitkin, Olson, Thompson

Aeronautical & Astronautical Engineering (AAE)

AAE 210, INTRODUCTION TO AEROSPACE ENGINEERING, 3 Credits

Topics will include the engineering fundamentals of aeronautics and astronautics, including an introduction to aerodynamics, propulsion, structures, orbital mechanics and mission planning. Current industry practices in aerospace vehicle specifications, manufacturing, flight testing and certification will be presented.

Prerequisite: ENGR 211 with C or better

AAE 411, AEROSPACE APPLICATIONS IN MECHANICAL ENGINEERING, 4 Credits

Explores the fundamentals of mechanical engineering applications to aerospace. Features an overview of modern aircraft and spacecraft analysis, with an emphasis on performance, stability, structures, materials, FAA and FAR standards. Applies current professional practices in the conceptual design of aerospace vehicles.

Prerequisite: ME 316 (may be taken concurrently) with C- or better

Equivalent to: ME 411

Recommended: ME 311

AAE 412, SPACE SYSTEMS ENGINEERING, 4 Credits

Introduction to space systems engineering. Topics will include the fundamentals of astronautics, orbital mechanics and trajectory design, flight dynamics, guidance and navigation, stability and control of spacecraft. Rocket propulsion concepts, including chemical rockets (liquid, gas and solid propellants), hybrid rocket engines and modern advances in satellite power systems will be discussed. Current design practices in space systems engineering will be emphasized.

Prerequisite: (ME 317 with C or better or ME 317H with C or better) and (ME 373 [C] or ME 373H [C])

AAE 413, AERO VEHICLES COMPONENTS DESIGN, 4 Credits

Develop mechanical design of aircraft subcomponents. Analyze and model aircraft components and evaluate their integration on aircraft. Apply real-world aircraft component design project with associated deliverables to customer, including basic requirements for Federal Aviation Administration (FAA) certification.

Prerequisite: ME 316 with C or better and ME 317 [C] and ME 331 [C] and ME 373 [C]

AAE 415, UAV ENGINEERING, 4 Credits

Develop a strong foundation in Unmanned Aerial Vehicles (UAV) systems technologies. Engineering evaluation of UAV systems, subcomponents, aircraft missions, operations and Federal Aviation Administration (FAA) requirements. Apply actual UAV models and subsystems to a real-world project on UAV deployment for humanitarian and environmental missions. Write a technical report as a team-project, developing and demonstrating critical thinking and engineering reporting skills in the subject. CROSSLISTED as AAE 415/HEST 415.

Prerequisite: ME 316 with C or better and ME 317 [C] and ME 331 [C] and ME 373 [C]

Equivalent to: HEST 415

AAE 512, SPACE SYSTEMS ENGINEERING, 4 Credits

Introduction to space systems engineering. Topics will include the fundamentals of astronautics, orbital mechanics and trajectory design, flight dynamics, guidance and navigation, stability and control of spacecraft. Rocket propulsion concepts, including chemical rockets (liquid, gas and solid propellants), hybrid rocket engines and modern advances in satellite power systems will be discussed. Current design practices in space systems engineering will be emphasized.

Recommended: (ME 373 or ME 373H) and (ME 317 or ME 317H)

Energy Systems Engineering (ESE)

ESE 330, MODELING AND ANALYSIS OF DYNAMIC SYSTEMS, 4 Credits

Presents basic concepts of dynamic behavior, and the analytical and computational techniques for predicting and assessing dynamic behavior. Modeling a basic system, compound system, dynamic stability, and natural behavior to continuing and abrupt inputs are presented.

Prerequisite: ENGR 202 with C or better and ENGR 212 [C] and MTH 256 [C] and MTH 306 [C]

ESE 355, ENERGY REGULATION, 4 Credits

Introductory course to the policies and laws governing energy generation and transmission in the United States with a focus on electricity. History of regulations give context to understand current regulation and potential future policies. Laws regulating the use of alternative energy resources covered in a practical setting. Offered at OSU-Cascades only.

Prerequisite: BA 360 (may be taken concurrently) with C or better or ENGR 390 (may be taken concurrently) with C or better

ESE 360, ENERGY CONSUMPTION ANALYSIS, 4 Credits

Analysis of energy use in transportation, residential and industrial sectors to understand how new technologies improve energy efficiency. Tradeoff techniques applied to decide between less efficient, less expensive systems versus more efficient, more expensive systems. International energy consumption compared, and energy losses evaluated for heating, cooling and electronic systems. Offered at OSU-Cascades only.

Prerequisite: (BA 360 (may be taken concurrently) with C or better or ENGR 390 (may be taken concurrently) with C or better) and ME 311 [C]

ESE 401, RESEARCH, 1-16 Credits

Equivalent to: ESC 401

This course is repeatable for 4 credits.

ESE 430, FEEDBACK CONTROL SYSTEMS, 4 Credits

Modeling and analysis of linear, continuous-time systems in the time and frequency domains. Fundamentals of single-input-single-output control system design using both time-domain and frequency-domain techniques.

Prerequisite: ESE 330 with C or better

ESE 450, ENERGY GENERATION SYSTEMS, 4 Credits

Survey of technical fundamentals and operational principles of conventional and renewable energy conversion systems to understand the environmental and sustainable issues for energy systems currently in use or may be used in the future to power our industrial society. Offered at OSU-Cascades only.

Prerequisite: ME 312 with C or better

ESE 470, ENERGY DISTRIBUTION SYSTEMS, 4 Credits

Detailed coverage of the electrical energy distribution system, its operation, control and design. Design considerations and impacts to meet emerging and evolving customer needs. Broader understanding of natural gas and oil pipeline distribution for these infrastructure commodities. Offered at OSU-Cascades only.

Prerequisite: ENGR 202 with C or better and ME 311 [C]

ESE 471, ENERGY STORAGE SYSTEMS, 4 Credits

Coverage of energy storage techniques involving electrochemical, mechanical and emerging options. Integration of the energy storage media, its effects on the bulk power system, and design tradeoffs to understand environmental impacts, cost, reliabilities, and efficiencies for commercialization of bulk energy storage. Offered at OSU-Cascades only.

Prerequisite: ENGR 202 with C or better and ME 312 [C]

ESE 497, ^MIME CAPSTONE DESIGN, 4 Credits

Product design; selection and replacement of major tools, processes, and equipment; paperwork controls; subsystem revision; system or plant revision; selection and training of personnel; long-run policies and strategy. CROSSLISTED as ESC 497/ESE 497. (Writing Intensive Course)

Attributes: CWIC – Core, Skills, WIC

Prerequisite: (ENGR 390 with C or better or BA 360 with C or better) and IE 425 [C] and (ME 312 [C] or ME 312H [C]) and (ME 331 [C] or ME 331H [C]) and ESE 355 [C] and ESE 360 [C] and (ST 314 [C] or ST 314H [C]) and WR 327 [C]

Equivalent to: IE 497, ME 497, MIME 497

ESE 498, ^MIME CAPSTONE DESIGN, 4 Credits

Product design; selection and replacement of major tools, processes, and equipment; paperwork controls; subsystem revision; system or plant revision; selection and training of personnel; long-run policies and strategy. (Writing Intensive Course)

Attributes: CWIC – Core, Skills, WIC

Prerequisite: ESE 497 with C or better or IE 497 with C or better or ME 497 with C or better or MIME 497 with C or better

Equivalent to: ESC 498, IE 498, ME 498

ESE 499, SPECIAL TOPICS, 0-16 Credits

This course is repeatable for 16 credits.

Industrial and Manufacturing Engineering (IE) IE 112, SPREADSHEET SKILLS FOR INDUSTRIAL & MANUFACTURING ENGINEERS, 1 Credit

Basic spreadsheet functionality needed to create spreadsheet applications for common industrial and manufacturing engineering information processing tasks, including simple databases, statistical analysis, quality control, forecasting, production planning and control, and operations analysis and improvement. Topics include creating spreadsheets, formatting, data types, formulas, charts, user-defined functions, and pivot tables.

IE 199, SPECIAL TOPICS, 1-16 Credits

Special topics in industrial engineering.

This course is repeatable for 16 credits.

IE 212, COMPUTATIONAL METHODS FOR INDUSTRIAL ENGINEERING, 4 Credits

Engineering problem solving using computational methods. Data structures. Modular programming. Sorting and search algorithms. Algorithms for inventory models, production scheduling, production line analysis, and optimization.

Prerequisite: ENGR 112 with C or better and IE 112 (may be taken concurrently) [C]

Recommended: Algebra, calculus, differentiation and integration

IE 255, INTRODUCTORY QUANTITATIVE ANALYSIS OF INDUSTRIAL AND MANUFACTURING SYSTEMS, 3 Credits

An introduction to basic analysis concepts that will be utilized in subsequent industrial and manufacturing engineering courses. Emphasis will be placed on fundamental concepts such as data collection, commonly applied quantitative analysis methods, and how these are utilized to support decisions in different industrial and manufacturing system applications. Examples include resource utilization calculations, equipment fraction equations, queuing models, basic statistical inference procedures, and probability models used in discrete event simulation.

Prerequisite: MTH 252 with C or better

IE 285, INTRODUCTION TO INDUSTRIAL AND MANUFACTURING ENGINEERING, 3 Credits

Introduction to selected topics in industrial and manufacturing engineering, including history and philosophy, product design and manufacturing cycle, integrate role of engineering and business, and multi-objective nature of organizations. Surveys of selected design problems in resource allocation, operations and quality management, and production engineering. CROSSLISTED as IE 285/MFGE 285.

Prerequisite: IE 112 (may be taken concurrently) with C or better or FOR 112 (may be taken concurrently) with C or better

Equivalent to: MFGE 285

IE 299, SPECIAL TOPICS, 1-16 Credits

Special topics in industrial engineering.

This course is repeatable for 16 credits.

IE 355, STATISTICAL QUALITY CONTROL, 4 Credits

Control of quality through the use of statistical analysis; typical control techniques and underlying theory. Development of reliability models and procedures for product assurance. Lec/lab.

Prerequisite: IE 255 with C or better or ST 314 with C or better

Equivalent to: IE 351

IE 356, EXPERIMENTAL DESIGN FOR INDUSTRIAL PROCESSES, 4 Credits

Systematic analysis of processes through the use of statistical analysis, methods, and procedures. Application of statistical techniques including use of classic process analysis techniques, regression and design of experiments. Lec/rec.

Prerequisite: IE 255 with C or better or ST 314 with C or better

Equivalent to: IE 352

IE 366, WORK SYSTEMS ENGINEERING, 4 Credits

Principles and techniques of work measurement, methods engineering, workplace design, work sampling, and predetermined time systems. Basic human factors engineering and ergonomics principles applied to workplace design. The work systems engineering process. Lec/lab/rec.

Prerequisite: (IE 255 with C or better or ST 314 with C or better) and PH 212 [C] and PH 213 [C]

Equivalent to: IE 341

IE 367, PRODUCTION PLANNING AND CONTROL, 4 Credits

Forecasting techniques, inventory analysis, master production scheduling, material and capacity requirements, planning and scheduling methods.

Prerequisite: IE 255 with C or better or ST 314 with C or better

Equivalent to: IE 362

IE 368, FACILITY DESIGN AND OPERATIONS MANAGEMENT, 4 Credits

Design and analysis of industrial facilities including just-in-time systems, queuing, material handling systems, material flow analysis, line balancing, systematic layout planning, design of warehouse facilities, and facilities location.

Prerequisite: ENGR 248 with C or better and (IE 255 [C] or ST 314 [C])

Equivalent to: IE 365

IE 380, *THE RESPONSIBLE ENGINEER, 3 Credits

The idea of responsibility and the ethical responsibilities of the engineer. Introduction to value, ethics, and ethical systems. Engineering as value creation and the ethical ramifications of engineering. Codes of engineering ethics. Recognizing and addressing ethical dilemmas in engineering. Examination of the individual, social, and environmental effects of engineering and technology. (Baccalaureate Core Course)

Attributes: CSST – Core, Synthesis, Science/Technology/Society

IE 399, SPECIAL TOPICS, 1-16 Credits

Special topics in industrial engineering.

This course is repeatable for 16 credits.

IE 403, THESIS, 1-16 Credits

This course is repeatable for 16 credits.

IE 405, READING AND CONFERENCE, 1-16 Credits

This course is repeatable for 16 credits.

IE 406, PROJECTS, 1-16 Credits

This course is repeatable for 16 credits.

IE 407, SEMINAR, 1-16 Credits

This course is repeatable for 16 credits.

IE 410, INTERNSHIP, 1-16 Credits

This course is repeatable for 16 credits.

IE 411, VISUAL PROGRAMMING FOR INDUSTRIAL APPLICATIONS, 4 Credits

Object-oriented modeling, Unified Modeling Language, software development concepts, file and database connectivity, and visual programming skills (Microsoft Visual Basic) for use in developing industrial applications, such as process monitoring and supply chain management.

Prerequisite: IE 212 with C or better

Equivalent to: IE 414

IE 412, INFORMATION SYSTEMS ENGINEERING, 4 Credits

Framework for enterprise information systems. Engineering and scientific systems. Requirements definition, enhanced entity relationship modeling, logical modeling, structured query language, relational model, referential integrity. Lec/lab.

Prerequisite: IE 212 with C or better

IE 415, SIMULATION AND DECISION SUPPORT SYSTEMS, 4 Credits

Analysis of operations and production systems through the application of computer simulation modeling techniques. Fundamentals of computer simulation including random number generation, input/output data analysis, model validation and verification. Lec/lab.

Prerequisite: IE 112 with C or better and (IE 255 [C] or ST 314 [C])

IE 418, TELECOMMUNICATION CONCEPTS, 3 Credits

Telecommunication concepts for industrial applications. OSI reference model, local area networks, wide area networks, internet architecture.

Taught fall in even years.

Prerequisite: IE 212 with C or better

Recommended: Previous programming experience

IE 419, WIRELESS NETWORKS, 3 Credits

RF fundamentals, ISO 802.11 standards, spread spectrum technology, narrow band technology, direct sequence and frequency hopping transmission schemes, electromagnetic interference, design of indoor wireless networks.

Prerequisite: IE 418 with C or better

IE 425, INDUSTRIAL SYSTEMS OPTIMIZATION, 4 Credits

A first course in operations research. Topics include mathematical programming formulations and solutions, the simplex method, network optimization, introduction to metaheuristics, and linear programming under uncertainty.

Prerequisite: (IE 255 with C or better or ST 314 with C or better) and (MTH 306 [C] or MTH 341 [C])

Equivalent to: IE 421, IE 422

IE 426, STOCHASTIC MODELS OF INDUSTRIAL SYSTEMS, 4 Credits

The application of probabilistic and stochastic modeling methodologies to analyze the performance of production and service systems. Major topics include probability models for space planning, Poisson arrival processes, discrete and continuous time Markov chain models of machine cycle times, and queuing models applied to various industrial systems. Other applications of these tools to model inventories, process behavior, and equipment reliability is illustrated.

Prerequisite: (IE 255 with C or better or ST 314 with C or better) and IE 425 [C]

IE 470, MANAGEMENT SYSTEMS ENGINEERING, 4 Credits

Improvement of organizational performance through the design and implementation of systems that integrate personnel, technological, environmental, and organizational variables. Topics include performance assessment and measurement as well as improvement methodologies.

Prerequisite: ENGR 390 with C or better and IE 355 [C] and IE 366 [C] and IE 367 [C] and IE 368 [C]

Equivalent to: IE 474

IE 471, PROJECT MANAGEMENT IN ENGINEERING, 3 Credits

Critical issues in the management of engineering and high-technology projects are discussed. Time, cost, and performance parameters are analyzed from the organizational, people, and resource perspectives. Network optimization and simulation concepts are introduced. Resource-constrained project scheduling case discussions and a term project are included.

Prerequisite: ENGR 390 with C or better and IE 355 [C] and IE 366 [C] and IE 367 [C] and IE 368 [C]

IE 475, ADVANCED MANUFACTURING COSTING TECHNIQUES, 3 Credits

Costing techniques applicable in advanced manufacturing enterprises: activity-based costing, economic value added, Japanese cost management techniques, life cycle costing, throughput accounting, cost of quality, and financial versus operational performance measures. Emphasis on linkages to such advanced manufacturing systems as cellular manufacturing, flexible manufacturing, JIT, Lean, and ERP.

Prerequisite: ENGR 390 with C or better and IE 355 [C] and IE 366 [C] and IE 367 [C] and IE 368 [C]

Equivalent to: IE 495

IE 499, SPECIAL TOPICS, 1-5 Credits

Recent advances in industrial engineering pertaining to the theory and application of system studies. Analysis and design of natural resource systems; evaluation; detection extraction; processing and marketing systems; advanced design of production systems with reference to social, economic, and regional planning; human engineering studies of man-machine systems; applications of operations research techniques. Nonsequence course. Not offered every term.

This course is repeatable for 99 credits.

IE 503, THESIS, 1-16 Credits

This course is repeatable for 999 credits.

IE 505, READING AND CONFERENCE, 1-16 Credits

This course is repeatable for 16 credits.

IE 506, PROJECTS, 1-16 Credits

Graded P/N.

This course is repeatable for 16 credits.

IE 507, SEMINAR, 1-16 Credits

This course is repeatable for 16 credits.

IE 511, VISUAL PROGRAMMING FOR INDUSTRIAL APPLICATIONS, 4 Credits

Object-oriented modeling, Unified Modeling Language, software development concepts, file and database connectivity, and visual programming skills (Microsoft Visual Basic) for use in developing industrial applications, such as process monitoring and supply chain management.

Equivalent to: IE 514

Recommended: IE 212

IE 512, INFORMATION SYSTEMS ENGINEERING, 4 Credits

Framework for enterprise information systems. Engineering and scientific systems. Requirements definition, enhanced entity relationship modeling, logical modeling, structured query language, relational model, referential integrity. Lec/lab.

IE 515, SIMULATION AND DECISION SUPPORT SYSTEMS, 4 Credits

Analysis of operations and production systems through the application of computer simulation modeling techniques. Fundamentals of computer simulation including random number generation, input/output data analysis, model validation and verification. Lec/lab.

Recommended: ST 314

IE 518, TELECOMMUNICATION CONCEPTS, 3 Credits

Telecommunication concepts for industrial applications. OSI reference model, local area networks, wide area networks, internet architecture. Taught fall in even years.

Recommended: IE 212 and previous programming experience.

IE 519, WIRELESS NETWORKS, 3 Credits

RF fundamentals, ISO 802.11 standards, spread spectrum technology, narrow band technology, direct sequence and frequency hopping transmission schemes, electromagnetic interference, design of indoor wireless networks.

Prerequisite: IE 518 with C or better

IE 521, INDUSTRIAL SYSTEMS OPTIMIZATION I, 3 Credits

Techniques for analysis and solution of problems in industrial and management systems. Emphasis on application of linear and integer programming and extensions.

Equivalent to: IE 525

Recommended: MTH 341

IE 522, INDUSTRIAL SYSTEMS OPTIMIZATION II, 3 Credits

Techniques for analysis and solution of problems in industrial and management systems. Emphasis on applications of dynamic programming. Markovian processes, and questions as applied to industrial problems.

Recommended: ST 314

IE 523, INTEGER PROGRAMMING, 3 Credits

Classic models and algorithms for discrete optimization. Includes intuition and theory about computational strategies for solution of integer programming and combinatorial optimization problems.

Prerequisite: IE 521 with C or better

IE 533, HUMAN ANALYTICS AND BEHAVIORAL OPERATIONS, 3 Credits

Introduces several quantitative applications related to determining workforce size, skill-sets, and multi-functionality in service and manufacturing systems based on measurable quality and productivity performance, at the intersection of human factors engineering and production planning. Modeling and solving problems in a context of the speed and accuracy trade-off. Models include learning, forgetting, teamwork, fatigue, procrastination, and individual difference measures.

Recommended: Introductory math programming

IE 542, DESIGN OF HUMAN FACTORS / ERGONOMICS EXPERIMENTS, 4 Credits

Designed to provide graduate students with introductions to a broad range of methods appropriate for studying humans, tasks, environments and their interaction along with various topics in the area of Human Factors/Ergonomics. Reading/discussion format.

Recommended: Graduate level statistics course

IE 545, HUMAN FACTORS ENGINEERING, 4 Credits

Analysis and design of work systems considering human characteristics, capabilities and limitations. Analysis and design of displays, controls, tools, and workstations. Human performance analysis. Human factors research methods.

Equivalent to: IE 541

IE 546, HUMAN-MACHINE SYSTEMS ENGINEERING, 3 Credits

Development of safe, high performance human-machine systems. System/function/task analysis, function allocation, design, mockups and rapid prototyping, human factors test and evaluation. Critical examination of the human-factors and domain-specific literature to identify human factors problems, and knowledge and methods to address those problems.

Equivalent to: IE 542

Recommended: IE 545

IE 548, COGNITIVE ENGINEERING, 3 Credits

Theories and models of human sensory, cognitive, and motor performance pertaining to the operation of complex systems. Applications to human-machine systems engineering. Research topics and methods related to cognitive engineering.

Recommended: IE 545

IE 552, DESIGN OF INDUSTRIAL EXPERIMENTS, 3 Credits

A first course in design of experiments with an emphasis on applications and fundamental data analysis methods. Basic statistical inference, analysis of variance, blocking, general factorial designs, and two-level factorial designs are covered.

Recommended: ST 314

IE 553, DESIGN OF INDUSTRIAL EXPERIMENTS II, 3 Credits

This second course in design of experiments is a continuation of IE 552. The same textbook is used. Topics covered include two-level fractional factorial designs, regression models, response surface methods, rules for expected sum of squares and expected mean squares, a summary of the 'no-name' approach to DOE, and analysis of experiments with unbalanced data (time permitting).

Prerequisite: IE 552 with C or better

IE 563, ADVANCED PRODUCTION PLANNING AND CONTROL, 3 Credits

Application of quantitative and heuristic methods to problems of production, material, and capacity planning. Mathematical models for inventory systems, sequencing, and scheduling. Assembly line balancing methods. Just-in-time manufacturing.

Recommended: IE 521 and ST 314

IE 564, DESIGN AND SCHEDULING OF CELLULAR MANUFACTURING SYSTEMS, 3 Credits

Designing manufacturing cells. Impact of alternate process plan on cell design. Part-machine assignment to cells. Disaggregated manufacturing cells. Group scheduling.

Recommended: Computer experience

IE 570, MANAGEMENT SYSTEMS ENGINEERING, 4 Credits

Improvement of organizational performance through the design and implementation of systems that integrate personnel, technological, environmental, and organizational variables. Topics include performance assessment and measurement as well as improvement methodologies.

Equivalent to: IE 574

IE 571, PROJECT MANAGEMENT IN ENGINEERING, 3 Credits

Critical issues in the management of engineering and high-technology projects are discussed. Time, cost, and performance parameters are analyzed from the organizational, people, and resource perspectives. Network optimization and simulation concepts are introduced. Resource-constrained project scheduling case discussions and a term project are included.

Available via Ecampus

IE 575, SYSTEMS THINKING THEORY AND PRACTICE, 4 Credits

An introduction to systems science theory and practice. Systems science theory is explored through the fundamentals of systems thinking theory, and theory of knowledge. Systems science practice is explored through system dynamics modeling techniques for simulating socio-technical systems, structures, and processes.

IE 581, OPERATIONS MANAGEMENT, 4 Credits

Critical and current issues on the implementation of operations management strategies for the engineering manager. Includes aspects of operations in an engineering management environment such as work systems design, forecasting, strategy, facilities location and design, management of quality and resources planning and management.

Prerequisite: IE 582 with B or better

Recommended: IE 571

Available via Ecampus

IE 582, INTRODUCTION TO MANAGEMENT FOR ENGINEERS AND SCIENTISTS, 4 Credits

An introduction to concepts, tools, and practices necessary for a broad understanding of the roles of engineering and technical managers. A mix of research results, case studies, and experiential learning is used to bolster theories of management, with focus on technical organizations.

Available via Ecampus

IE 583, ADVANCED ENGINEERING ECONOMICS ANALYSIS, 4 Credits

Examines the economics dimension of engineering management, from costing techniques to financial analysis. Topics include industrial cost analysis and estimation, economic planning, forecasting, and budgeting, and financial analysis for engineering and engineering management.

Prerequisite: IE 582 with B or better

Recommended: Basic courses in engineering economic analysis (ENGR 390)

Available via Ecampus

IE 584, SYSTEMS ENGINEERING, 4 Credits

An overview of systems engineering within engineering management practice. Principles of systems engineering are explored through traditional and contemporary hard and soft systems of engineering techniques and practices, and through current future developments in the field.

Prerequisite: IE 582 with B- or better

Recommended: IE 581 and IE 583 and IE 586 and IE 587

Available via Ecampus

IE 585, LEGAL ASPECT OF ENGINEERING MANAGEMENT, 3 Credits

A survey of legal topics relevant to engineers, including basic of legal system, labor law, intellectual property, torts, and contracts. This is an introductory course, emphasizes on legal principles that can provide engineers with the ability to recognize legal issues that are likely to arise in the engineering profession and engineering management. Note: This is an introductory class and will in no way make a student a lawyer. Students are advised to seek legal representation if he/she encounters a legal issue.

Prerequisite: IE 582 with B or better

Recommended: IE 581 and IE 583 and (IE 586 or CCE 552)

Available via Ecampus

IE 586, PROJECT RISK MANAGEMENT, 4 Credits

An introduction to the concept of project risk in producing constructed engineering projects. Course content includes project baselining, risk definition and identification, risk assessment and management techniques, risk control, risk response, and risk management.

CROSSLISTED as CCE 552/IE 586.

Equivalent to: CCE 552

Available via Ecampus

IE 587, MANAGEMENT OF INFORMATION SYSTEMS, 4 Credits

An introduction to the management of information systems and their strategic importance in business. Topics covered include global e-business and collaboration, databases and information management, basics of telecommunications and wireless technology, security vulnerabilities of information systems, basics of business intelligence and business analytics, knowledge management and enhanced decision making.

Prerequisite: IE 582 with B or better

Available via Ecampus

IE 588, MANAGEMENT OF NEW PRODUCT DEVELOPMENT, 4 Credits

Introduces the new product development (NPD) process with the objective of understanding the underlying structure in NPD and exploring the methods to manage NPD processes by applying them to case studies and term project. The NPD process is investigated through its five key phases: (1) Opportunity identification/selection, (2) Concept generation, (3) Concept/project evaluation, (4) Development, and (5) Launch.

Prerequisite: IE 581 with B or better and IE 582 [B] and IE 583 [B]

Recommended: IE 584

Available via Ecampus

IE 589, PROFESSIONAL RESPONSIBILITY AND ETHICS, 3 Credits

An in-depth exploration of professional engineering ethics. Course content includes conceptual theoretical basis of ethics, ethics among professional organizations, ethical consideration of design, critical analysis of ethical situations, ethics in the workplace, and ethical considerations regarding the broader environment. CROSSLISTED as CCE 554/IE 589.

Equivalent to: CCE 554

Available via Ecampus

IE 590, STRATEGIC PLANNING IN ENGINEERING ORGANIZATIONS, 4 Credits

Provides an overview the strategic planning process from a variety engineering perspective. Variety engineering is explored via key management control theory concepts and through applying students' work experience.

Prerequisite: IE 581 with B or better and IE 582 [B] and IE 583 [B]
Available via Ecampus

IE 591, STATISTICAL CONCEPTS FOR ENGINEERING MANAGERS, 4 Credits

Provides a first review of basic probability and statistical inference concepts and methods relevant for engineering managers. This is followed by a presentation of frequently utilized statistical methods in industry. These include process control, regression analysis, and experimental design. For each method, the fundamental ideas will be covered, and simple examples will be presented to provide engineering managers with the background needed to initiate and manage applications of these methods in industry. The course will end with an overview of process optimization, and robust parameter design.

Prerequisite: IE 582 with B or better
Available via Ecampus

IE 594, RESEARCH METHODS IN ENGINEERING, 3 Credits

Introduction to research methodologies including surveys, interviews, quasi-experimentation, and case studies. Methods for research design, and collection and analysis of data.

Equivalent to: IE 574

IE 599, SPECIAL TOPICS, 1-5 Credits

Recent advances in industrial engineering pertaining to the theory and application of system studies. Analysis and design of natural resource systems; evaluation; detection extraction; processing and marketing systems; advanced design of production systems with reference to social, economic, and regional planning; human engineering studies of man-machine systems; applications of operations research techniques. Nonsequence course. Not offered every term.

Equivalent to: IE 592

This course is repeatable for 99 credits.
Available via Ecampus

IE 603, THESIS, 1-16 Credits

This course is repeatable for 999 credits.

IE 605, READING AND CONFERENCE, 1-16 Credits

This course is repeatable for 16 credits.

IE 606, PROJECTS, 1-16 Credits

This course is repeatable for 16 credits.

IE 607, SEMINAR, 1-16 Credits

This course is repeatable for 16 credits.

Materials Science (MATS)

MATS 221, THE SCIENCE, ENGINEERING AND SOCIAL IMPACT OF NANOTECHNOLOGY, 3 Credits

Nanotechnology is an emerging engineering field that manipulates atoms and molecules to fabricate new materials and tiny devices. Properties of nanostructured materials, manufacturing methods, characterization methods, and impact on health and safety. Benefits and concerns about nanotechnology will be assessed. Lec/rec. CROSSLISTED as ENG 221/ MATS 221.

Equivalent to: ENGR 221

Recommended: One year of college science.

MATS 321, INTRODUCTION TO MATERIALS SCIENCE, 4 Credits

Crystal structure, microstructure, and physical properties of metals, ceramics, polymers, composites, and amorphous materials. Also includes elementary mechanical behavior and phase equilibria.

Prerequisite: CH 202 with C or better or CH 222 with C or better or CH 232 with C or better or CH 232H with C or better or CH 224H with C or better

Equivalent to: ENGR 321, ENGR 321H, MATS 321H

Available via Ecampus

MATS 321H, INTRODUCTION TO MATERIALS SCIENCE, 4 Credits

Crystal structure, microstructure, and physical properties of metals, ceramics, polymers, composites, and amorphous materials. Also includes elementary mechanical behavior and phase equilibria.

Attributes: HNRS – Honors Course Designator

Prerequisite: CH 202 with C or better or CH 222 with C or better or CH 232 with C or better or CH 232H with C or better or CH 224H with C or better

Equivalent to: ENGR 321, ENGR 321H, MATS 321

MATS 322, MECHANICAL PROPERTIES OF MATERIALS, 3 Credits

Mechanical behavior of materials, relating laboratory test results to material structure, and elements of mechanical analysis.

Prerequisite: (ENGR 213 with C or better or ENGR 213H with C or better) and (ENGR 321 [C] or ENGR 321H [C] or MATS 321 [C])

Equivalent to: ENGR 322

MATS 413, THERMODYNAMICS AND PHASE EQUILIBRIA OF MATERIALS, 4 Credits

Explores the statistical interpretation of entropy, heat capacity, enthalpy of condensed phases, solution thermodynamics, liquid-solid and solid-solid phase equilibria. Considers the principles of thermodynamics governing phase stability with a focus on liquid-solid and solid-solid equilibria, and phase stability in two-component systems. Examines the relationship of Gibbs free energy to phase stability.

Prerequisite: MATS 321 with C or better and (ME 311 [C] or NSE 311 [C] or CHE 311 [C])

MATS 441, PHYSICAL METALLURGY, 3 Credits

Introduction to properties of metals and alloys including solidification, diffusion, solid solutions, intermediate phases, annealing, heat treatment and phase transformation with a focus on ferrous and non-ferrous metal systems. Identifies relationships between material composition, structure, and properties resulting from synthesis, processing or service. Explores the knowledge of ferrous and non-ferrous alloy systems and their significant metallurgical properties and applications.

Prerequisite: MATS 321 with C or better

MATS 445, WELDING METALLURGY, 4 Credits

Theory-based course focused on the metallurgy of welds. Topics covered include welding/joining processes, heat input, diffusion, solidification, phase transformation, materials compatibility and welding defects. This is NOT a practical welding class.

Prerequisite: (MATS 321 with C or better or ENGR 321 with C or better or ENGR 321H with C or better) or MATS 570 with C or better

MATS 455, EXPERIMENTAL TECHNIQUES IN MATERIAL SCIENCE, 4 Credits

Materials processing, characterization, computational and data analysis techniques in materials science. Focus on processing-structure-property relationships. Lec/lab.

Prerequisite: (ENGR 321 with C or better or ENGR 321H with C or better)

Equivalent to: ME 455

This course is repeatable for 8 credits.

Recommended: ME 570

MATS 478, THIN FILM MATERIALS CHARACTERIZATION AND PROPERTIES, 4 Credits

Processing of thin films and characterization of the microstructure; diffusion and solid state reactions; mechanical, magnetic and electronic properties of thin films.

Prerequisite: (ME 311 with C or better or ME 311H with C or better) and (ENGR 321 [C] or ENGR 321H [C] or MATS 321 [C]) and (ENGR 322 [C] or MATS 322 [C])

Equivalent to: ME 478

MATS 499, SPECIAL TOPICS, 1-16 Credits

This course is repeatable for 16 credits.

MATS 545, WELDING METALLURGY, 4 Credits

Theory-based course focused on the metallurgy of welds. Topics covered include welding/joining processes, heat input, diffusion, solidification, phase transformation, materials compatibility and welding defects. This is NOT a practical welding class.

Recommended: (MATS 321 or ENGR 321 or ENGR 321H) or MATS 570

MATS 555, EXPERIMENTAL TECHNIQUES IN MATERIAL SCIENCE, 4 Credits

Materials processing, characterization, computational and data analysis techniques in materials science. Focus on processing-structure-property relationships.

Prerequisite: MATS 570 with C or better

Equivalent to: ME 555

This course is repeatable for 8 credits.

Recommended: ENGR 321 or ENGR 321H

MATS 570, STRUCTURE-PROPERTY RELATIONS IN MATERIALS, 4 Credits

Fundamentals of the interactions between the structure and properties of materials. Atomic bonding and atom interactions. Geometric and algebraic representations of symmetry. Introduction to phase equilibria. Phenomenological background of elasticity and plasticity in materials. Anisotropic materials and tensor representations. Influence of structure on thermal, electrical, and optical properties of materials.

Equivalent to: ME 570

MATS 571, ELECTRONIC PROPERTIES OF MATERIALS, 4 Credits

Development of a quantitative description of the electronic structure of solids starting with the quantum mechanical model of the atom, atomic bonding, and band theory of solids. Quantitative description of the electronic properties of metals, semiconductors, and insulators.

Equivalent to: ME 571

Recommended: CH 545 or ME 570

MATS 578, THIN FILM MATERIALS CHARACTERIZATION AND PROPERTIES, 4 Credits

Processing of thin films and characterization of the microstructure; diffusion and solid state reactions; mechanical, magnetic and electronic properties of thin films.

Equivalent to: ME 578

MATS 581, THERMODYNAMICS OF SOLIDS, 4 Credits

Thermodynamics of solutions and phase equilibrium. Phase diagrams and invariant reactions. Order and disorder in solutions. Applications to advanced materials development. Lec/lab.

Equivalent to: ME 581

MATS 582, RATE PROCESSES IN MATERIALS, 3 Credits

Diffusion in solids, including vacancy and interstitial and short-circuit diffusion. Phase transformations including classic nucleation and growth theory. Applications to materials development.

Prerequisite: MATS 581 with C or better or ME 581 with C or better

Equivalent to: ME 582

MATS 584, ADVANCED FRACTURE OF MATERIALS, 4 Credits

Fracture mechanics will be used as a basis for predicting failure of materials, understanding failure mechanisms, and identifying causes of failure. Course will include discussion of recent journal articles, experimental demonstrations, and analysis of real fracture data.

Equivalent to: ME 584

Recommended: ENGR 322

MATS 587, DISLOCATIONS, DEFORMATION, AND CREEP, 4 Credits

The effects of point, line, and planar defects on plastic deformation and creep behavior in solids will be discussed with emphasis on the role of dislocations and vacancies.

Equivalent to: ME 587

Recommended: ENGR 322

MATS 588, COMPUTATIONAL METHODS IN MATERIALS SCIENCE, 4 Credits

A broad introduction to important materials science simulation methods. These include molecular dynamics, density functional theory, and Monte Carlo methods. Learning is through a mixture of lecture and hands-on lab projects in which students use computational methods to explore and reinforce fundamental concepts in materials science. Lec/lab.

Equivalent to: ME 588

Recommended: Experience with Matlab or Mathematica or an equivalent numerical and programming environment.

MATS 599, SPECIAL TOPICS, 1-16 Credits

This course is repeatable for 16 credits.

MATS 659, PRINCIPLES OF TRANSMISSION ELECTRON MICROSCOPY, 4 Credits

This lecture-only course covers basic principles of transmission electron microscopy (TEM) including instrument components, electron optics, electron diffraction, and the origins and interpretation of image contrast. Spectroscopic techniques are covered, but diffraction and imaging techniques are emphasized. Coverage of experimental techniques will focus on those useful for addressing problems in materials science.

Recommended: MATS 570 and (CH 616 or MATS 555)

MATS 671, ELECTRONIC PROPERTIES OF OXIDES, 3 Credits

Emphasizes band theory of solids applied to metal oxide materials. Reviews metallic oxides, non-stoichiometric semiconductors and associated defect chemistry, electrostatics, linear dielectrics, non-linear dielectrics, electromechanical phenomena including piezoelectricity, and the optical properties of oxides.

Equivalent to: ME 671

Recommended: MATS 571 or PH 575

Mechanical Engineering (ME)

ME 206, PROJECTS, 1-16 Credits

This course is repeatable for 16 credits.

ME 250, INTRODUCTION TO MANUFACTURING PROCESSES, 1 Credit

Use of measuring and layout tools, interpretation of blueprints and drawings, identification of engineering materials. Operation of machine tools, including calculation of machining parameters. Operation of gas and MIG welding equipment. Lec/lab. Graded P/N.

Prerequisite: ENGR 248 with C or better and (PH 211 [C] or PH 211H [C])

ME 299, SPECIAL TOPICS, 1-16 Credits

Graded P/N.

Equivalent to: ME 299H

This course is repeatable for 16 credits.

ME 299H, SPECIAL STUDIES, 1-16 Credits

Graded P/N.

Attributes: HNRS – Honors Course Designator

Equivalent to: ME 299

This course is repeatable for 16 credits.

ME 306, PROJECTS, 1-16 Credits

This course is repeatable for 16 credits.

ME 311, INTRODUCTION TO THERMAL-FLUID SCIENCES, 4 Credits

Basic concepts of fluid mechanics, thermodynamics and heat transfer are introduced. Conservation of mass, energy, moment and the second law of thermodynamics are included. CROSSLISTED as ME 311/NSE 311.

Prerequisite: (ENGR 212 with C or better or ENGR 212H with C or better) and (MTH 256 [C] or MTH 256H [C])

Equivalent to: ENGR 311, ENGR 311H, ME 311H, NE 311, NE 311H, NSE 311, NSE 311H

ME 311H, INTRODUCTION TO THERMAL-FLUID SCIENCES, 4 Credits

Basic concepts of fluid mechanics, thermodynamics and heat transfer are introduced. Conservation of mass, energy, moment and the second law of thermodynamics are included. CROSSLISTED as ME 311/NSE 311.

Attributes: HNRS – Honors Course Designator

Prerequisite: (ENGR 212 with C or better or ENGR 212H with C or better) and (MTH 256 [C] or MTH 256H [C])

Equivalent to: ENGR 311, ENGR 311H, ME 311, NE 311, NE 311H, NSE 311, NSE 311H

ME 312, THERMODYNAMICS, 4 Credits

Analyzes exergy destruction, machine and cycle processes, law of corresponding states, non-reactive gas mixtures, reactive mixtures, thermodynamics of compressible fluid flow. CROSSLISTED as ME 312/NSE 312.

Prerequisite: ME 311 with C or better or ME 311H with C or better or NSE 311 with C or better or NSE 311H with C or better or NE 311 with C or better or NE 311H with C or better

Equivalent to: ENGR 312, ME 312H, NE 312, NE 312H, NSE 312, NSE 312H

ME 312H, THERMODYNAMICS, 4 Credits

Analyzes exergy destruction, machine and cycle processes, law of corresponding states, non-reactive gas mixtures, reactive mixtures, thermodynamics of compressible fluid flow. CROSSLISTED as ME 312/NSE 312.

Attributes: HNRS – Honors Course Designator

Prerequisite: ME 311 with C or better or ME 311H with C or better or NSE 311 with C or better or NSE 311H with C or better or NE 311 with C or better or NE 311H with C or better

Equivalent to: ENGR 312, ME 312, NE 312, NE 312H, NSE 312, NSE 312H

ME 316, MECHANICS OF MATERIALS, 3 Credits

Determination of stresses, deflections, and stability of deformable bodies with an introduction to finite element analysis.

Prerequisite: (ENGR 213 with C or better or ENGR 213H with C or better) and (MTH 256 [C] or MTH 256H [C])

ME 317, INTERMEDIATE DYNAMICS, 4 Credits

Continues the study of kinematics and kinetics of particles and rigid bodies, with applications to mechanical systems of current interest to engineers.

Prerequisite: (ENGR 212 with C or better or ENGR 212H with C or better) and (MTH 256 [C] or MTH 256H [C]) and (ENGR 112 [C] or CS 161 [C] or CBEE 102 [C] or CBEE 102H [C] or NSE 115 [C])

Equivalent to: ME 317H

ME 317H, INTERMEDIATE DYNAMICS, 4 Credits

Continues the study of kinematics and kinetics of particles and rigid bodies, with applications to mechanical systems of current interest to engineers.

Attributes: HNRS – Honors Course Designator

Prerequisite: (ENGR 212 with C or better or ENGR 212H with C or better) and (MTH 256 [C] or MTH 256H [C]) and (ENGR 112 [C] or CS 161 [C] or CBEE 102 [C] or CBEE 102H [C] or NSE 115 [C])

Equivalent to: ME 317

ME 331, INTRODUCTORY FLUID MECHANICS, 4 Credits

Introduces the concepts and applications of fluid mechanics and dimensional analysis with an emphasis on fluid behavior, internal and external flows, analysis of engineering applications of incompressible pipe systems, and external aerodynamics. CROSSLISTED as ME 331/NSE 331.

Prerequisite: ENGR 311 with C or better or ENGR 311H with C or better or ME 311 with C or better or ME 311H with C or better or NSE 311 with C or better or NSE 311H with C or better or NE 311 with C or better or NE 311H with C or better

Equivalent to: ENGR 331, ENGR 331H, ME 331H, NE 331, NE 331H, NSE 331, NSE 331H

ME 331H, INTRODUCTORY FLUID MECHANICS, 4 Credits

Introduces the concepts and applications of fluid mechanics and dimensional analysis with an emphasis on fluid behavior, internal and external flows, analysis of engineering applications of incompressible pipe systems, and external aerodynamics. CROSSLISTED as ME 331/NSE 331.

Attributes: HNRS – Honors Course Designator

Prerequisite: ENGR 311 with C or better or ENGR 311H with C or better or ME 311 with C or better or ME 311H with C or better or NSE 311 with C or better or NSE 311H with C or better or NE 311 with C or better or NE 311H with C or better

Equivalent to: ENGR 331, ENGR 331H, ME 331, NE 331, NE 331H, NSE 331, NSE 331H

ME 332, HEAT TRANSFER, 4 Credits

Analyzes conductive, convective and radiative energy transfer using control volume and differential analysis and prediction of transport properties. CROSSLISTED as ME 332/NSE 332.

Prerequisite: ME 331 with C or better or ME 331H with C or better or NSE 331 with C or better or NSE 331H with C or better or NE 331 with C or better or NE 331H with C or better

Equivalent to: ME 332H, NE 332, NE 332H, NSE 332, NSE 332H

ME 332H, HEAT TRANSFER, 4 Credits

Analyzes conductive, convective and radiative energy transfer using control volume and differential analysis and prediction of transport properties. CROSSLISTED as ME 332/NSE 332.

Attributes: HNRS – Honors Course Designator

Prerequisite: ME 331 with C or better or ME 331H with C or better or NSE 331 with C or better or NSE 331H with C or better or NE 331 with C or better or NE 331H with C or better

Equivalent to: ME 332, NE 332, NE 332H, NSE 332, NSE 332H

ME 351, INTRODUCTION TO INSTRUMENTATION AND MEASUREMENT SYSTEMS, 4 Credits

Illustrates the function, operation, and application of common mechanical engineering instruments, measurement principles, and statistical analysis. Demonstrates elements of measurement systems, including transduction, signal conditioning, and data recording. Examines function and operation of digital data acquisition systems.

Prerequisite: (ENGR 202 with C or better or ENGR 202H with C or better) and (ENGR 212 [C] or ENGR 212H [C]) and (ENGR 213 [C] or ENGR 213H [C])

Equivalent to: ME 451

ME 373, MECHANICAL ENGINEERING METHODS, 4 Credits

Analytical and numerical methods for solving representative mechanical engineering problems. Lec/rec.

Prerequisite: (ENGR 112 with C or better or ENGR 112H with C or better) and (MTH 256 [C] or MTH 256H [C]) and MTH 341 [C]

Equivalent to: ME 373H

ME 373H, MECHANICAL ENGINEERING METHODS, 4 Credits

Analytical and numerical methods for solving representative mechanical engineering problems. Lec/rec.

Attributes: HNRS – Honors Course Designator

Prerequisite: (ENGR 112 with C or better or ENGR 112H with C or better) and (MTH 256 [C] or MTH 256H [C]) and MTH 341 [C]

Equivalent to: ME 373

ME 382, INTRODUCTION TO DESIGN, 4 Credits

Organization, planning, economics, and the use of creativity and optimization in solving mechanical design problems. Case studies and/or industrial design problems. Lec/lab.

Prerequisite: ENGR 248 with C or better and ME 250 (may be taken concurrently) [C] and ENGR 212 [C] and ENGR 213 [C]

Equivalent to: ME 382H

ME 382H, INTRODUCTION TO DESIGN, 4 Credits

Organization, planning, economics, and the use of creativity and optimization in solving mechanical design problems. Case studies and/or industrial design problems. Lec/lab.

Attributes: HNRS – Honors Course Designator

Prerequisite: ENGR 248 with C or better and ME 250 (may be taken concurrently) [C] and (PH 211 [C] or PH 211H [C])

Equivalent to: ME 382

ME 383, MECHANICAL COMPONENT DESIGN, 4 Credits

Failure analysis and design of machine components. Lec/lab.

Prerequisite: ME 316 with C or better and ME 250 (may be taken concurrently) [C] and (ENGR 212 [C] or ENGR 212H [C]) and ENGR 213 [C]

Equivalent to: ME 383H

ME 383H, MECHANICAL COMPONENT DESIGN, 4 Credits

Failure analysis and design of machine components. Lec/lab.

Attributes: HNRS – Honors Course Designator

Prerequisite: ME 316 with C or better and ME 250 (may be taken concurrently) [C] and (ENGR 212 [C] or ENGR 212H [C]) and ENGR 213 [C]

Equivalent to: ME 383

ME 401, RESEARCH, 1-16 Credits

This course is repeatable for 9 credits.

ME 403, THESIS, 1-16 Credits

This course is repeatable for 16 credits.

ME 405, READING AND CONFERENCE, 1-16 Credits

Equivalent to: ME 405H

This course is repeatable for 9 credits.

ME 405H, READING AND CONFERENCE, 1-16 Credits

Attributes: HNRS – Honors Course Designator

Equivalent to: ME 405

This course is repeatable for 9 credits.

ME 406, PROJECTS, 1-16 Credits

This course is repeatable for 15 credits.

ME 407, SEMINAR, 1-16 Credits

Equivalent to: ME 407H

This course is repeatable for 2 credits.

ME 410, INTERNSHIP, 1-16 Credits

Credits may not apply toward BS degree in Mechanical Engineering. Graded P/N.

This course is repeatable for 16 credits.

ME 411, AEROSPACE APPLICATIONS IN MECHANICAL ENGINEERING, 4 Credits

Provides students with the fundamentals of mechanical engineering applications to aerospace. Topics covered include an overview of modern aircraft and spacecraft analysis, with an emphasis on performance, stability, structures, materials, FAA and FAR standards and current professional practices in the conceptual design of aerospace vehicles. Student projects will integrate course topics.

Prerequisite: (ME 316 with C or better and (ME 317 [C] or ME 317H [C]) and (ME 331 [C] or ME 331H [C]) and (ME 373 [C] or ME 373H [C]))

ME 412, DESIGN OF MECHANISMS, 4 Credits

Analysis and study of the function, classification, position, velocity, and acceleration of multi-element mechanical linkages and mechanisms. Synthesis of mechanisms for specified multiple point paths, quick return, dwell, and straight-line motion. The lecture will instruct students in the kinematic analysis and synthesis of mechanisms through the use of theory and software packages. The laboratory will familiarize students with a modern mechanism design and animation software package. Lec/lab.

Prerequisite: (ME 317 with C or better or ME 317H with C or better) and ME 383 [C]

ME 420, APPLIED STRESS ANALYSIS, 4 Credits

Elasticity theory, failure theories, energy methods, finite element analysis.

Prerequisite: ME 316 with C or better

ME 422, MECHANICAL VIBRATIONS, 4 Credits

Dynamic response of single and multiple degree-of-freedom systems.

Prerequisite: ME 317 with C or better or ME 317H with C or better

Equivalent to: ME 422H

ME 422H, MECHANICAL VIBRATIONS, 4 Credits

Dynamic response of single and multiple degree-of-freedom systems.

Attributes: HNRS – Honors Course Designator

Prerequisite: ME 317 with C or better or ME 317H with C or better

Equivalent to: ME 422

ME 424, FINITE ELEMENT MODELING OF MECHANICAL ENGINEERING SYSTEMS, 3 Credits

Application of modern finite element code in the analysis of complex mechanical engineering systems. Extensive use of engineering workstations. Lec/lab.

Prerequisite: ME 420 with C or better or ME 520 with C or better

ME 430, SYSTEMS DYNAMICS AND CONTROL, 4 Credits

Modeling and analysis of linear continuous systems in time and frequency domains. Fundamentals of single-input-single-output control system design. CROSSLISTED as ECE 451/ME 430.

Prerequisite: (ME 317 with C or better or ME 317H with C or better or (ECE 351 with C or better and ECE 352 [C] and (ENGR 212 [C] or ENGR 212H [C])))

Equivalent to: ECE 451, ME 430H

Available via Ecampus

ME 430H, SYSTEMS DYNAMICS AND CONTROL, 4 Credits

Modeling and analysis of linear continuous systems in time and frequency domains. Fundamentals of single-input-single-output control system design. CROSSLISTED as ECE 451/ME 430.

Attributes: HNRS – Honors Course Designator

Prerequisite: (ME 317 with C or better or ME 317H with C or better or (ECE 351 with C or better and ECE 352 [C] and (ENGR 212 [C] or ENGR 212H [C])))

Equivalent to: ECE 451, ME 430

ME 443, RENEWABLE ENERGY: THERMAL FLUID SYSTEMS, 4 Credits

Evaluates several thermal/fluid power conversion strategies that deal with both thermal and fluid energy sources in terms of basic conversion technology, resource potential and developmental challenges. There are four modules, each targeting a particular renewable energy system in thermal and fluid sciences.

Prerequisite: (ME 311 with C or better or ME 311H with C or better or NE 311 with C or better or NE 311H with C or better) and (ME 331 [C] or ME 331H [C] or NE 331 [C] or NE 331H [C]) and (ME 332 [C] or ME 332H [C] or NE 332 [C] or NE 332H [C])

ME 444, THERMAL SYSTEMS DESIGN AND ANALYSIS, 4 Credits

Integration of the concepts, laws, and methodologies from fluid mechanics, heat transfer, and thermodynamics, into a set of practical tools for thermal energy systems design and analysis.

Prerequisite: (ME 332 with C or better or ME 332H with C or better or NSE 332 with C or better or NSE 332H with C or better) and (ME 312 (may be taken concurrently) [C] or ME 312H (may be taken concurrently) [C] or NSE 312 (may be taken concurrently) [C] or NSE 312H (may be taken concurrently) [C])

ME 445, INTRODUCTION TO COMBUSTION, 4 Credits

Study of combustion science based on the background of chemistry, thermodynamics, fluid mechanics, heat and mass transfer. Stoichiometry, energetics of chemical reactions, flame temperature, equilibrium product analyses, chemical kinetics, and chain reactions.

Prerequisite: (ME 312 with C or better or ME 312H with C or better) and (ME 332 [C] or ME 332H [C])

ME 450, APPLIED HEAT TRANSFER, 4 Credits

An intermediate heat transfer course seeking to lay a foundation for determining the heating and cooling characteristics with a variety of modern and classical processes. Included is design of multi-component heat transfer systems. Lecture, 110 minutes twice per week.

Prerequisite: ME 332 with C or better or ME 332H with C or better

ME 451, INTRODUCTION TO INSTRUMENTATION AND MEASUREMENT SYSTEMS, 4 Credits

Function, operation, and application of common mechanical engineering instruments, measurement principles, and statistical analysis. Major elements of measurement systems, including transduction, signal conditioning, and data recording. Function and operation of digital data acquisition systems. Lec/lab.

Prerequisite: (ENGR 202 with C or better or ENGR 202H with C or better) and (ME 311 [C] or ME 311H [C]) and ME 316 [C] and (ME 317 [C] or ME 317H [C]) and (ME 373 [C] or ME 373H [C]) and (ST 314 [C] or ST 314H [C])

Equivalent to: ME 351

ME 452, THERMAL AND FLUIDS SCIENCES LABORATORY, 4 Credits

Course emphasis is on experiments related to thermodynamics, heat transfer, and fluid mechanics. Proper experimental methods, data and uncertainty analysis related to thermal and fluids measurements are discussed.

Prerequisite: (ME 311 with C or better or ME 311H with C or better) and (ME 331 [C] or ME 331H [C]) and (ME 332 [C] or ME 332H [C])

Equivalent to: ME 452H

ME 452H, THERMAL AND FLUIDS SCIENCES LABORATORY, 4 Credits

Course emphasis is on experiments related to thermodynamics, heat transfer, and fluid mechanics. Proper experimental methods, data and uncertainty analysis related to thermal and fluids measurements are discussed.

Attributes: HNRS – Honors Course Designator

Prerequisite: (ME 311 with C or better or ME 311H with C or better) and (ME 331 [C] or ME 331H [C]) and (ME 332 [C] or ME 332H [C])

Equivalent to: ME 452

ME 453, STRUCTURE AND MECHANICS LABORATORY, 4 Credits

Techniques for measurement of structural response and material properties. Proper use of rosette strain gauges, load cells, and displacement transducers. Full-field strain measurement using photoelasticity and digital image correlation. Proper implementation of material testing standards. Characterization of anisotropic composite materials.

Prerequisite: ME 451 with C or better

ME 460, INTERMEDIATE FLUID MECHANICS, 4 Credits

Ideal fluid flow including potential flow theory. Introduction to compressible flow. Viscous flow and boundary layer theory. Introduction to turbulence.

Prerequisite: ME 331 with C or better or ME 331H with C or better

ME 461, GAS DYNAMICS, 4 Credits

Studies one-dimensional isentropic flow, nozzles, diffusers, normal and oblique shocks, compressible flow with friction and heating, and an introduction to propulsion systems.

Prerequisite: (ME 312 with C or better or ME 312H with C or better) and (ME 331 [C] or ME 331H [C])

ME 480, MATERIALS SELECTION, 3 Credits

Selecting materials for engineering applications. The major families of materials, their properties, and how their properties are controlled; case studies and design projects emphasizing materials selection.

Prerequisite: MATS 322 with C or better or ENGR 322 with C or better

ME 484, FRACTURE OF MATERIALS, 3 Credits

Fracture mechanics and fatigue mechanisms: mechanisms of ductile and brittle fracture. Environmentally induced fracture and fatigue. Considerations in design of engineering materials and structures will be discussed.

Prerequisite: MATS 322 with C or better or ENGR 322 with C or better

ME 499, SPECIAL TOPICS, 0-16 Credits

Equivalent to: ME 499H

This course is repeatable for 16 credits.

ME 499H, SPECIAL TOPICS, 0-16 Credits

Attributes: HNRS – Honors Course Designator

Equivalent to: ME 499

This course is repeatable for 16 credits.

ME 501, RESEARCH, 1-16 Credits

This course is repeatable for 16 credits.

ME 502, INDEPENDENT STUDIES, 1-16 Credits

This course is repeatable for 16 credits.

ME 503, THESIS, 1-16 Credits

This course is repeatable for 999 credits.

ME 505, READING AND CONFERENCE, 1-16 Credits

This course is repeatable for 16 credits.

ME 506, PROJECTS, 1-16 Credits

Graded P/N.

This course is repeatable for 16 credits.

ME 507, SEMINAR, 1-16 Credits

This course is repeatable for 16 credits.

ME 508, THERMAL FLUID SCIENCE SEMINAR, 1 Credit

Student participation seminar experience for 1 course credit. Students will present and listen to seminars concerning ongoing research within the thermal fluid sciences.

ME 509, MATERIALS SCIENCE SEMINAR, 1 Credit

Student participation seminar experience for one credit; students will listen to seminars concerning ongoing research activities within materials science. Students will also have the opportunity to present their own research results periodically. Graded P/N.

Equivalent to: MATS 509

ME 511, PRECISION MACHINE DESIGN, 3 Credits

Tolerance analysis and application in design/manufacturing practice, principles of machine design and computational analysis of errors in machine design, sensor mounting and sensor calibration, machine level error budget with geometric and thermal errors, structural design of joints and supports, deterministic damping, exact constraint design for flexures and couplings, bearing systems design, motion and power system design for machine tools. CROSSLISTED as ME 511/MFGE 511.

Equivalent to: MFGE 511

Recommended: An understanding of mechanical component design and solid mechanics.

ME 512, DESIGN OF MECHANISMS, 4 Credits

Analysis and study of the function, classification, position, velocity, and acceleration of multi-element mechanical linkages and mechanisms. Synthesis of mechanisms for specified multiple point paths, quick return, dwell, and straight-line motion. The lecture will instruct students in the kinematic analysis and synthesis of mechanisms through the use of theory and software packages. The laboratory will familiarize students with a modern mechanism design and animation software package. Lec/lab.

Recommended: (ME 317 or ME 317H) and ME 383

ME 513, BIO-INSPIRED DESIGN, 4 Credits

Intersection of design and biology that seeks to systematically mine biological knowledge to solve design problems. Investigates inspiration from nature from three different types: visual, conceptual, and computational. Includes design rules, heuristics, principles or patterns to solve engineering problems. Algorithmic bio-inspiration emulates natural algorithms for control or optimization problems.

ME 515, RISK AND RELIABILITY ANALYSIS IN ENGINEERING DESIGN, 4 Credits

Fundamentals of risk, uncertainty, and reliability. Methods to analyze and quantify the risk of failures, and the reliability of complex systems, including fault tree analysis, reliability block diagrams, probabilistic risk assessment. Introduction to research methods for risk and reliability analysis during the early design stages.

ME 516, MODELING AND ANALYSIS OF COMPLEX SYSTEMS, 4 Credits

Introduction to challenges and considerations when designing complex systems. Fundamentals of systems engineering and methods used in practice. Models and tools used to enable the use of models for trade studies during the design of complex systems. Model-based design environments and methodologies. Introduction to decision support tools in design.

ME 517, OPTIMIZATION IN DESIGN, 4 Credits

Optimization methods as applied to engineering design, theory and application of nonlinear optimization techniques for multivariate unconstrained and constrained problems. Model boundedness and sensitivity.

ME 519, SELECTED TOPICS IN DESIGN, 3-4 Credits

Topics in mechanical design selected from the following: design processes, quality engineering, design for assembly, statistical machine design, the Taguchi method, and parametric design.

This course is repeatable for 32 credits.

ME 520, APPLIED STRESS ANALYSIS, 4 Credits

Elasticity theory, failure theories, energy methods, finite element analysis.

Recommended: ME 316

ME 521, LINEAR ELASTICITY, 4 Credits

A general introduction to the theory of elasticity. The solution of 2-D problems using the Airy stress function in rectangular and polar coordinates. The solution of 3-D problems using the Galerkin vector, the Papkovitch-Neuber solution, and complex variable methods. Applications to asymptotic fields at discontinuities, contact and crack problems, and thermoelasticity.

Recommended: ME 316

ME 522, MECHANICAL VIBRATIONS, 4 Credits

Dynamic response of single and multiple degree-of-freedom systems.

Recommended: ME 317

ME 523, ADVANCED STRESS ANALYSIS, 4 Credits

An introduction to the mechanics of nonlinear elastic, plastic, and viscoelastic material behavior including large deformations.

Recommended: ME 316

ME 524, FINITE ELEMENT MODELING OF MECHANICAL ENGINEERING SYSTEMS, 3 Credits

Application of modern finite element code in the analysis of complex mechanical engineering systems. Extensive use of engineering workstations. Lec/lab.

Prerequisite: ME 520 with C or better

ME 526, NUMERICAL METHODS FOR ENGINEERING ANALYSIS, 3 Credits

Numerical solutions of linear equations, difference equations, ordinary and partial differential equations. CROSSLISTED as ME 526/NSE 526.

Equivalent to: NE 526, NSE 526

Recommended: Programming experience and previous exposure to numerical methods

ME 529, SELECTED TOPICS IN SOLID MECHANICS, 3-4 Credits

Advanced topics in solid mechanics emphasizing research applications of current interest.

This course is repeatable for 32 credits.

ME 531, LINEAR MULTIVARIABLE CONTROL SYSTEMS I, 4 Credits

Theoretical design of control systems for systems modeled by linear multivariable differential equations. Topics covered include controllability, observability, state feedback control, pole placement, output feedback, estimator design, and control designs that include both estimators and regulators.

ME 532, LINEAR MULTIVARIABLE CONTROL SYSTEMS II, 4 Credits

Focuses on designing control systems where the device to be controlled is an uncertain system, yet can be described by a set of linear differential equations. Lec.

Prerequisite: ME 531 with C or better

ME 533, NONLINEAR DYNAMIC ANALYSIS, 4 Credits

Course focuses on understanding the behavior of nonlinear dynamic systems of interest to mechanical engineers. Lec.

Recommended: ME 317

ME 534, NONLINEAR MULTIVARIABLE CONTROL SYSTEMS, 4 Credits

Focuses on designing control systems when the device to be controlled is mathematically described by a nonlinear set of differential equations. Lec.

Prerequisite: ME 533 with C or better

ME 539, SELECTED TOPICS IN DYNAMICS, 1-16 Credits

Advanced topics in dynamics emphasizing research applications of current interest.

This course is repeatable for 30 credits.

ME 540, INTERMEDIATE THERMODYNAMICS, 4 Credits

Students are expected to master classical thermodynamics by way of solving extended problems using software tools. Statistical thermodynamics concepts are also introduced and exercised.

Recommended: ME 312

ME 541, LIQUID-VAPOR PHASE CHANGE AND HEAT TRANSFER, 4 Credits

Advanced treatment of underlying physics and engineering modeling approaches for heat transfer associated with vapor/liquid phase change processes. Topics include thermodynamics and mechanical aspects of phase change processes, pool boiling, filmwise and dropwise condensation, internal convective boiling and condensation, and other emerging areas in phase change heat transfer.

ME 543, RENEWABLE ENERGY: THERMAL FLUID SYSTEMS, 4 Credits

Evaluates several thermal/fluid power conversion strategies that deal with both thermal and fluid energy sources in terms of basic conversion technology, resource potential and developmental challenges. There are four modules, each targeting a particular renewable energy system in thermal and fluid sciences.

Recommended: (ME 311 or ME 311H or NE 311 or NE 311H) and (ME 331 or ME 331H or NE 331 or NE 331H) and (ME 332 or ME 332H or NE 332 or NE 332H)

ME 544, ADVANCED POWER GENERATION SYSTEMS, 4 Credits

Thermal mechanical evaluation of modern power generation technologies, including fossil and nuclear Rankine cycle power plants, gas turbines, cogeneration power plants, distributed power generation and fuel cells. Lec/rec.

Recommended: ME 312 and (ME 332 or ME 332H)

ME 545, INTRODUCTION TO COMBUSTION, 4 Credits

Study of combustion science based on the background of chemistry, thermodynamics, fluid mechanics, heat and mass transfer. Stoichiometry, energetics of chemical reactions, flame temperature, equilibrium product analyses, chemical kinetics, and chain reactions.

Recommended: ME 312 and (ME 332 or ME 332H)

ME 546, CONVECTION HEAT TRANSFER, 3 Credits

An advanced treatment of forced and natural convection heat transfer processes emphasizing underlying physical phenomena. Current topical literature will be considered; analytical and numerical problem solving is included.

Recommended: (ME 332 or ME 332H) and ME 373

ME 547, CONDUCTIVE HEAT TRANSFER, 3 Credits

Analytical and numerical solutions to steady state and transient conduction problems.

Recommended: (ME 332 or ME 332H) and ME 373

ME 548, RADIATION HEAT TRANSFER, 3 Credits

Analytical and numerical methods of solution of thermal radiation problems.

Recommended: (ME 332 or ME 332H) and ME 373

ME 549, SELECTED TOPICS IN HEAT TRANSFER, 3 Credits

Topics in heat transfer including advanced problems in conduction, radiation, and convection. Additional examination of heat transfer in multiphase systems, inverse problems, combined modes, equipment design, solution techniques and other topics of current interest considered, including extensive use of current literature. Not all topics covered each year.

This course is repeatable for 9 credits.

ME 550, APPLIED HEAT TRANSFER, 4 Credits

An intermediate heat transfer course seeking to lay a foundation for determining the heating and cooling characteristics with a variety of modern and classical processes. Included is design of multi-component heat transfer systems. Lecture, 110 minutes twice per week.

Recommended: ME 332 or ME 332H

ME 552, MEASUREMENTS IN FLUID MECHANICS AND HEAT TRANSFER, 4 Credits

Course emphasis is on measurement techniques and data analysis methods related to fluid mechanics and heat transfer. Proper experimental methods, data and uncertainty analyses related to thermal and fluids measurements are discussed. Local and spatial mapping of fluid and thermal fields are highlighted.

Recommended: (ME 331 or ME 331H) and (ME 332 or ME 332H) and ME 451.

ME 553, STRUCTURE AND MECHANICS LABORATORY, 4 Credits

Techniques for measurement of structural response and material properties. Proper use of rosette strain gauges, load cells, and displacement transducers. Full-field strain measurement using photoelasticity and digital image correlation. Proper implementation of material testing standards. Characterization of anisotropic composite materials.

Recommended: ME 451

ME 560, INTERMEDIATE FLUID MECHANICS, 4 Credits

Ideal fluid flow including potential flow theory. Introduction to compressible flow. Viscous flow and boundary layer theory. Introduction to turbulence.

Recommended: ME 331

ME 561, GAS DYNAMICS, 4 Credits

Studies one-dimensional isentropic flow, nozzles, diffusers, normal and oblique shocks, compressible flow with friction and heating, and an introduction to propulsion systems.

Recommended: ME 312 and (ME 331 or ME 331H)

ME 564, TURBULENCE MODELING, 3 Credits

An introductory course on theory of different turbulence modeling techniques such as Reynolds Averaged Navier Stokes (RANS), Large Eddy Simulation (LES), and Direct Numerical Simulation (DNS) applied to a range of turbulent flows including free shear flows, boundary layers, and internal flows.

Prerequisite: ME 560 with C or better and (ME 565 [C] or ME 566 [C])

ME 565, INCOMPRESSIBLE FLUID MECHANICS, 3 Credits

Generalized fluid mechanics; kinematics; methods of description, geometry of the vector field, dynamics of nonviscous fluids, potential motion, two-dimensional potential flow with vorticity.

ME 566, VISCOUS FLOW, 3 Credits

Boundary layer, stability, transition prediction methods, computational methods in fluid mechanics, recent developments.

ME 567, ENGINEERING APPLICATIONS OF COMPUTATIONAL FLUID DYNAMICS, 4 Credits

Basic concepts of computational fluid dynamics, a technique used for solving fully three-dimensional fluid flow problems with no exact solution, will be discussed and applied to general engineering applications using commercially available software. Lec.

Recommended: ME 312 and (ME 331 or ME 331H)

ME 568, TURBULENT FLOW DYNAMICS, 4 Credits

An introductory course of the basic physics of turbulent flows, coverage will include statistical methods and physical interpretation of a range of flows including boundary layer flows, internal flows, and environmental flows.

Prerequisite: ME 560 with C or better

Recommended: A first course in fluid mechanics such as ME 331

ME 569, SELECTED TOPICS IN FLUID MECHANICS, 2-4 Credits

Topics in fluid mechanics emphasizing research applications of current interest.

This course is repeatable for 32 credits.

ME 580, MATERIALS SELECTION, 3 Credits

Selecting materials for engineering applications. The major families of materials, their properties, and how their properties are controlled; case studies and design projects emphasizing materials selection. Lec/lab.

Equivalent to: MATS 580

Recommended: MATS 322 or ENGR 322

ME 583, COMPOSITE MATERIALS, 3 Credits

Explores fibers and matrices, mechanics of composites, reinforcement and failure mechanisms, properties and applications.

Recommended: ME 420 and ME 483 with a minimum grade of C

ME 585, FATIGUE OF MATERIALS, 4 Credits

Analyzes the failure of materials by fatigue including how fatigue behavior is characterized, how fatigue failure is predicted, the physical mechanisms responsible for fatigue failure of various materials, and how such behavior is related to the atomic structure and microstructure of the material.

Prerequisite: ME 570 with C or better or MATS 570 with C or better

ME 589, SELECTED TOPICS IN MATERIALS, 3 Credits

Topics in materials science to correspond to areas of graduate research. Topics will be chosen from the following list: optical materials, dielectrics, oxidation and corrosion, ceramics, thermophysical properties, polymers and viscoelasticity, coatings and thin films. Lec/rec.

This course is repeatable for 32 credits.

ME 596, SELECTED TOPICS IN THERMODYNAMICS, 3 Credits

Topics in thermodynamics including advanced problems in classical thermodynamics and statistical thermodynamics of current interest. Topics will likely be considered, including extensive use of literature. Not all topics covered each year.

This course is repeatable for 32 credits.

ME 597, PRECISION MOTION GENERATION, 4 Credits

Introduces fundamental knowledge in mechatronic systems used in manufacturing equipment such as CNC machine tools, and their computer numerical controls. Students will be exposed to sensors and actuators utilized in machine tools, industrial robots and for process automation. Fundamental knowledge to model and identify dynamics of motion delivery systems, design and analysis of accurate position control algorithms for precision motion generation will be covered. Digital motion control design will be introduced. Motion planning and real-time path interpolation algorithms will be covered. Students will be able to design NC systems for 2D motion platforms.

Recommended: ME 430

ME 599, SPECIAL TOPICS, 0-16 Credits

This course is repeatable for 32 credits.

ME 601, RESEARCH, 1-16 Credits

This course is repeatable for 16 credits.

ME 603, THESIS, 1-16 Credits

This course is repeatable for 999 credits.

ME 605, READING AND CONFERENCE, 1-16 Credits

This course is repeatable for 16 credits.

ME 606, PROJECTS, 1-16 Credits

This course is repeatable for 16 credits.

ME 607, SEMINAR, 1-16 Credits

This course is repeatable for 16 credits.

ME 611, MODERN PRODUCT DESIGN, 4 Credits

Modern product development, design and prototyping are covered. Product development and prototyping is examined from a research standpoint in this course. Customer outcomes gathering, functional modeling, product architecture, modern techniques for concept generation and selection are explored. Also covered are recently developed theories and techniques for prototyping. The topics' place in the overall design process is shown through a product development and prototyping project.

ME 613, SUSTAINABLE PRODUCT DESIGN, 4 Credits

Graduate students will work in multidisciplinary design teams to develop innovative and environmentally friendly products. Combining the principles of integrated product development and sustainable design thinking, students will (a) advance their knowledge of the design process by creating a patent-quality new product, (b) learn and employ environmentally-minded design theory and methods, including various software packages and online tools, and (c) further enhance team-working skills by working collaboratively in a professional design team. Sustainable Product Development is conducted as a collaborative design experience, in that lectures, discussion, and team working time will be integrated into class sessions.

ME 615, DESIGN UNDER UNCERTAINTY, 4 Credits

Tackles the problem of decision making in engineering design. The fundamental challenge faced in making decisions in engineering designs is that they are almost exclusively decisions made under uncertainty. Sources of uncertainty could result from engineering models, experiments conducted, or lack of knowledge of future events. The course will cover three basic topics 1) how do we quantify uncertainty, 2) how do we account for the uncertainty in decision making, and 3) how do we make design selection decisions about products or systems we design.

Prerequisite: ME 517 with C or better

ME 617, DESIGN AUTOMATION, 4 Credits

Design automation is the field of study whereby advanced numerical methods are used to automate difficult or tedious design decisions. Typically, such methods are based on numerical optimization and artificial intelligence. They work in tandem with other engineering digital tools like computer-aided design, computer-aided manufacturing, and finite-element analysis. This course builds upon a fundamental understanding of optimization to introduce students to a range of different techniques that may be used to support engineering decision-making. This includes heuristic methods, AI tree-search, discrete and stochastic algorithms. The course concludes with discussion of recent innovations in multi-objective, multi-disciplinary and robust optimization.

Prerequisite: ME 517 with C or better

ME 667, COMPUTATIONAL FLUID DYNAMICS, 3 Credits

Application of modern computational techniques to solve a wide variety of fluid dynamics problems including both potential and viscous flow with requirements for computer code development.

Prerequisite: (ME 560 with C or better or ME 565 with C or better or ME 566 with C or better) and (ME 526 [C] or ME 575 [C])

Manufacturing Engineering (MFGE)

MFGE 241, INTRODUCTION TO MECHATRONICS, 3 Credits

Explores the fundamentals of mechatronics: electronic circuits, tools, and basic sensors/actuators commonly used in the manufacturing process monitoring. Examines the operation and use of these instruments and tools for mechatronics design and prototyping. Examines the fundamentals of five types of sensors: distance, movement, proximity, stress/strain, and temperature, with a focus on the mathematical modeling of the sensors when they are embedded in a mechanical system. Apply basic programming in LabVIEW software to support the operation of data sampling through a data acquisition card. Integrate mechanical design with electronics controlled by a computer in an open loop fashion in the lab.

Prerequisite: ENGR 202 with C or better

MFGE 285, INTRODUCTION TO INDUSTRIAL AND MANUFACTURING ENGINEERING, 3 Credits

Introduction to selected topics in industrial and manufacturing engineering, including history and philosophy, product design and manufacturing cycle, integrate role of engineering and business, and multi-objective nature of organizations. Surveys of selected design problems in resource allocation, operations and quality management, and production engineering. CROSSLISTED as IE 285/MFGE 285.

Prerequisite: IE 112 (may be taken concurrently) with C or better or FOR 112 (may be taken concurrently) with C or better

Equivalent to: IE 285

MFGE 336, PRODUCTION ENGINEERING, 4 Credits

Provides a general understanding of the production engineering function within industry and the means by which to achieve tight tolerances through machining. Geometric dimensioning and tolerancing, fixture and gage design, and fundamentals of metal cutting mechanics are introduced, and their interactions are explored. Lec/lab.

Prerequisite: (ENGR 213 with C or better or ENGR 213H with C or better) and ENGR 248 [C] and (ENGR 321 [C] or ENGR 321H [C] or MATS 321 [C] or MATS 321H [C]) and ME 250 [C]

Equivalent to: IE 336

MFGE 337, MATERIALS AND MANUFACTURING PROCESSES, 4 Credits

Introduces mechanical manufacturing methods by which materials are economically shaped into valuable products. The overall goal is to develop an understanding of how the functionality, shape, materials, cost and sustainability of a product influence manufacturing process selection and design. Lec/lab.

Prerequisite: ((ENGR 321 with C or better or ENGR 321H with C or better or MATS 321 with C or better or MATS 321H with C or better) and ME 250 [C] and MFGE 336 [C])

Equivalent to: IE 337

MFGE 341, LOGICAL CONTROL FOR MECHATRONICS SYSTEMS, 4 Credits

Explore embedded software and hardware infrastructures used in mechatronics systems. Examine binary number and Boolean algebra using AND, OR, and XOR operators in microcontroller-controlled systems, and flip-flops and other basic components that realize binary control functions. Explore the working principles of AVR microcontroller systems, including the internal structure of clock timers, memory space, and IO addresses. Implement basic microcontroller operations using Assembly language. Demonstrate functions such as open loop control and wired/wireless communication in labs by programming a commercial microcontroller platform with assembly language.

Prerequisite: MFGE 241 with C or better

MFGE 413, COMPUTER AIDED DESIGN AND MANUFACTURING, 4 Credits

Introduces students to the application of computer aided engineering tools across the extended product design and manufacturing cycle. Students become familiar with new product development and working in a sustaining engineering environment with an emphasis on using computer-aided design (CAD) and computer-aided manufacturing (CAM) tools to gain competitive advantage.

Prerequisite: ENGR 248 with C or better and (IE 366 [C] or ME 382 [C] or ME 382H [C])

Equivalent to: ME 413

MFGE 436, LEAN MANUFACTURING SYSTEMS ENGINEERING, 4 Credits

The planning, evaluation, deployment, and integration of lean manufacturing theory and methods. Examines manufacturing processes/equipment and systems, e.g., planning/control, product design, supply chain resource management. Lec/lab.

Prerequisite: ENGR 390 with C or better or ENGR 391 with C or better

Equivalent to: IE 436

MFGE 437, COMPUTER CONTROL OF MANUFACTURING PROCESSES, 4 Credits

Introduces fundamental knowledge in the automation of manufacturing systems and processes. Automated manufacturing system design and operations—computer numerical control (CNC) technology; NC part programming; sensors and actuators, their modeling and dynamic simulation; feedback motion delivery systems design and tuning; programmable logic controls (PLC) for industrial control systems, and path planning for numerical controlled (NC) machinery. Lec/lab.

Prerequisite: (ME 317 with C or better or ME 317H with C or better or MFGE 336 with C or better) and (ENGR 212 [C] or ENGR 212H [C])

Equivalent to: IE 437

MFGE 438, COMPOSITES MANUFACTURING, 4 Credits

Introduction to fiber-reinforced composite materials and their applications. Topics include matrices and reinforcement; open and closed molding processes; filament winding, quality, testing, damage assessment; basics of factory operations and sustainability of composites. Students will complete laboratory projects using fiber-reinforced laminates. Lec/lab.

Prerequisite: ENGR 213 with C or better or ENGR 213H with C or better

MFGE 442, ADVANCED SIGNAL PROCESSING FOR MECHATRONICS SYSTEMS, 4 Credits

Examine continuous and discrete Fourier Transforms, and Fast Fourier Transform algorithm concepts. Explore the design of low, high and band-pass filtering based on Finite (FIR) and Infinite (IIR) Impulse Response filters, and 1D and 2D image signal processing basics. Apply Artificial Neural Network (ANN) Basics for pattern recognition, regression and classification. Implement digital filtering on micro-processor systems, and apply ANN for image processing in the labs.

Prerequisite: MFGE 441 with C or better

MFGE 499, SPECIAL TOPICS, 0-5 Credits

This course is repeatable for 99 credits.

MFGE 507, SEMINAR, 1-16 Credits

Graded P/N.

*This course is repeatable for 16 credits.***MFGE 511, PRECISION MACHINE DESIGN, 3 Credits**

Tolerance analysis and application in design/manufacturing practice, principles of machine design and computational analysis of errors in machine design, sensor mounting and sensor calibration, machine level error budget with geometric and thermal errors, structural design of joints and supports, deterministic damping, exact constraint design for flexures and couplings, bearing systems design, motion and power system design for machine tools. CROSSLISTED as ME 511/MFGE 511.

Equivalent to: ME 511**Recommended:** An understanding of mechanical component design and solid mechanics.**MFGE 531, MICROMANUFACTURING, 4 Credits**

Introduction to microsystem platforms, scaling laws and size effects in micromanufacturing techniques with an emphasis on microchannel arrays, microchannel lamination and micro-scale characterization. Lec/lab.

Equivalent to: IE 531**MFGE 535, INDUSTRIAL SUSTAINABILITY ANALYSIS, 3 Credits**

Students are exposed to the role of business and engineering in the design and implementation of sustainable industrial systems. Drivers, metrics, and analysis concepts, methods, and tools are introduced. Students incorporate business and engineering considerations in making product, manufacturing process, and supply chain design considerations.

MFGE 536, LEAN MANUFACTURING SYSTEMS ENGINEERING, 4 Credits

The planning, evaluation, deployment, and integration of lean manufacturing theory and methods. Examines manufacturing processes/equipment and systems, e.g., planning/control, product design, supply chain resource management. Lec/lab.

Equivalent to: IE 536*Available via Ecampus***MFGE 538, COMPOSITES MANUFACTURING, 4 Credits**

Introduction to fiber-reinforced composite materials and their applications. Topics include matrices and reinforcement; open and closed molding processes; filament winding, quality, testing, damage assessment; basics of factory operations and sustainability of composites. Students will complete laboratory projects using fiber-reinforced laminates. Lec/lab.

Recommended: (ENGR 213 or ENGR 213H)**MFGE 551, ADDITIVE MANUFACTURING, 3 Credits**

Introduces basic principles and process physics for additive manufacturing as compared with subtractive manufacturing. Various processes in AM (extrusion, jetting, photopolymerization, powder bed fusion, direct energy deposition and sheet lamination) and laser AM are discussed. Materials selection in AM (metals, polymers, ceramics and composites), powder metallurgy and metallurgical phenomena in additive manufacturing will be covered.

MFGE 599, SPECIAL TOPICS, 0-5 Credits*This course is repeatable for 99 credits.***Mechanical/Industrial/Manufacturing Engineering (MIME)****MIME 101, INTRODUCTION TO MIME, 3 Credits**

Provides students with an overview of mechanical, industrial, manufacturing, and energy systems engineering careers and an introduction to technical areas of study. Skills necessary for success in both the academic curriculum and in the engineering profession will also be emphasized, including communication and ethics. Lec/rec.

Equivalent to: ME 101, MIME 101H**MIME 101H, INTRODUCTION TO MIME, 3 Credits**

Provides students with an overview of mechanical, industrial, manufacturing, and energy systems engineering careers and an introduction to technical areas of study. Skills necessary for success in both the academic curriculum and in the engineering profession will also be emphasized, including communication and ethics. Lec/rec.

Attributes: HNRS – Honors Course Designator**Equivalent to:** MIME 101**MIME 199, SPECIAL TOPICS, 0-4 Credits****Equivalent to:** MIME 101**MIME 299, SPECIAL TOPICS, 0-4 Credits***This course is repeatable for 4 credits.***MIME 399, SPECIAL TOPICS, 0-4 Credits**

Special topics in mechanical, industrial, and manufacturing engineering.

This course is repeatable for 16 credits.

MIME 497, ^MIME CAPSTONE DESIGN, 4 Credits

Integrates engineering knowledge and experience by applying skills to work on real-world engineering project. Involves product design; selection and replacement of major tools, processes, and equipment; paperwork controls; subsystem revision; system or plant revision; selection and training of personnel; and long-run policies and strategy. (Writing Intensive Course)

Attributes: CWIC – Core, Skills, WIC

Prerequisite: (IE 355 with C or better and IE 356 [C] and IE 366 [C] and IE 367 [C] and IE 368 [C] and WR 327 [C]) or (MATS 322 [C] and ENGR 390 [C] and ME 250 [C] and (ME 312 [C] or ME 312H [C]) and (ME 317 [C] or ME 317H [C]) and (ME 382 [C] or ME 382H [C]) and (ME 383 [C] or ME 383H [C]) and (ST 314 [C] or ST 314H [C]) and WR 327 [C])

Equivalent to: ESE 497, IE 497, ME 497

MIME 498, ^MIME CAPSTONE DESIGN, 4 Credits

Product design; selection and replacement of major tools, processes, and equipment; paperwork controls; subsystem revision; system or plant revision; selection and training of personnel; long-run policies and strategy. (Writing Intensive Course)

Attributes: CWIC – Core, Skills, WIC

Prerequisite: MIME 497 with C or better or ESE 497 with C or better

Equivalent to: ESE 498, IE 498, ME 498

MIME 504, WRITING AND CONFERENCE/ EXPLORATION, 1-9 Credits

Students will be allowed to register for a variable number of MIME 504 credits to bring their registration up to full-time status (9 credits). Graded P/N.

Equivalent to: IE 504, ME 504, ROB 504

This course is repeatable for 15 credits.

MIME 507, SEMINAR/NEW STUDENT ORIENTATION, 1 Credit

Robotics (ROB)

ROB 421, APPLIED ROBOTICS, 4 Credits

Multidisciplinary teams of students design, build, and demonstrate a robotic system, including all sensing, computation, and actuation. The specific task, such as checkers-playing robots, changes each year, and is designed to be challenging for ambitious students. Robots will compete in a friendly competition at the end of the term. Lec/lab.

Prerequisite: ME 430 with C or better

Equivalent to: ENGR 421

ROB 456, INTELLIGENT ROBOTS, 4 Credits

Foundations of probabilistic reasoning for robotics. Topics include state estimation, robot motion, perception, localization and decision making under uncertainty.

Prerequisite: ST 314 with C or better

Equivalent to: ME 456

Recommended: CS 331, CS 361, ECE 353, or other programming experience

ROB 501, RESEARCH, 1-16 Credits

Graded P/N.

This course is repeatable for 99 credits.

ROB 503, THESIS, 1-16 Credits

This course is repeatable for 999 credits.

ROB 505, READING AND CONFERENCE, 1-16 Credits

This course is repeatable for 16 credits.

ROB 506, PROJECTS, 1-16 Credits

Graded P/N.

This course is repeatable for 16 credits.

ROB 507, SEMINAR, 1-16 Credits

Graded P/N.

This course is repeatable for 16 credits.

ROB 514, INTRODUCTION TO ROBOTICS, 4 Credits

A broad introduction to the field of robotics, and to the graduate Robotics program. The goal of the class is to take students with different backgrounds (mechanical engineering, computer science, electrical engineering, physics, etc.) and give them a common base in the fundamentals of robotics. A secondary goal is to introduce students to the Robotics program, and to give them some of the skills that will make them successful, both in the program and as a professional roboticist.

ROB 521, RESEARCH ROBOTICS, 4 Credits

Multidisciplinary teams of students will use the backdrop of a robotics competition to generate a research question, then design, build, and demonstrate a robotic system that is used to answer this research question. An example may be a Jenga-playing robot, where students try a new computer vision algorithm, or test a theory on force control. This directly parallels graduate research in robotics, where systems-building is necessary, and toy problems can illustrate research results, but the important focus is a core research question. The specific competition task changes each year, and robots will compete at the end of the term. Lec/lab.

Equivalent to: ENGR 521

ROB 534, SEQUENTIAL DECISION MAKING IN ROBOTICS, 4 Credits

Examines sequential decision making in robotics with a focus on motion planning and related optimization problems applied to fielded systems in marine, aerial, and ground domains. Discussions regarding both fundamental background material as well as cutting edge research in the following areas: discrete planning, sampling-based planning, planning under uncertainty, multi-robot systems, optimization, and performance guarantees.

ROB 537, LEARNING-BASED CONTROL, 4 Credits

Provides an introduction to learning systems and their application to the control of nonlinear systems. Covered topics include neural networks, reinforcement learning, and evolutionary algorithms. Includes project component in which students write a technical paper and give a conference style presentation based on their project.

Equivalent to: ME 537

ROB 538, MULTIAGENT SYSTEMS, 4 Credits

Provides an introduction to multiagent systems. In particular, it focuses on how to coordinate agents using different approaches. Covered topics include multiagent learning, game theory, swarms, social choice, and auctions. Includes significant reading and critiquing of assigned papers.

Equivalent to: ME 538

ROB 541, GEOMETRIC MECHANICS, 4 Credits

An introduction to geometric methods in the analysis of dynamic systems. Using the kinematics of simple robotic systems as a motivating example, we explore topics such as manifolds and Lie groups, representations of velocity, holonomic and nonholonomic constraints, constraint curvature and response to cyclic inputs, distance metrics.

Recommended: Prior exposure to linear algebra and differential equations

ROB 542, ACTUATOR DYNAMICS, 4 Credits

Focuses on how inertia, spring compliance, and other passive dynamics affect highly dynamic, software-controlled systems. Examples include robotic manipulation tasks, robot-human interaction, CNC machines, or legged locomotion. Lec/lab.

Recommended: Prior courses on dynamics and control such as ME 531, ME 533, ME 535

ROB 545, ROBOTIC MANIPULATION, 4 Credits

Introduction to the mechanical processes governing manipulation with a focus on the kinematics, statics, and dynamics of interacting rigid bodies. Topics include numerical inverse kinematics, dynamics of open chains, and interaction control. Some manipulation problems considered include grasping, picking and placing, and assembly.

ROB 562, HUMAN CONTROL SYSTEMS, 4 Credits

Covers mechanisms of human motor systems and control of the neuromusculoskeletal anatomy followed by functional analysis of these system components. Then all the components are integrated to study feedback control dynamics. Covers classic to modern theories of motor control, adaptation, cognitive involvement, and rehabilitation techniques.

Equivalent to: ME 539

Recommended: Basic feedback control systems, linear algebra, differential equations

ROB 564, SOFT ROBOTICS, 4 Credits

Soft robotics researchers propose building intelligent machines purely out of stretchable compressible soft materials. The course is centered on term-long projects that will result in real soft robots with the goal of presenting to the international community. The topics covered include rapid digital manufacturing, soft actuators, soft sensors, soft logic, soft energy, applications of soft robotics, and modeling soft mechanics.

ROB 567, HUMAN ROBOT INTERACTION, 4 Credits

The field of human-robot interaction brings together research and application of methodology from robotics, human factors, human-computer interaction, interaction design, cognitive psychology, education and other fields to enable robots to have more natural and more rewarding interactions with humans throughout their spheres of functioning.

Recommended: Background in one of human factors, usability/hci, programming experience, design

ROB 568, SOCIAL ROBOTICS, 4 Credits

In-depth exploration of the leading research, design principles, and challenges in Human-Robot Interaction (HRI), with an emphasis on socially interactive robots. Topics include social embodiment, multi-modal communication, human-robot teamwork, social learning, aspects of social psychology and cognition, as well as applications and evaluation with human subjects. Requires participation, lightning talks, student-led lectures, written critiques of class readings, and a group project involving a hypothetical social robotics project.

ROB 599, SPECIAL TOPICS, 0-16 Credits

This course is repeatable for 32 credits.

ROB 601, RESEARCH, 1-16 Credits

Graded P/N.

This course is repeatable for 99 credits.

ROB 603, THESIS, 1-16 Credits

This course is repeatable for 999 credits.

ROB 605, READING AND CONFERENCE, 1-16 Credits

This course is repeatable for 16 credits.

Science of Engineering (ESC)

ESC 111, INTRODUCTION TO ENGINEERING, 3 Credits

Describes different fields of engineering; Performs calculations and synthesize results; Develops critical thinking skills and apply to engineering problems; Applies engineering specific technical and soft skills.

Equivalent to: MIME 101

ESC 340, INTRO TO EXPERIMENTATION, 4 Credits

Theory and application of instrumentation and measurement techniques are covered. Course topics include fundamentals of sampling theory, error and uncertainty analysis, signal conditioning, sensor fundamentals, and data analysis. Laboratory exercises provide experience utilizing data acquisition hardware and software, as well as a variety of sensors for measuring parameters from mechanical and electrical engineering systems.

Prerequisite: CS 162 with C or better and ENGR 202 [C] and PH 213 [C] and ST 314 [C]

ESC 350, ENGINEERING MATERIALS, 4 Credits

An introduction to materials and their structures and properties. The physical and chemical phenomena responsible for the electrical, mechanical, and thermal behavior of solids will be studied.

Prerequisite: PH 213 with C or better and CH 232 [C]

ESC 401, RESEARCH, 1-16 Credits

Equivalent to: ESE 401

This course is repeatable for 4 credits.

ESC 497, ^MIME CAPSTONE DESIGN, 4 Credits

Product design; selection and replacement of major tools, processes, and equipment; paperwork controls; subsystem revision; system or plant revision; selection and training of personnel; long-run policies and strategy. CROSSLISTED as ESC 497/ESE 497. (Writing Intensive Course)

Attributes: CWIC – Core, Skills, WIC

Prerequisite: (ENGR 390 with C or better or BA 360 with C or better) and IE 425 [C] and (ME 312 [C] or ME 312H [C]) and (ME 331 [C] or ME 331H [C]) and ESE 355 [C] and ESE 360 [C] and (ST 314 [C] or ST 314H [C]) and WR 327 [C]

Equivalent to: ESE 497, MIME 497

ESC 498, ^MIME CAPSTONE DESIGN, 4 Credits

Product design; selection and replacement of major tools, processes, and equipment; paperwork controls; subsystem revision; system or plant revision; selection and training of personnel; long-run policies and strategy. (Writing Intensive Course)

Attributes: CWIC – Core, Skills, WIC

Prerequisite: ESE 497 with C or better or IE 497 with C or better or ME 497 with C or better or MIME 497 with C or better

Equivalent to: ESE 498, IE 498, ME 498

ESC 499, SPECIAL TOPICS, 4 Credits

This course is repeatable for 16 credits.