INDUSTRIAL ENGINEERING (IE)

Courses primarily for undergraduates:

IE 1010: Industrial Engineering Profession
Credits: Required. Contact Hours: Lecture 1.
Introduce students to the industrial engineering profession, its scope, industrial engineering tools, and future trends. Offered on a satisfactory-fail basis only. (Typically Offered: Fall, Spring)

IE 1480: Information Engineering
Credits: 3.
Prereq: Credit or concurrent enrollment in MATH 1430
Solving engineering problems with information-driven solutions. Effective communication via technical writing and presentations. Elements of computer science including the software development process, algorithm structure, computational thinking, and the human-computer interface. Database structure. Graduation Restriction: Only one of ENGR 1600, ABE 1600, AERE 1600, BME 1600, CE 1600, CHE 1600, CPRE 1850, EE 1850, IE 1480, ME 1600, and SE 1850 may count towards graduation. (Typically Offered: Fall, Spring)

IE 2220: Design & Analysis Methods for System Improvements
Credits: 3. Contact Hours: Lecture 3.
Prereq: Credit or enrollment in IE 2710
Study of system improvement methods and strategies. Specific areas of lean system improvements include continuous improvement, setup reduction, workplace organization, and inventory and waste reduction. Methods and strategies for productivity analysis to quantify the impact of changes. (Typically Offered: Spring)

IE 2480: Engineering System Design, Manufacturing Processes and Specifications
Credits: 3. Contact Hours: Lecture 2, Laboratory 2.
*Prereq: Credit or concurrent enrollment in (*IE 1010*;* MATE 2730*);* MATH 1660 *or* MATH 1660H*;* PHYS 2310 *or* PHYS 2310H
Introduction to metrology, engineering drawings and specifications. Engineering methods for designing and improving systems. Theory, applications, and quality issues related to machining processes. (Typically Offered: Fall)

IE 2710: Applied Ergonomics and Work Design
Credits: 3. Contact Hours: Lecture 3.
Prereq: PHYS 2310 *and* PHYS 2310L
Basic concepts of ergonomics and human factors in the context of work design. Their impact on worker and workplace productivity, and cost. Investigations of work physiology, biomechanics, anthropometry, work sampling, work evaluation methods, and their measurement as they relate to the design of human-machine systems. (Typically Offered: Spring)

IE 3050: Engineering Economic Analysis
Credits: 3. Contact Hours: Lecture 3.
Prereq: MATH 1660
Time value of money principles applied to business, engineering, and personal economic decisions. Project evaluation and comparison based on equivalence calculations, net present worth, and rate of return analysis. Cash flows for engineering projects that consider life-cycle costs, borrowing, depreciation, taxes, and inflation. Engineering decisions with uncertainty and incorporation of risk into project valuations. (Typically Offered: Fall, Spring, Summer)

IE 3120: Optimization
Credits: 3. Contact Hours: Lecture 3.
Prereq: Credit or enrollment in MATH 2670
Concepts, optimization and analysis techniques, and applications of operations research. Formulation of mathematical models for systems, concepts, and methods of improving search, linear programming and sensitivity analysis, network models, and integer programming. (Typically Offered: Fall)

IE 3410: Production Systems
Credits: 3. Contact Hours: Lecture 3.
Prereq: Credit or concurrent enrollment in IE 3120; STAT 2310
Introduction of key concepts in the design and analysis of production systems. Topics include inventory control, forecasting, material requirement planning, Kanban systems, project planning and scheduling including Critical Path Method (CPM). Advanced design, analysis, operation, and improvement of supply chains with effectiveness, efficiency, sustainability and social responsibility. (Typically Offered: Fall)

IE 3480: Solidification Processes
(Cross-listed with MATE 3480).
Credits: 3. Contact Hours: Lecture 2, Laboratory 2.
Prereq: IE 2480 *and* MATE 2730*, or* MATE 2150
Theory and applications related to metal casting, welding, polymer processing, powder metallurgy, and composites manufacturing, and related rapid manufacturing processes. (Typically Offered: Spring)

IE 3610: Statistical Quality Assurance
(Cross-listed with STAT 3610).
Credits: 3. Contact Hours: Lecture 3.
Prereq: STAT 2310*,* STAT 3010*,* STAT 3260*, or* STAT 5870
Statistical methods for process improvement. Simple quality assurance principles and tools. Measurement system precision and accuracy assessment. Control charts. Process capability assessment. Experimental design and analysis for process improvement. Significant external project in process improvement. (Typically Offered: Fall, Spring)

IE 4030: Introduction to Sustainable Production Systems
Credits: 3. Contact Hours: Lecture 3.
Prereq: Credit or enrollment IE 3410
Quantitative introduction of sustainability concepts in production planning and inventory control. Review of material recovery (recycling) and product/component recovery (remanufacturing) from productivity perspectives. Sustainability rubrics ranging from design and process to systems. Application to multi-echelon networks subject to forward/backward flow of material and information. Closed-loop supply chains. Comparative study of sustainable vs. traditional models for local and global production systems.

IE 4050: Advanced Engineering Economy for Complex Engineering Projects
Credits: 3. Contact Hours: Lecture 3.
Prereq: MATH 2650*,* MATH 2670*,* STAT 2310 *and I E 3050*
Overview of engineering economic valuation and complex engineering projects. Stochastic dynamic programming for project valuation. Modeling and analysis of confounding factors of engineering projects. Integration and synthesis of valuation methodologies to complex projects. Applications to power plants, transmission networks, and satellites.

IE 4130: Stochastic Modeling, Analysis and Simulation
Credits: 4. Contact Hours: Lecture 3, Discussion 1.
Prereq: MATH 2650 *and* STAT 2310
Development of probabilistic models and simulation models using a simulation language. Fitting of parametric distributions to data. Introduction to Markov processes and queueing models. Model output analysis and utilization for improved decision-making. Application of models to engineering design of effective and efficient manufacturing and service systems. (Typically Offered: Fall)

IE 4200: Engineering Problem Solving with R
Credits: 3. Contact Hours: Lecture 3.
Prereq: STAT 2310
Introduction to data analytics using R programming language. Data manipulation. Exploratory data analysis via basic graphics. Basic statistical analysis including statistical tests and linear regression. R Markdown. Simulation by replicating a calculation. Conditional expressions, loops, and functions. High level data visualizations using ggplot graphics. Data extraction from text. Optimization via R build-in functions. Logistic regression. High performance computing tools. Project required for graduate credits. (Typically Offered: Spring)

IE 4300: Entrepreneurial Product Engineering
(Cross-listed with ENGR 4300).
Credits: 3. Contact Hours: Lecture 3.
Prereq: Junior classification
Process of innovative product development in both entrepreneurial and intra-preneurial settings. Define, prototype and validate a product concept based on competitive bench-marking, market positioning and customer requirement evaluation in a target market into a product design that is consistent with defined business goals and strategies. Combination of lecture, discussion, problem solving and case study review. (Typically Offered: Fall, Spring)

IE 4320: Industrial Automation
Credits: 3. Contact Hours: Lecture 2, Laboratory 3.
Prereq: PHYS 2320*;* PHYS 2320L
Overview of electrical circuit theory and its relationship to industrial control systems. Theory and application of transducers in the form of sensors and actuators, with applications in manufacturing, distribution and mechanical systems. Programmable Logic Controllers (PLC), their programming and use for automation solutions. Introduction of automated identification systems such as Radio Frequency Identification (RFID) and Bar Coding technologies. (Typically Offered: Spring)

IE 4340X: Entrepreneurial Product Engineering Design Project
(Cross-listed with ENGR 4340X).
Credits: 0-99. Contact Hours: Laboratory 4, Lecture 1.
Repeatable.
Prereq: IE 4300 *or* ENGR 4300
Open-ended design project related to creating, validating and launching a new engineered product into the marketplace. Fundamentals related to launching new engineered products in an Entrepreneurial way. Students submit new product ideas or select from a list of company supplied ideas. Application of engineering design principles including product definition, competitive evaluation, requirements evaluation, product design, manufacturing design, manufacturing costing, prototype creation, field validation, user evaluation. (Typically Offered: Spring)

IE 4370: Reliability and Safety Engineering
Credits: 3. Contact Hours: Lecture 3.
Prereq: STAT 2310 *or* STAT 3050 *or* STAT 5870
Mathematical basics for dealing with reliability data, theory, and analysis. Bayesian reliability analysis. Engineering ethics in safety evaluations. Case studies of accidents in large technological systems. Fault and event tree analysis.

IE 4410: Industrial Engineering Design
Credits: 3. Contact Hours: Lecture 1, Laboratory 6.
Prereq: IE 2480, IE 2710, IE 3610*; (credit or enrollment in IE 3410,* IE 4130*, AND* IE 4480*)*
An engineering design project performed in a real-world company that requires students to develop quantitative objectives, conduct field-based current state measurements, and create multiple design alternatives to meet or exceed customer requirements. Student teams work with company stakeholders to document, quantitatively justify, and implement to the extent practical, solutions that generate substantive economic impact. (Typically Offered: Fall, Spring)

IE 4440: Micro/Nano Scale Additive Printing
Credits: 3. Contact Hours: Lecture 3.
Introduction of physical theory, design, analysis, fabrication, and characterization of micro/nano scale fabrication and manufacturing systems; introduction of micro/nano scale additive manufacturing; and deep understanding of additive printing for micro/nano scale applications. Focus on the fabrication/manufacturing of important types of microstructures used in micro/nano devices using additive printing, and the techniques and tools used to characterize them. Students are expected to finish a team projected related applying additive printing experimentally or theoretically to the design of a sensor. (Typically Offered: Fall)

IE 4450: Additive Manufacturing and Rapid Production Methods
Credits: 3. Contact Hours: Lecture 3.
Introduction to additive manufacturing and other rapid prototyping and manufacturing methodologies. Operating principles and characteristics of current and developing processes. Use of rapid prototypes in product design, development, and service. Selection of rapid prototyping and manufacturing systems, from design to mass production. Hybrid manufacturing and other integration of rapid production methods.

IE 4460: Geometric Variability in Manufacturing
Credits: 3. Contact Hours: Lecture 3.
Assessment, accommodation, and control of geometric variability in manufacturing processes, specifically composites, metalcasting, welding, machining, powder metallurgy and additive processing. Techniques include the design of the component, tooling, process plan and inspection methodology.

IE 4470: Biomedical Design and Manufacturing
(Cross-listed with BME 4470).
Credits: 3. Contact Hours: Lecture 3.
Exploration of biology, materials, body mechanics, manufacturing, quality control, and ethics and the intersection of these subjects as they relate to biomedical manufacturing. Study of medical data (CT, MRI, etc.) processing, biomedical design, 3D bioprinting and additive manufacturing concepts.

IE 4480: Manufacturing Systems Engineering
Credits: 3. Contact Hours: Lecture 3.
Prereq: IE 2480
Fixturing and tooling requirements for manufacturing process planning, geometric dimensioning and tolerancing, computer aided inspection, cellular and flexible manufacturing, facility layout and controlled flow production. (Typically Offered: Spring)

IE 4490: Computer Aided Design and Manufacturing
Credits: 3. Contact Hours: Lecture 3.
Prereq: IE 2480*, and* MATH 2650
Representation and interpretation of curves, surfaces and solids. Parametric curves and surfaces and solid modeling. Use of CAD software and CAD/CAM integration. Computer numerical control, CNC programming languages, and process planning.

IE 4500: Technical Sales for Engineers
Credits: 3. Contact Hours: Lecture 3.
Prereq: Credit or enrollment in IE 3050
Technical sales process methodology, tools and techniques. Customer relationship management (CRM) sales automation applications, prospecting and lead qualification, market analysis and industry segmentation. Responding to prospective requests for quotation and proposal (RFQs and RFPs) in written and verbal form. Technical needs analysis, business value proposition development, proposal creation and competitive positioning. Evaluating organizational decision-making processes and people, being a trusted advisor, and practicing sales closing strategies. (Typically Offered: Fall)

IE 4520: Introduction To Systems Engineering And Analysis
(Cross-listed with AERE 4520).
Credits: 3. Contact Hours: Lecture 3.
Prereq: Junior Classification in an Engineering Major
Principles of systems engineering to include problem statement formulation, stakeholder analysis, requirements definition, system architecture and concept generation, system integration and interface management, verification and validation, and system commissioning and decommissioning operations. Introduction to discrete event simulation processes. Students will work in groups to propose, research, and present findings for a systems engineering topic of current relevance. (Typically Offered: Summer)

IE 4530X: Engineering Problem Solving for Defense
Credits: 3.
Prereq: Permission of Instructor; Sophomore classification
The primary objective of IE 4530X is to obtain practice in comprehensive engineering and communication skills, while simultaneously honing personal effectiveness and entrepreneurial skills, through the development and completion of an engineering project sponsored by a Department of Defense (DOD) agency. Engineering expectations include applying both previously learned and newly acquired knowledge and skills to identify, formulate, and solve a complex engineering problem, which results in tangible deliverables for the DOD agency. The semester's projects will revolve around the theme of prototyping solutions for national security. Engineered solutions will consider extensive ramifications, including defense and security, political, ethical, environmental and energy, and global issues. Project developments will be communicated via the Lean Startup methodology made famous by Stanford University to iteratively cut through the complexity. Student teams will provide the DOD sponsor with a validated problem, a validated solution concept, and a prototyped Minimal Viable Product.

IE 4680: Large-Scale Complex Engineered Systems (LSCES)
(Cross-listed with AERE 4680).
Credits: 3. Contact Hours: Lecture 3.
Prereq: Senior classification in an Engineering major or Permission of Instructor
Introduction to the theorectical foundation and methods associated with the design for large-scale complex engineered systems, including objective function formation, design reliability, value-driven design, product robustness, utility theory, economic factors for the formation of a value function and complexity science as a means of detecting unintended consequences in the product behavior. (Typically Offered: Spring)

IE 4700: Systems Engineering and Project Management
Credits: 3. Contact Hours: Lecture 3.
Prereq: Credit or enrollment in IE 3050; or instructor permission; Credit or enrollment in STAT 2310 *or* STAT 3010 *or* STAT 3050 *or* STAT 3260 *or STAT 4010 or* STAT 5870*; or instructor permission*
Systems view of projects and the processes by which they are implemented. Focuses on qualitative and quantitative tools and techniques of project management. Topics will include organizational structure types; project selection methodologies; simulation and optimization; and earned value management. Case studies will be included, and a group project required.

IE 4720: Design and Evaluation of Human-Computer Interaction
(Dual-listed with IE 5720).
Credits: 3. Contact Hours: Lecture 3.
Prereq: Junior classification
Human factors methods applied to interface requirements, design, prototyping, and evaluation. Concepts related to understanding user characteristics, design principles, usability analysis, methods and techniques for design and evaluation of the interface. The evaluation and design of the information presentation characteristics of a wide variety of interfaces: web sites (e-commerce), mobile applications, and information presentation systems (cockpits, instrumentation, etc.).

IE 4810: e-Commerce Systems Engineering
Credits: 3. Contact Hours: Lecture 3.
Prereq: IE 1480.
Design, analysis, and implementation of e-commerce systems. Information infrastructure, enterprise models, enterprise processes, enterprise views. Data structures and algorithms used in e-commerce systems, SQL, exchange protocols, client/server model, web-based views.

IE 4830: Data Mining
Credits: 3. Contact Hours: Lecture 3.
Prereq: IE 1480*,* IE 3120*,* STAT 2310
Foundations of classification, data clustering and association rule mining. Techniques for data mining, with focus on tree-based methods for classification (simple trees, random forest and boosted trees), ensemble learning, optimization algorithms and deep learning with neural networks. Performance metrics and resampling methods for evaluating model quality. A computing project in R is required.

IE 4870: Big Data Analytics and Optimization
Credits: 3. Contact Hours: Lecture 3.
Prereq: IE 3120 *and* STAT 2310
Optimization and statistical learning related to big data problems. Modern modeling for data-driven optimization problems and their applications in big data analytics. Algorithms for optimization and statistical learning and their implementation. Applications in manufacturing sector and service sciences. (Typically Offered: Spring)

IE 4900: Independent Study
Credits: 1-5. Repeatable.
Prereq: Senior classification; Permission of Instructor
Independent study and work in the areas of industrial engineering design, practice, or research.

IE 4900H: Independent Study: Honors
Credits: 1-5. Repeatable.
Prereq: Senior classification; Permission of Instructor
Independent study and work in the areas of industrial engineering design, practice, or research.

Courses primarily for graduate students, open to qualified undergraduates:

IE 5010: I E Graduate Seminar
Credits: Required. Contact Hours: Lecture 1.
Repeatable.
Principles and practices for research tasks at the M.S. level including proposal writing, presentations, paper preparation, and project management. Offered on a satisfactory-fail basis only.

IE 5030: Introduction to Sustainable Production Systems
Credits: 3. Contact Hours: Lecture 3.
Quantitative introduction of sustainability concepts in production planning and inventory control. Review of material recovery (recycling) and product/component recovery (remanufacturing) from productivity perspectives. Sustainability rubrics ranging from design and process to systems. Application to multi-echelon networks subject to forward/backward flow of material and information. Closed-loop supply chains. Comparative study of sustainable vs. traditional models for local and global production systems.

IE 5050: Advanced Engineering Economy for Complex Engineering Projects
Credits: 3. Contact Hours: Lecture 3.
Overview of engineering economic valuation and complex engineering projects. Stochastic dynamic programming for project valuation. Modeling and analysis of confounding factors of engineering projects. Integration and synthesis of valuation methodologies to complex projects. Applications to power plants, transmission networks, and satellites.

IE 5080: Design and Analysis of Allocation Mechanisms
Credits: 3. Contact Hours: Lecture 3.
Market-based allocation mechanisms from quantitative economic systems perspective. Pricing and costing models designed and analyzed with respect to decentralized decision processes, information requirements, and coordination. Financial Engineering Techniques. Case studies and examples from industries such as regulated utilities, semiconductor manufacturers, and financial engineering services.

IE 5100: Network Analysis
Credits: 3. Contact Hours: Lecture 3.
Formulation and solution of deterministic network flow problems including shortest path, minimum cost flow, and maximum flow. Network and graph formulations of combinatorial problems including assignment, matching, and spanning trees. Solution algorithm design and analysis based on optimality conditions and duality.

IE 5130: Analysis of Stochastic Systems
Credits: 3. Contact Hours: Lecture 3.
Introduction to modeling and analysis of manufacturing and service systems subject to uncertainty. Topics include the Poisson process, renewal processes, Markov chains, and Brownian motion. Applications to inventory systems, production system design, production scheduling, reliability, and capacity planning.

IE 5140: Production Scheduling
Credits: 3. Contact Hours: Lecture 3.
Introduction to the theory of machine shop systems. Complexity results for various systems such as job, flow and open shops. Applications of linear programming, integer programming, network analysis. Enumerative methods for machine sequencing. Introduction to stochastic scheduling.

IE 5190: Simulation Modeling and Analysis
Credits: 3. Contact Hours: Lecture 3.
Event scheduling, process interaction, and continuous modeling techniques. Introduction of Bayesian simulation techniques and commonly used numerical methods. Probability and statistics related to simulation parameters including run length, metrics, inference, design of experiments, variance reduction, and stopping rules. Simulation of stochastic concepts and processes. Aspects of simulation languages. A computing project in a programing language is required.

IE 5200: Engineering Problem Solving with R
Credits: 3. Contact Hours: Lecture 3.
Introduction to data analytics using R programming language. Data manipulation. Exploratory data analysis via basic graphics. Basic statistical analysis including statistical tests and linear regression. R Markdown. Simulation by replicating a calculation. Conditional expressions, loops, and functions. High level data visualizations using ggplot graphics. Data extraction from text. Optimization via R build-in functions. Logistic regression. High performance computing tools. Project required for graduate credits. (Typically Offered: Spring)

IE 5310: Quality Control and Engineering Statistics
(Cross-listed with STAT 5310).
Credits: 3. Contact Hours: Lecture 3.
Prereq: STAT 5870 *and* STAT 5880
Statistical methods and theory applicable to problems of industrial process monitoring and improvement. Statistical issues in industrial measurement; Shewhart, CUSUM, and other control charts; feedback control; process characterization studies; estimation of product and process characteristics; acceptance sampling, continuous sampling and sequential sampling; economic and decision theoretic arguments in industrial statistics.

IE 5330: Reliability
(Cross-listed with STAT 5330).
Credits: 3. Contact Hours: Lecture 3.
Probabilistic modeling and inference in engineering reliability; lifetime models, product limit estimator, probability plotting, maximum likelihood estimation for censored data, Bayesian methods in reliability, system reliability models, competing risk analysis, acceleration models and analysis of accelerated test data; analysis of recurrent events and degradation data; planning studies to obtain reliability data. Offered even-numbered years. (Typically Offered: Spring)

IE 5340: Linear Programming
Credits: 3. Contact Hours: Lecture 3.
Formulation of optimization problems as mathematical models, such as linear programming, integer programming, and multi-objective optimization. Introduction to classic optimization algorithms, such as Simplex and cutting plane algorithms. Basic concepts of duality theory and sensitivity analysis. Using computer solvers to obtain optimal solutions to optimization models.

IE 5370: Reliability and Safety Engineering
Credits: 3. Contact Hours: Lecture 3.
Mathematical basics for dealing with reliability data, theory, and analysis. Bayesian reliability analysis. Engineering ethics in safety evaluations. Case studies of accidents in large technological systems. Fault and event tree analysis.

IE 5410: Inventory Control and Production Planning
Credits: 3. Contact Hours: Lecture 3.
Economic Order Quantity, dynamic lot sizing, newsboy, base stock, and (Q,r) models. Material Requirements Planning, Just-In-Time (JIT), variability in production systems, push and pull production systems, aggregate and workforce planning, and capacity management. Supply Chain Contracts.

IE 5440: Micro/Nano Scale Additive Printing
Credits: 3. Contact Hours: Lecture 3.
Prereq: IE 3480 *or Graduate Classification*
Introduction of physical theory, design, analysis, fabrication, and characterization of micro/nano scale fabrication and manufacturing systems; introduction of micro/nano scale additive manufacturing; and deep understanding of additive printing for micro/nano scale applications. Focus on the fabrication/manufacturing of important types of microstructures used in micro/nano devices using additive printing, and the techniques and tools used to characterize them. Students are expected to finish a team projected related applying additive printing experimentally or theoretically to the design of a sensor. (Typically Offered: Fall)

IE 5450: Additive Manufacturing and Rapid Production Methods
Credits: 3. Contact Hours: Lecture 3.
*Prereq: (*IE 2480 *and* MATH 2650*) or Graduate Classification*
Introduction to additive manufacturing and other rapid prototyping and manufacturing methodologies. Operating principles and characteristics of current and developing processes. Use of rapid prototypes in product design, development, and service. Selection of rapid prototyping and manufacturing systems, from design to mass production. Hybrid manufacturing and other integration of rapid production methods.

IE 5460: Geometric Variability in Manufacturing
Credits: 3. Contact Hours: Lecture 3.
*Prereq: (*IE 3480 *or* MATE 2160 *or ME 3240) or Graduate Classification*
Assessment, accommodation, and control of geometric variability in manufacturing processes, specifically composites, metalcasting, welding, machining, powder metallurgy and additive processing. Techniques include the design of the component, tooling, process plan and inspection methodology.

IE 5470: Biomedical Design and Manufacturing
Credits: 3. Contact Hours: Lecture 3.
Exploration of biology, materials, body mechanics, manufacturing, quality control, and ethics and the intersection of these subjects as they relate to biomedical manufacturing. Study of medical data (CT, MRI, etc.) processing, biomedical design, 3D bioprinting and additive manufacturing concepts.

IE 5490: Computer Aided Design and Manufacturing
Credits: 3. Contact Hours: Lecture 3.
Representation and interpretation of curves, surfaces and solids. Parametric curves and surfaces and solid modeling. Use of CAD software and CAD/CAM integration. Computer numerical control, CNC programming languages, and process planning.

IE 5600: Engineering Risk Analysis
Credits: 3. Contact Hours: Lecture 3.
Overview of probabilistic risk analysis, modeling risks, and risk management. Topics include probability, influence diagrams, subjective probability assessment, fault tree analysis, decision making with uncertainty, risk perception, risk communication, and intelligent adversary. Use of Monte Carlo simulation to combine different sources of uncertainty and risk to generate probability distributions over an outcome. Application of probabilistic risk analysis to business investments, engineering systems, critical infrastructure, defense and security, and health systems.

IE 5610: Total Quality Management
Credits: 3. Contact Hours: Lecture 3.
Perspectives for how to analyze and implement total quality management in different organizations, to include manufacturing firms, service industries, the non-profit sector, and government agencies. Topics include the different viewpoints of quality (from the customer, workforce, and process perspective); aligning quality in an organization's goals; performance measurement; quality in supply chain management; and reliability. Some advanced statistical elements of quality control will also be discussed.

IE 5630: Engineering and Systems Management
Credits: 3. Contact Hours: Lecture 3.
Introduction to engineering management concepts and examples relevant to the engineering manager today. Topics include decision trees and associated probabilities; personnel issues and challenges; working with management, client and the project team; personality types; and documents/forms that are useful for the engineering manager. Case studies, and a group project required.

IE 5640: Decision Analysis
Credits: 3. Contact Hours: Lecture 3.
Application of normative decision theory to problems with uncertainty and/or multiple objectives. The first decision framework will be a single-objective decision problem with uncertainty that takes into account a decision maker's attitude towards risk. The second decision framework will be a multi-criteria decision problem in which a decision maker has multiple objectives. Topics include utility theory, value of information, sensitivity analysis, value-focused thinking, cost-effectiveness analysis, influence diagrams, and behavioral decision making. Examples will be drawn from business, systems engineering and design, and government.

IE 5650: Systems Engineering and Analysis
(Cross-listed with AERE 5650/ EE 5650).
Credits: 3. Contact Hours: Lecture 3.
Introduction to organized multidisciplinary approach to designing and developing systems. Concepts, principles, and practice of systems engineering as applied to large integrated systems. Life cycle costing, scheduling, risk management, functional analysis, conceptual and detail design, test and evaluation, and systems engineering planning and organization. Graduation Restrictions: Not available for degrees in industrial engineering.

IE 5660: Applied Systems Engineering
Credits: 3. Contact Hours: Lecture 3.
Design for reliability, maintainability, usability, supportability, producibility, disposability, and life cycle costs in the context of the systems engineering process. Students will be required to apply the principles of systems engineering to a project including proposal, program plan, systems engineering management plan, and test and evaluation plan. Graduation Restriction: Not available for degrees in industrial engineering.

IE 5680: Large-Scale Complex Engineered Systems (LSCES)
(Cross-listed with AERE 5680).
Credits: 3. Contact Hours: Lecture 3.
Introduction to the theoretical foundation and methods associated with the design for large-scale complex engineered systems, including objective function formation, design reliability, value-driven design, product robustness, utility theory, economic factors for the formation of a value function and complexity science as a means of detecting unintended consequences in the product behavior. (Typically Offered: Spring)

IE 5700: Systems Engineering and Project Management
Credits: 3. Contact Hours: Lecture 3.
Prereq: IE 3050 *and (*STAT 2310 *or* STAT 3050*) and Junior classification or Graduate Classification*
Systems view of projects and the processes by which they are implemented. Focuses on qualitative and quantitative tools and techniques of project management. Topics will include organizational structure types; project selection methodologies; simulation and optimization; and earned value management. Case studies will be included, and a group project required.

IE 5710: Occupational Biomechanics
Credits: 3. Contact Hours: Lecture 3.
Anatomical, physiological, and biomechanical bases of physical ergonomics. Anthropometry, body mechanics, strength of biomaterials, human motor control. Use of bioinstrumentation, passive industrial surveillance techniques and active risk assessment techniques. Acute injury and cumulative trauma disorders. Static and dynamic biomechanical modeling. Emphasis on low back, shoulder and hand/wrist biomechanics.

IE 5720: Design and Evaluation of Human-Computer Interaction
(Dual-listed with IE 4720).
Credits: 3. Contact Hours: Lecture 3.
Human factors methods applied to interface requirements, design, prototyping, and evaluation. Concepts related to understanding user characteristics, design principles, usability analysis, methods and techniques for design and evaluation of the interface. The evaluation and design of the information presentation characteristics of a wide variety of interfaces: web sites (e-commerce), mobile applications, and information presentation systems (cockpits, instrumentation, etc.).

IE 5760: Human Factors in Product Design
Credits: 3. Contact Hours: Lecture 3.
Investigation of the human interface to consumer and industrial systems and products, providing a basis for their design and evaluation. Discussions of human factors in the product design process: modeling the human during product use; usability; human factors methods in product design evaluation; user-device interface; safety, warnings, and instructions for products; considerations for human factors in the design of products for international use.

IE 5770: Human Factors
Credits: 3. Contact Hours: Lecture 3.
Physical and psychological factors affecting human performance in systems. Signal detection theory, human reliability modeling, information theory, and performance shaping applied to safety, reliability, productivity, stress reduction, training, and human/equipment interface design. Laboratory assignments related to system design and operation.

IE 5800X: Introduction of Project Management for Thesis Research
(Cross-listed with CHE 5800X/ MSE 5800X).
Credits: 1. Contact Hours: Lecture 1.
Tools and skills of Project Management (PM) adapted from industry to improve efficiency in thesis research. Project charter initiation for thesis, timeline and meeting scheduling tools, expectation management, and communication with advisors. Practice of the PM skills using student's own thesis. Presentation of a project charter. Demonstration of knowledge of related PM skills and the ability of utilizing these skills for thesis research. Sharing thesis ideas and learning experience in the Graduate for Advancing Professional Skills (GAPS) learning community. Offered on a satisfactory-fail basis only. (Typically Offered: Fall)

IE 5810: e-Commerce Systems Engineering
Credits: 3. Contact Hours: Lecture 3.
Design, analysis, and implementation of e-commerce systems. Information infrastructure, enterprise models, enterprise processes, enterprise views. Data structures and algorithms used in e-commerce systems, SQL, exchange protocols, client/server model, web-based views.

IE 5820: Enterprise Modeling and Integration
Credits: 3. Contact Hours: Lecture 3.
The design and analysis of enterprise models to support information engineering of enterprise-wide systems. Representation of system behavior and structure including process modeling, information modeling, and conceptual modeling. Applications in enterprise application integration, enterprise resource planning systems, product data management systems, and manufacturing execution systems.

IE 5830: Data Mining
Credits: 3. Contact Hours: Lecture 3.
Foundations of classification, data clustering and association rule mining. Techniques for data mining, with focus on tree-based methods for classification (simple trees, random forest and boosted trees), ensemble learning, optimization algorithms and deep learning with neural networks. Performance metrics and resampling methods for evaluating model quality. A computing project in R is required.

IE 5850: Requirements and Architecture Engineering
Credits: 3. Contact Hours: Lecture 3.
Principles and practices for requirements engineering as part of the product development process with emphasis on software systems engineering. Problem definition, problem analysis, requirements analysis, requirements elicitation, validation, specifications. Case studies using requirements engineering methods and techniques.

IE 5870: Big Data Analytics and Optimization
Credits: 3. Contact Hours: Lecture 3.
Optimization and statistical learning related to big data problems. Modern modeling for data-driven optimization problems and their applications in big data analytics. Algorithms for optimization and statistical learning and their implementation. Applications in manufacturing sector and service sciences. (Typically Offered: Spring)

IE 5880: Information Systems for Manufacturing
Credits: 3. Contact Hours: Lecture 3.
Design and implementation of systems for the collection, maintenance, and usage of information needed for manufacturing operations, such as process control, quality, process definition, production definitions, inventory, and plant maintenance. Topics include interfacing with multiple data sources, methods to utilize the information to improve the process, system architectures, and maintaining adequate and accurate data for entities internal and external to the enterprise to achieve best manufacturing practices.

IE 5900: Special Topics
Credits: 1-3. Repeatable.
Prereq: Instructor Permission for Course
Advanced study of a research topic in the field of industrial engineering.

IE 5990: Creative Component
Credits: 1-30.
Prereq: Instructor Permission for Course
Offered on a satisfactory-fail basis only.

Courses for graduate students:

IE 6130: Stochastic Production Systems
Credits: 3. Contact Hours: Lecture 3.
Modeling techniques to evaluate performance and address issues in design, control, and operation of systems. Markov models of single-stage make-to-order and make-to-stock systems. Approximations for non-Markovian systems. Impact of variability on flow lines. Open and closed queuing networks.

IE 6310: Nonlinear Programming
Credits: 3. Contact Hours: Lecture 3.
Develop nonlinear models, convex sets and functions, optimality conditions, Lagrangian duality, unconstrained minimization techniques. Constrained minimization techniques covering penalty and barrier functions, sequential quadratic programming, the reduced gradient method, nonlinear control concepts.

IE 6320: Integer Programming
Credits: 3. Contact Hours: Lecture 3.
Integer programming including cutting planes, branch and bound, and Lagrangian relaxation. Introduction to complexity issues and search-based heuristics.

IE 6330: Stochastic Programming
Credits: 3. Contact Hours: Lecture 3.
Mathematical programming with uncertain parameters; modeling risk within optimization; multi-stage recourse and probabilistically constrained models; solution and approximation algorithms including Benders decomposition and progressive hedging; and applications to planning, allocation and design problems.

IE 6340: Computational Optimization
Credits: 3. Contact Hours: Lecture 3.
Theory, algorithm, and computer implementation of optimization models. Simplex, Benders decomposition, computational complexity, mixed integer linear program, linear program with complementarity constraints, inverse optimization, bilevel discrete optimization. Open source and commercial optimization solvers will be introduced and used.

IE 6420: Simultaneous Engineering in Manufacturing Systems
Credits: 3. Contact Hours: Lecture 3.
Current engineering methods for the product life cycle process. Feature-based design, computer-aided process planning, and data-driven product engineering.

IE 6710: Research Practicum in Human Factors and Ergonomics
Credits: 3. Contact Hours: Lecture 3.
Repeatable.
Research topic development, literature evaluation, experimental design, use of bioinstrumentation, data collection, basic data interpretation, statistical analysis, manuscript preparation.

IE 6720: Human Factors in Automation Design
Credits: 3. Contact Hours: Lecture 3.
Concepts in human-automation systems, including levels of automation, types of automation, and level of control. Implications of how adaptive automation affects error, trust, workload, situation awareness, and performance. Understand how human operators are affected by automation implementation in real-world systems. Apply human factors concepts to the design and evaluation of human-automation systems. Offered even-numbered years. (Typically Offered: Fall)

IE 6730: Spine Biomechanics
Credits: 3. Contact Hours: Lecture 3.
Repeatable, maximum of 3 times.
Gross and fine anatomy of spine, mechanism of pain, epidemiology, in vitro testing, psychophysical studies, spine stability models, bioinstrumentation: intradiscal pressure, intra-abdominal pressure and electromyography. Biomechanics of lifting and twisting, effects of vibration, effects of posture/lifting style, lifting belts, physical models, optimization models, mathematical models, muscle models, finite element models, current trends in medical management and rehabilitation, chiropractic. Offered odd-numbered years. (Typically Offered: Fall)

IE 6810: Cognitive Engineering
(Cross-listed with HCI 6810).
Credits: 3. Contact Hours: Lecture 3.
Provides an overview of human cognitive capabilities and limitations in the design of products, workplaces, and large systems. Contexts vary broadly and could range from simple use of mobile devices to an air-traffic control or nuclear plant command center. Course focuses on what we can infer about users' thoughts and feelings based on what we can measure about their performance and physiological state. Covers the challenge of designing automated systems.

IE 6900: Advanced Topics
Credits: 1-3. Repeatable.
Prereq: Instructor Permission for Course
Advanced topics related to Ph.D. research in industrial engineering under the direction of the instructor.

IE 6970: Engineering Internship
Credits: Required. Repeatable.
One Fall OR Spring semester combined with one summer, maximum per academic year. Excludes Fall/Spring combination. Professional work period. Offered on a satisfactory-fail basis only. (Typically Offered: Fall, Spring, Summer)

IE 6990: Research
Credits: 1-30. Repeatable.
Prereq: Instructor Permission for Course