Industrial and Systems Engineering (ISE)

ISE 135 Computer-Based Modeling for Industrial Engineering (3 credit hours)
Introductory course in computer-based modeling and programming using Python for Engineering Applications. Emphasis on algorithm development and engineering problem solving. Methodical development of Python scripts to link with Microsoft Excel using xlwings plugin through proper specifications; documentation, style; control structures; data types and data abstraction; graphical user interface design. Projects: design problems from industrial engineering systems. Functional relationships will be given and programs will be designed and developed from a list of specifications.

Prerequisite: E 115, Corequisite: MA 141
Typically offered in Fall and Spring

ISE 215 Foundations of Design & 3D Modeling for Engineers (1 credit hours)
This is an 8 week course. An introductory engineering graphics course which builds on the foundations of computer-aided 2D sketching and 3D modeling for industrial engineers. Students will develop and refine their ability to communicate designs via modeling techniques prolific in industry. The concurrent nature of ideation, engineering analysis and manufacturing will be emphasized as students review case studies and develop their own models. Constraint-based design will drive strategies that accurately reflect design intent and promote part family relationships and automation. Students will work in small teams to create a mechanism that must achieve certain functional criteria. ISE majors have priority registration for this course.

Prerequisite: E115 and Corequisite: ISE216
Typically offered in Fall and Spring

ISE 216 Product Development and Rapid Prototyping (3 credit hours)
Introduction to product development and prototyping. Team-based development of a new product during the semester. Specific topics are voice of the customer, product specification and parameter specification, Quality Function Deployment and the House of Quality, concept generation, concept selection, detailed design using SolidWorks, prototyping, design for assembly, design for the environment, and intellectual properties and patents. Team presentations of a functional prototype of their product at the end of the semester.

Corequisite: ISE 215
Typically offered in Fall and Spring

ISE 311 Engineering Economic Analysis (3 credit hours)
Engineering and managerial decision making. The theory of interest and its uses. Equivalent annual costs, present worth, internal rates of return, and benefit/cost ratios. Accounting depreciation and its tax effects. Economic lot size and similar cost minimization models. Sensitivity analysis. Cost dichotomies: fixed vs. variable, and incremental vs. sunk, use of accounting data. Replacement theory and economic life. Engineering examples.

Prerequisite: Grade of C or better in MA 141
Typically offered in Fall, Spring, and Summer

ISE 315 Introduction to Computer-Aided Manufacturing (1 credit hours)
This is an 8 week course. Introduction to the principles of modern-day multi-axis machine tool control, using computer-aided manufacturing (CAM) software tools. Emphasis is placed on transferring part geometry from CAD to CAM, for the development of CNC-ready programs. Industry file formats, machining strategies, G & M-code generation, optimization and verification techniques will also be investigated. Upon successful completion of this course, students will be able to demonstrate proficiency in the use of industry-relevant CAD/CAM software and will be able to extend that knowledge to practice through exercises and projects. Use of CNC machine tools will be introduced and demonstrated in the department's physical lab spaces. ISE majors have priority registration for this course.

Prerequisite: ISE 215 and Co-requisite: ISE 316
Typically offered in Fall, Spring, and Summer

ISE 316 Manufacturing Engineering I - Processes (3 credit hours)
Analytical study and design of manufacturing engineering with emphasis on mfg. and processes. Addresses the interaction of design, materials, and processing. Laboratory instruction and hands-on experience in metrology, machining, process planning,economic justification, and current mfg. methodologies.

Prerequisite: MSE 200 and ISE 216; Co-requisite: ISE 315
Typically offered in Fall, Spring, and Summer

ISE 352 Fundamentals of Human-Machine Systems Design (3 credit hours)
Introduction to work methods and ergonomics. Coverage of methods to improve operator performance and production process efficiency. Techniques include project evaluation and review, operator-machine ratios, line balancing, work sampling, time study, wage payment, and pre-determined time systems. Ergonomics component includes workstation and hand-tool design, and methods for designing cognitive work and work environment.

Prerequisite: C- or better in ST 371; C or better in ISE 135
Typically offered in Fall and Spring

ISE 361 Deterministic Models in Industrial Engineering (3 credit hours)
Introduction to mathematical modeling, analysis techniques, and solution procedures applicable to decision-making problems in a deterministic environment. Linear programming models and algorithms and associated computer codes are emphasized.

Prerequisite: (MA 303 or MA 341) and C or better in ISE 135
Typically offered in Fall, Spring, and Summer

ISE 362 Stochastic Models in Industrial Engineering (3 credit hours)
Introduction to mathematical modeling, analysis, and solution procedures applicable to uncertain (stochastic) production systems. Methodologies covered include probability theory and stochastic processes. Applications relate to design and analysisof problems, capacity planning, inventory control, waiting lines, and system reliability and maintainability.

Prerequisite: C or better in ISE 135 and (MA 303 or MA 341) and C- or better in ST 371 or ST 370
Typically offered in Fall and Spring

ISE 398 Lean Six Sigma for Industrial Engineering (1 credit hours)
This course leverages the Lean Six Sigma framework to analyze and solve problems as related to quality improvement projects. Students in this course will apply the Lean Six Sigma philosophy and goals to build problem-solving, analytical and technical skills while implementing successful change management techniques.

Corequisite: ISE 498 or ISE 521
Typically offered in Fall and Spring

ISE 408 Design and Control of Production and Service Systems (3 credit hours)
This course focuses on understanding the behavior of manufacturing plants and service systems through a thorough, generalizable and fundamental understanding of the factors affecting their behavior.

Prerequisite: ISE 135, ISE 362, and C- or better in ST 371
Typically offered in Fall and Spring

ISE 411/ISE 511 Supply Chain Economics and Decision Making (3 credit hours)
This course introduces students to the principles of microeconomic analysis applied to decision-making in supply chains. Emphasis will be put on strategic interactions between different decision makers in the supply chain, including suppliers, manufacturers, retailers, and consumers. Topics include classical demand and production theory, pricing and revenue management, competition between firms, and cooperation between and within firms under information asymmetry.

Prerequisite: ISE 135
Typically offered in Fall only

ISE 413/ISE 513 Humanitarian Logistics (3 credit hours)
This course provides a comprehensive treatment of humanitarian logistics (HumLog) from an operations research perspective, focusing on the use of quantitative modeling for decision making and best practices disaster management. Background and overview on disaster management will be covered. The four phases of the disaster management cycle are introduced as well as the types of decisions that are made in each phase. Mathematical models are presented for typical humanitarian logistics decisions, such as inventory prepositioning, facility location, transportation, routing and capacity planning.

Prerequisite: ISE 361
Typically offered in Spring only

ISE 416 Manufacturing Engineering II - Automation (3 credit hours)
Integration of design and mfg. through computer aided/automated process planning, concurrent engineering, and rapid prototyping. Fixed and programmable automation in mfg. and service. Autonomous mfg. systems such as computer numerical control (CNC), industrial robotics, automated inspection, electronics manufacturing and assembly.

Prerequisite: ISE 316
Typically offered in Fall only

ISE 417 Database Applications in Industrial & Systems Engineering (3 credit hours)
Rapid applications development (RAD) tools to design and implement database-based applications. The SQL database query language, a standard RAD environment and how to access information in a database from it, use of Visual Basic for Applications, and how to integrate these tools together to design and build engineering applications. Examples will be from manufacturing and production systems.

Prerequisite: C or better in ISE 135
Typically offered in Fall, Spring, and Summer

ISE 425/OR 425/OR 525/ISE 525 Medical Decision Making (3 credit hours)
This will focus on the use of optimization in Medicine. The main goal of this course is for you to develop an understanding of the recent methodological literature on optimization methods applied to medical decision making. We will cover a broad range of topics, both from the methodological perspective (study models using integer programming, dynamic programming, simulation, etc.) and from the public policy/public health perspective (who are the stake holders, what are the relevant questions modelers can answer, how is the patient taken into account, etc.).

P: ISE/OR 505 or equivalent and ISE 560 or equivalent or permission by instructor
Typically offered in Spring only

ISE 433/ISE 533/OR 433/OR 533 Service Systems Engineering (3 credit hours)
This course intends to provide a comprehensive treatment on the use of quantitative modeling for decision making and best practices in the service industries. The goal of this class is to teach students to able to identify, understand, and analyze services; and acquire the quantitative skills necessary to model key decisions and performance metrics associated with services. Students will be exposed both to classical and contemporary examples of challenges and opportunities that arise when working in the service sector.

Prerequisite: ISE 361
Typically offered in Spring only

ISE 435/ISE 535 Python Programming for Industrial & Systems Engineers (3 credit hours)
The objective of this course is to build on your knowledge of computing and data analysis by focusing on programming using the Python language. IN particular, you will learn more about the Python and its ecosystem of libraries, how to use data structures in Python programs, conduct File I/O operations, and perform numerical and scientific computing within Python. This course is designed for senior undergraduate and graduate students to get the basics of the Python language and learn to use it to perform scientific computing within Python with two of its most popular packages in use for heavy data intensive analysis - Numpy and SciPy. Several engineering examples from physics, industrial engineering core courses and general engineering will be used to contextualize the programming examples.

Prerequisites: ST 370 OR ST 371 and ISE 135 OR CSC 111 OR CSC 113 OR CSC 116 or ST 307 OR ST 308 OR ECE 209. Restrictive Statement: Department Approval Required
Typically offered in Fall only

ISE 437 Data Analytics for Industrial Engineering (3 credit hours)
In this course undergraduate students will learn to integrate statistical and mathematical modeling tools they learned in their previous classes to be able to design, develop and implement comprehensive advanced analytics solutions to address real industry problems. All class modules will be illustrated through real applications in Media, Financial, Retail and Manufacturing industries.

Prerequisites: (ST 370 or ST 371) and (ISE 135 or CSC 111 or CSC 113 or CSC 116 or ST 307 or ST 308 or ECE 209) and ISE 361.
Typically offered in Spring only

ISE 441 Introduction to Simulation (3 credit hours)
Discrete-event stochastic simulation for the modeling and analysis of systems. Programming of simulation models in a simulation language. Input data analysis, variance reduction techniques, validation and verification, and analysis of simulation output. Random number generators and random variate generation.

Prerequisite: MA 242, ST 372, ISE 362 and C or better in ISE 135
Typically offered in Fall and Spring

ISE 443 Quality Design and Control (3 credit hours)
Statistical methods in quality control. Control charts for variables and attributes. Process capability assessment. Role of experimentation in designing for quality. Total Quality Management. Tools for continuous quality improvement. Quality Function Deployment.

Prerequisite: ST 372 Restriction: ST 435 cannot be used as a substitute for this course.
Typically offered in Fall and Spring

ISE 447/ISE 547 Applications of Data Science in Healthcare (3 credit hours)
Health professional are capable of collecting massive amounts of data and look for best strategies to use this information. Healthcare analytics have the potential to reduce costs of treatment, predict outbreaks of epidemics, avoid preventable diseases and improve the quality of life in general. This course will explore some of the frequently used data science methods in healthcare and examine a compilation of the most recent academic journal articles on the subject. Students are expected to have a strong background in optimization and stochastic modeling.

Prerequisite: ISE 362
Typically offered in Fall only

ISE 452 Advanced Human-Machine Systems Design (3 credit hours)
Advanced concepts in human-machine systems design. Consideration of anatomical and physiological bases for design of work systems. Advanced biomechanical analysis and modeling for manual material handling design. Physiological and psychological capabilities and limitations as related to work systems design and human performance. Coverage of human information processing and performance theories and models, including pipe-line, signal detection theory, information theory, and motor control theory. Additional topics include human factors experimentation and neuroergonomics (brain and behavior).

Prerequisite: CE 214 and ISE 352
Typically offered in Spring only

ISE 453 Modeling and Analysis of Supply Chains (3 credit hours)
This course presents an overview of the basic issues and strategies involved in operating today's global supply chains, from the design of the supply chain network through the management and location of inventories to the design and operation of the logistics systems that distribute goods from their source to the consumer.

Prerequisite: ST 371 (C- or better), ISE 135, ISE 361, ISE 362
Typically offered in Fall and Spring

ISE 462 Advanced Stochastic Models in Industrial Engineering (3 credit hours)
Advanced topics related to mathematical modeling, analysis, and solution procedures applicable to uncertain (stochastic) production systems. Methodologies covered include economic analysis under uncertainty, discrete and continuous time stochastic processes. Applications relate to design, analysis and control relating to capacity planning, inventory control, waiting lines, and system reliability and maintainability.

Prerequisite: ISE 362
Typically offered in Fall only

ISE 489 Special Topics in Industrial and Systems Engineering (1-3 credit hours)
Directed coursework in Industrial and Systems Engineering with an emphasis on special topics and emerging areas of interest within the discipline.

Typically offered in Fall, Spring, and Summer

ISE 495 Project Work in Industrial Engineering (1-3 credit hours)
Special investigations, study or research related to the field of industrial engineering. In a given semester several students and/or student groups may be working in widely divergent areas under the direction of several members of the faculty.

Prerequisite: Junior standing.
Typically offered in Fall and Spring

ISE 498 Senior Design Project (3 credit hours)
Individual or group design projects requiring problem definition and analysis, synthesis, specification and presentation of a designed solution. Students work under faculty supervision either on actual industrial engineering problems posed by local industrial, service and governmental organization or on emerging research issues.

Prerequisite: ISE 408 and ISE 441 and ISE 453
Typically offered in Fall and Spring

ISE 501/OR 501 Introduction to Operations Research (3 credit hours)
The course aims to introduce the various types of operations research models and techniques. We will address how to formulate a wide range of decision problems using an appropriate mathematical programming model and solve them using an appropriate algorithm or solver. The emphasis will be given to Linear Programming, Network Models, and Integer Programming. Some example applications of mathematical programming to be covered in this class include production planning, network analysis, project scheduling, logistics network design, fixed charge problems, set covering problem, etc.

Prerequisites: An introductory course in linear algebra and calculus.
Typically offered in Fall, Spring, and Summer

ISE 505/MA 505/OR 505 Linear Programming (3 credit hours)
Introduction including: applications to economics and engineering; the simplex and interior-point methods; parametric programming and post-optimality analysis; duality matrix games, linear systems solvability theory and linear systems duality theory; polyhedral sets and cones, including their convexity and separation properties and dual representations; equilibrium prices, Lagrange multipliers, subgradients and sensitivity analysis.

Prerequisite: An introductory linear algebra course similar to MA 405
Typically offered in Fall only

ISE 510 Applied Engineering Economy (3 credit hours)
Engineering economy analysis of alternative projects including tax and inflation aspects, sensitivity analysis, risk assessment, decision criteria. Emphasis on applications.

Prerequisite: Undergrad. courses in engineering economics and ST
Typically offered in Spring only

ISE 511/ISE 411 Supply Chain Economics and Decision Making (3 credit hours)
This course introduces students to the principles of microeconomic analysis applied to decision-making in supply chains. Emphasis will be put on strategic interactions between different decision makers in the supply chain, including suppliers, manufacturers, retailers, and consumers. Topics include classical demand and production theory, pricing and revenue management, competition between firms, and cooperation between and within firms under information asymmetry.

Prerequisite: ISE 135
Typically offered in Fall only

ISE 513/ISE 413 Humanitarian Logistics (3 credit hours)
This course provides a comprehensive treatment of humanitarian logistics (HumLog) from an operations research perspective, focusing on the use of quantitative modeling for decision making and best practices disaster management. Background and overview on disaster management will be covered. The four phases of the disaster management cycle are introduced as well as the types of decisions that are made in each phase. Mathematical models are presented for typical humanitarian logistics decisions, such as inventory prepositioning, facility location, transportation, routing and capacity planning.

Prerequisite: ISE 361
Typically offered in Spring only

ISE 515 Manufacturing Process Engineering (3 credit hours)
Manufacturing process engineering, primary, secondary, finishing and assembly processes. Traditional and non-traditional manufacturing processes, group technology, manufacturing analyses and application of economic analyses. Graduate standing in Engineering.

Typically offered in Fall and Summer

ISE 517 Fundamentals of Additive Manufacturing (3 credit hours)
The course will cover Additive Manufacturing in depth as well as related topics like 3D scanning and reverse engineering. The course will be a combination of lectures and hands-on labs. The students will work on teams to completed a semester long design and 3D printing project.

Typically offered in Fall only

ISE 519 Database Applications in Industrial and Systems Engineering (3 credit hours)
Rapid applications development (RAD) tools to design and implement database-based applications. The SQL database query language, a standard RAD environment and how to access information in a database from it, use of Visual Basic for Applications, and how to integrate these tools together to design and build engineering applications. Examples will be from manufacturing and production systems. Examples from manufacturing and production systems.

Typically offered in Fall, Spring, and Summer

ISE 520 Healthcare Systems Performance Improvement I (3 credit hours)
Methods used to improve the performance of health care delivery systems with emphasis on patient care cost, access, and quality. Adaptation of lean and six-sigma to rapid and continuous health care systems improvement through organizational and process transformation. Fundamentals of scheduling, staffing, and productivity in health systems employing simulation and optimization. Health care policy and management.

Prerequisite: ST 372 and ISE 352 and ISE 361, and ISE 441 or equivalent courses.
Typically offered in Fall only

ISE 521 Healthcare Systems Performance Improvement II (3 credit hours)
Continuation of ISE 520 with a concentration on the completion of a healthcare systems process improvement project at the sponsoring health care institution. Project must employ the tools and techniques of healthcare systems process improvement. The project is done in conjunction with a diverse and multi-disciplinary team from the healthcare institution. The student must serve as a facilitator and coach, resulting in a project with measured success. Success will be determined by the improvement in patient care as quantified in cost, quality, and access.

Prerequisite: ISE 520
Typically offered in Spring only

ISE 525/ISE 425/OR 425/OR 525 Medical Decision Making (3 credit hours)
This will focus on the use of optimization in Medicine. The main goal of this course is for you to develop an understanding of the recent methodological literature on optimization methods applied to medical decision making. We will cover a broad range of topics, both from the methodological perspective (study models using integer programming, dynamic programming, simulation, etc.) and from the public policy/public health perspective (who are the stake holders, what are the relevant questions modelers can answer, how is the patient taken into account, etc.).

P: ISE/OR 505 or equivalent and ISE 560 or equivalent or permission by instructor
Typically offered in Spring only

ISE 533/OR 433/OR 533/ISE 433 Service Systems Engineering (3 credit hours)

This course intends to provide a comprehensive treatment on the use of quantitative modeling for decision making and best practices in the service industries. The goal of this class is to teach students to able to identify, understand, and analyze services; and acquire the quantitative skills necessary to model key decisions and performance metrics associated with services. Students will be exposed both to classical and contemporary examples of challenges and opportunities that arise when working in the service sector.

Prerequisite: ISE 361
Typically offered in Spring only

ISE 534/EM 534 Artificial Intelligence for Engineering Managers (3 credit hours)

This course is designed for engineering managers to develop the skills necessary to manage AI and machine learning projects. It covers a broad range of AI topics including the various methods and algorithms (such as machine learning, deep learning, and large language models) and associated applications in different industries. The focus is on understanding the technical aspects of AI sufficient to manage teams, make informed decisions on AI adoption, and create project plans that estimate resources, costs, and timelines. The course aims to equip managers with the knowledge to assess the impact of AI on their firms and the broader economy. It is not a technical course for becoming an AI/ML engineer, but rather a management-oriented course to help in the deployment and oversight of AI projects.

Typically offered in Fall, Spring, and Summer

ISE 535/ISE 435 Python Programming for Industrial & Systems Engineers (3 credit hours)

The objective of this course is to build on your knowledge of computing and data analysis by focusing on programming using the Python language. IN particular, you will learn more about the Python and its ecosystem of libraries, how to use data structures in Python programs, conduct File I/O operations, and perform numerical and scientific computing within Python. This course is designed for senior undergraduate and graduate students to get the basics of the Python language and learn to use it to perform scientific computing within Python with two of its most popular packages in use for heavy data intensive analysis - Numpy and SciPy. Several engineering examples from physics, industrial engineering core courses and general engineering will be used to contextualize the programming examples.

Prerequisites: ST 370 OR ST 371 and ISE 135 OR CSC 111 OR CSC 113 OR CSC 116 or ST 307 OR ST 308 OR ECE 209. Restrictive Statement: Department Approval Required
Typically offered in Fall only

ISE 537 Statistical Models for Systems Analytics in Industrial Engineering (3 credit hours)

In this course, graduate students will learn basic data science methodologies. Examples of the methodologies include linear regression, generalized linear models, regularization and variable selection, and dimensionality reduction. In addition, students will also learn how to use these methods to solve real-world Industrial Engineering-related problems by analyzing industrial datasets and projects.

Prerequisite: ST 370: "Probability and Statistics for Engineers" or equivalent
Typically offered in Spring only

ISE 538/EM 538 Practical Machine Learning for Engineering Analytics (3 credit hours)

Machine learning has become integral to engineering analytics, significantly improving predictive capabilities and providing valuable insights from complex datasets. In engineering, machine learning models can analyze vast amounts of data from multiple sources to identify patterns and make accurate predictions. These predictions can optimize system performance, predict equipment failures, and improve maintenance schedules. Machine learning techniques transform how engineers approach problem-solving, enabling them to make more informed decisions and implement more effective solutions. One of the critical aspects of this course is the focus on practical examples and hands-on experience with machine learning tools and techniques. Through lectures, case studies, interactive assignments, and projects, students will gain a comprehensive understanding of machine learning applications in engineering analytics. The course will cover fundamental machine learning concepts, such as supervised and unsupervised learning, classification, regression, anomaly detection, and clustering.

Typically offered in Fall and Spring

ISE 540/PSY 540 Human Factors In Systems Design (3 credit hours)

Introduction to problems of the systems development cycle, including human-machine function allocation, military specifications, display-control compatibility, the personnel sub-system concept and maintainability design. Detailed treatment given to people as information processing mechanisms.

Prerequisite: IE 452 or PSY 340, Corequisite: ST 507 or 515
Typically offered in Spring only

ISE 541 Occupational Safety Engineering (3 credit hours)

This course aims to equip students with a comprehensive understanding of workplace safety, emphasizing the importance of creating a safe and healthy environment for all workers. It covers the fundamentals of occupational safety, including safety regulations and control methods, and provides a working knowledge of the occupational safety and health standards. Through case studies, classroom interaction, and real-world examples, students will develop problem-solving skills essential for identifying and eliminating potential hazards during the design and engineering phases of new products or facilities. Additionally, the course introduces various online resources to help address safety issues in the workplace.

Typically offered in Spring only

ISE 543 Musculoskeletal Mechanics (3 credit hours)

Anatomy, physiology and biomechanics of musculoskeletal system including muscle bone, tendon, ligament, cartilage, nerve. Modeling of tissue and joints with special emphasis on spine and upper extremity. Physical, mathematical, optimization and finite element modeling techniques as applied in biomechanics research.

Prerequisite: BIO 125 or BAE(BIO) 235 or Graduate standing

ISE 544 Occupational Biomechanics (3 credit hours)
Anatomical, physiological, and biomechanical bases of physical ergonomics. Strength of biomaterials, human motor capabilities, body mechanics, kinematics and anthropometry. Use of bioinstrumentation, active and passive industrial surveillance techniques and the NIOSH lifting guide. Acute injury and cumulative trauma disorders. Static and dynamic biomechanical modeling. Emphasis on low back, shoulder and hand/wrist biomechanics.

Prerequisite: Graduate standing
Typically offered in Fall only

ISE 546/CSC 546 Management Decision and Control Systems (3 credit hours)
Planning, design, and development and implementation of comprehensive computer-based information systems to support management decisions. Formal information systems principles; information requirements analysis; knowledge acquisition techniques; information modeling. Information resource management for quality operational control and decision support; system evaluation, process improvement and cost effectiveness.

Prerequisite: CSC 423 or BUS 541
Typically offered in Fall only

ISE 547/ISE 447 Applications of Data Science in Healthcare (3 credit hours)
Health professional are capable of collecting massive amounts of data and look for best strategies to use this information. Healthcare analytics have the potential to reduce costs of treatment, predict outbreaks of epidemics, avoid preventable diseases and improve the quality of life in general. This course will explore some of the frequently used data science methods in healthcare and examine a compilation of the most recent academic journal articles on the subject. Students are expected to have a strong background in optimization and stochastic modeling.

Prerequisite: ISE 362
Typically offered in Fall only

ISE 552 Design and Control of Production and Service Systems (3 credit hours)
Basic terminology and techniques for the control of production and service systems including economic order quantity models; stochastic inventory models; material requirements planning; Theory of Constraints; single and mixed model assembly lines ; and lean manufacturing. Emphasis on mathematical models of the interaction between limited capacity and stochastic variability through the use of queueing models to describe system behavior.

Prerequisite: ST 371 or ST 372
Typically offered in Fall only

ISE 553 Modeling and Analysis of Supply Chains (3 credit hours)
Basic issues in operating supply chains, using state of the art modeling tools available for their analysis. Emphasis on using engineering models to develop insights into the behavior of these systems.

Prerequisite: ISE 361 and ST 372
Typically offered in Spring only
This course is offered alternate even years

ISE 554 Introduction to Product Development (3 credit hours)
New product development is a critical process that crosses multiple functional areas in a firm. In today's globally competitive business environment, new product development is not a strategic option - it is a fundamental prerequisite for a company's survival, organizational renewal, and economic prosperity. Innovative design and new product development is not the domain of any one function, but a multidisciplinary process that requires coordination, communication, and integration. This course accomplishes design-business-engineering collaboration by creating cross-disciplinary teams whereby students learn and apply the necessary skills to design, develop and prototype an innovative product solution that meets market needs.

Typically offered in Fall only

ISE 555 Digital Manufacturing (3 credit hours)
This course aims to introduce students on the power of digital manufacturing and design technologies, particularly how product data can seamlessly transfer through the entire lifecycle of a manufactured product. Students will also be introduced to methods to design and build plugin apps that interface with the design models. All hands-on modeling and virtual manufacturing exercises will be in Autodesk Fusion 360, a cloud based design and manufacturing software.

R: ISE 316 or Graduate Standing
Typically offered in Fall only

ISE 560/OR 560 Stochastic Models in Industrial Engineering (3 credit hours)
ISE/OR 560 will introduce mathematical modeling, analysis, and solution procedures applicable to uncertain (stochastic) production and service systems. Methodologies covered include probability theory and stochastic processes including discrete and continuous Markov processes. Applications relate to design and analysis of problems, capacity planning, inventory control, waiting lines, and service systems.

Typically offered in Fall only

ISE 562/TE 562/OR 562 Simulation Modeling (3 credit hours)
This course concentrates on design, construction, and use of discrete/continuous simulation object-based models employing the SIMIO software, with application to manufacturing, service, and healthcare. The focus is on methods for modeling and analyzing complex problems using simulation objects. Analysis includes data-based modeling, process design, input modeling, output analysis, and the use of 3D animation with other graphical displays. Object-oriented modeling is used to extend models and enhance re-usability.

Typically offered in Spring only

ISE 589 Special Topics In Industrial Engineering (1-6 credit hours)
Special developments in some phase of industrial engineering using traditional course format. Identification of various specific topics and prerequisites for each section from term to term.

ISE 601 Seminar (1 credit hours)
Seminar discussion of industrial engineering problems for graduate students. Case analyses and reports.

Typically offered in Fall and Spring

ISE 610 Special Topics in Industrial Engineering (3-6 credit hours)
Special developments in some phase of industrial engineering using traditional course format. Identification of various specific topics and prerequisites for each section from term to term.

ISE 637 Directed Study in Industrial Engineering (1-3 credit hours)
Independent study providing opportunity for individual students to explore topics of special interest under direction of a member of faculty.

Typically offered in Fall and Summer

ISE 639 Advanced Directed Study in Industrial Engineering (1-3 credit hours)
Independent study providing an opportunity for individual graduate students to explore advanced topics of special interest under the direction of a member of the faculty.

Typically offered in Fall, Spring, and Summer

ISE 677 Industrial Engineering Projects (1-6 credit hours)
Investigation and written report on assigned problems germane to industrial engineering. Maximum of six credits to be earned for MIE degree.

Prerequisite: MIE candidates
Typically offered in Fall, Spring, and Summer

ISE 685 Master's Supervised Teaching (1-3 credit hours)
Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

Prerequisite: Master's student
Typically offered in Fall, Spring, and Summer

ISE 688 Non-Thesis Masters Continuous Registration - Half Time Registration (1 credit hours)
For students in non-thesis master's programs who have completed all credit hour requirements for their degree but need to maintain half-time continuous registration to complete incomplete grades, projects, final master's exam, etc.

Prerequisite: Master's student
Typically offered in Fall, Spring, and Summer

ISE 689 Non-Thesis Master Continuous Registration - Full Time Registration (3 credit hours)
For students in non-thesis master's programs who have completed all credit hour requirements for their degree but need to maintain full-time continuous registration to complete incomplete grades, projects, final master's exam, etc. Students may register for this course a maximum of one semester.

Prerequisite: Master's student
Typically offered in Fall, Spring, and Summer

ISE 693 Master's Supervised Research (1-9 credit hours)
Instruction in research and research under the mentorship of a member of the Graduate Faculty.

Prerequisite: Master's student
Typically offered in Fall, Spring, and Summer

ISE 695 Master's Thesis Research (1-9 credit hours)
Thesis research.

Typically offered in Fall, Spring, and Summer

ISE 696 Summer Thesis Research (1 credit hours)
For graduate students whose programs of work specify no formal course work during a summer session and who will be devoting full time to thesis research.

Prerequisite: Master's student
Typically offered in Summer only

ISE 699 Master's Thesis Preparation (1-9 credit hours)
For student who have completed all credit hour requirements and full-time enrollment for the master's degree and are writing and defending their theses.

Prerequisite: Master's student
Typically offered in Fall, Spring, and Summer

ISE 707 Real-Time Control of Automated Manufacturing (3 credit hours)
Concepts and application of real-time control of automated manufacturing systems. Development of prototype manufacturing control applications involving introductions to following topics: computer architecture; real-time, multi-tasking operating systems; data modeling; multi-processing systems; local area networks; inter-task communication; and development of multi-tasking control systems. Design development of control system.

Typically offered in Fall only
This course is offered alternate years

ISE 708/MA 708/OR 708 Integer Programming (3 credit hours)
General integer programming problems and principal methods of solving them. Emphasis on intuitive presentation of ideas underlying various algorithms rather than detailed description of computer codes. Students have some "hands on" computing experience that should enable them to adapt ideas presented in course to integer programming problems they may encounter.

Prerequisite: MA 405, OR (MA,IE) 505, Corequisite: Some familiarity with computers (e.g., CSC 112)
Typically offered in Spring only
This course is offered alternate years

ISE 709/OR 709 Dynamic Programming (3 credit hours)
Introduction to theory and computational aspects of dynamic programming and its application to sequential decision problems.

Prerequisite: MA 405, ST 421
Typically offered in Spring only

ISE 711 Capital Investment Economic Analysis (3 credit hours)
Analysis of economic merits of alternatives including interest and income tax considerations. Risk and sensitivity exploration techniques. Introduction to analytical techniques for multiple objectives or criteria. Use of mathematical programming andcomputers for capital budgeting.

Prerequisites: ISE 311 and ST 371
Typically offered in Fall only

ISE 712 Bayesian Decision Analysis For Engineers and Managers (3 credit hours)
The Bayesian approach to decision making, with numerous applications in engineering and business. Expected value maximization, decision trees, Bayes' theorem, value of information, sequential procedures and optimal strategies. Axiomatic utility theory and controversies, utility of money, theoretical and empirical determination of utility functions and relationship to mean-variance analysis. Brief introduction to multi-attribute problems, time streams and group decisions.

Prerequisite: ST 371 or ST 421
Typically offered in Spring only

ISE 714 Product Manufacturing Engineering for the Medical Device Industry (3 credit hours)
Product development course targeted toward the medical device industry. Product design and development, concept generation and selection, parametric feature-based CAD, design for manufacturability (DFM) and assembly (DFA), tolerancing, rapid prototyping, tool design, tool fabrication, and medical device fabrication.

Prerequisite: ISE 515
Typically offered in Spring only

ISE 715 Manufacturing Process Engineering (3 credit hours)
Manufacturing process engineering, primary,secondary, finishing and assembly processes. concurrent engineering, process planning, group technology, manufacturing analyses and application of economic analyses.

Typically offered in Spring only

ISE 716 Automated Systems Engineering (3 credit hours)
General principles of operation and programming of automated systems. Automated assembly, automated manufacturing, and inspection systems. Control of automated manufacturing. Industrial logic systems and programmable logic controllers. Computer numerical control, industrial robotics, and computer integrated manufacturing.

Typically offered in Fall and Spring

ISE 718 Micro/Nano-Scale Fabrication and Manufacturing (3 credit hours)
Introduction to physical theory, process design, analysis, and characterization of micro/nano scale fabrication and manufacturing. The main focus of the course is on the fabrication/manufacturing of important types of microstructures used in micro/nano devices and the techniques and tools used to fabricate and characterize them.

Prerequisite: ISE 316 or graduate standing in the college of engineering
Typically offered in Spring only

ISE 723 Production Planning, Scheduling and Inventory Control (3 credit hours)
An analysis of Production-Inventory systems. Modeling and Analysis of single and multi-product inventory systems for single and multi-period environments under deterministic and stochastic assumptions. Development of optimal and heuristics scheduling models for single and multi-resource systems under deterministic and stochastic assumptions.

Prerequisite: Introduction to optimization, similar to OR 501 and a basic probability & statistics course similar to ST 515
Typically offered in Spring only

ISE 725 Foundations of Smart Manufacturing (3 credit hours)
The course introduces the concepts and applications of smart manufacturing systems that begin from the machine asset on the factory floor to the higher order information technology systems. Development of prototype smart manufacturing applications involving introduction to topics such as: real-time streaming machine sensor data through machine to machine (m2m) industrial communication protocols; unified namespaces for factory integration of information and operational technology; data modeling and data store architectures specifically for time series analysis and machine vision theory and applications critical to quality inspections at the factory floor.

Typically offered in Spring only

ISE 726 Theory of Activity Networks (3 credit hours)
Introduction to graph theory and network theory. In-depth discussion of theory underlying (1) deterministic activity networks (CPM): optimal time-cost trade offs; the problem of scarce resources; (2) probabilistic activity networks (PERT): critical evaluation of underlying assumptions; (3) generalized activity networks (GERT, GAN): applications of signal flow graphs and semi-Markov process to probabilistic branching; relation to the theory of scheduling.

Prerequisite: OR 501, OR(IE,MA) 505
Typically offered in Spring only
This course is offered alternate years

ISE 731 Multi-Attribute Decision Analysis (3 credit hours)
Specification of attributes/criteria/objectives for complex decisions. Determination of alternatives, attribute weights and decision-making process. Graphical and weighted evaluation techniques. Multi-attribute utility, multi-objective/goal programming and analytic hierarchy process methodologies. Computer applications and case studies.

Typically offered in Spring only

ISE 740/PSY 740 Engineering Psychology of Human-computer Interaction (3 credit hours)
Exploration of usability of computer technology. Theory and practice of user-centered design for HCI applications. Course focuses on current usability paradigms and principles, psychology of users, iterative and participatory design processes, system requirements specification, prototyping, user support systems, usability evaluation and engineering, interface design guidelines and standards. Application domains include, universal design, virtual reality, and scientific data visualization.

Prerequisite: IE(PSY) 540 or CSC 554

ISE 741 Systems Safety Engineering (3 credit hours)
Systems safety engineering. Course familiarizes students with techniques for identifying and recognizing potential safety hazards and the concept of risk assessment. Preliminary Hazard Analysis, Failure Modes and Effects Analysis, System and Subsystem Hazard Analysis, Fault Tree Analysis, Process Safety Management (29CFR1910.119) are explored together with applications to hazard analysis and control. Industrial situations and case studies are employed to illustrate usefulness of various system safety techniques.

Typically offered in Fall only

ISE 742 Environmental Stress, Physiology and Performance (3 credit hours)
Human skilled performance as affected by environmental stressors, including noise, vibration, heat, cold, accelerator, pressure altitude, toxic agents and illumination. Physiological effects of stressors and their relationship to health, performanceand, ultimately, to safety. Impact biomechanics and crash survival. Human survival in adverse environments. Combined stressor effects, physiological arousal, fatigue and performance decrement.

Typically offered in Spring only
This course is offered alternate years

ISE 743/PSY 743 Ergonomic Performance Assessment (3 credit hours)
Fundamentals of ergonomic performance measurement used to assess the effects of environment and system design on human performance. Treatment of topics such as workload measurement, measurement of complex performance, simulator studies, measurement of change, task taxonomies, criterion task sets and statistical methods of task analysis. Problems of laboratory and field research, measurement of change and generalizability of findings.

Prerequisite: PSY 200, ST 507 and 508
Typically offered in Fall only
This course is offered alternate years

ISE 744 Human Information Processing (3 credit hours)
Fundamentals of human information processing basic to skilled operator performance and the design of displays, controls and complex systems. Treatment of topics such as channel capacity, working memory, long-term memory, decision making, attention and process monitoring. Problems of display and control design and evaluation, evaluation of textual material, and human-computer interaction.

Prerequisite: PSY 200, ST 507 and 508
Typically offered in Spring only
This course is offered alternate years

ISE 745/PSY 745 Human Performance Modeling (3 credit hours)
Advanced aspects of human performance research. Qualitative models of human information processing. Characteristics and role of memory in decision making and response execution. Sensory channel parameters, attention allocation, time-sharing of tasks. Situation awareness and workload responses in complex tasks. Limitations of human factors experimentation. Factors in human multiple task performance. Cognitive task analysis and computational cognitave modeling/simulation of user behavior in specific applications.

Prerequisite: ST 507 or 515 or equivalent; IE (PSY) 540, CSC 554 or IE (PSY) 744

ISE 747/OR 747 Reliability Engineering (3 credit hours)
Introduction to basic concepts of reliability engineering. Application of probability and statistics to estimate reliability of industrial systems; development of reliability measures; analysis of static and dynamic reliability models; development and analysis of fault trees; analysis of Markovian and non-Markovian models; and optimization of reliability models.

Prerequisite: ST 511
Typically offered in Fall only
This course is offered alternate years

ISE 748 Quality Engineering (3 credit hours)
Introduction to basic concepts of quality engineering. Statistical process control (SPC) methods, acceptance sampling techniques, concept of parameter design and statistical as well as analytical techniques for its implementation, tolerance analysisand design, components of cost of poor quality and an introduction to quality management.

Prerequisite: an undergraduate or graduate course in probability and statistics (similar to ST 371 and ST 372 or ST 515), and fluency in a computer programming language or spreadsheet.
Typically offered in Spring only
This course is offered alternate years

ISE 754 Logistics Engineering (3 credit hours)
Elements of logistics networks. Supply chain design: facility location and allocation; great-circle distances; geocoding. Multi-echelon production and inventory systems; sourcing decision systems. Vehicle routing: exact, approximation, and heuristic procedures; traveling salesman problem; basic vehicle routing problem and extensions; backhauling; mixed-mode transportation system design.

Prerequisite: ISE 453
Typically offered in Spring only

ISE 760/OR 760 Applied Stochastic Models in Industrial Engineering (3 credit hours)
Formulation and analysis of stochastic models with particular emphasis on applications in industrial engineering; univariate, multivariate and conditional probability distributions; unconditional and conditional expectations; elements of stochastic processes; moment-generating functions; concepts of stochastic convergence; limit theorems; homogeneous, nonhomogeneous and compound Poisson processes; basic renewal theory; transient and steady-state properties of Markov processes in discrete and continuous time.

Prerequisite: MA 303, ST 371
Typically offered in Spring only

ISE 761/OR 761 Queues and Stochastic Service Systems (3 credit hours)
Introduction of general concepts of stochastic processes. Poisson processes, Markov processes and renewal theory. Usage of these in analysis of queues, from with a completely memoryless queue to one with general parameters. Applications to many engineering problems.

Typically offered in Spring only

ISE 762/CSC 762/OR 762 Stochastic Simulation (3 credit hours)
Basic discrete event simulation methodology: random number generators, generating random objects, design of discrete event simulation, validation, analysis of simulation output, variance reduction techniques, Markov chain Monte Carlo, simulation optimization. The course has computer assignments and projects. This course is a sequel to ISE/OR 760 Stochastic Models which serves as a prerequisite. This is NOT a software based course! Students who are looking for a class on simulation software, such as Arena and Simio, are recommended to take ISE 562 (master-level simulation class).

Students should have completed a course on stochastic models (similar to ISE 560 or ISE 760) and have a working knowledge of a programming language (e.g., Python, Matlab, R, or others).
Typically offered in Fall and Spring

ISE 766/MA 766/OR 766 Network Flows (3 credit hours)
Study of problems of flows in networks. These problems include the determination of shortest chain, maximal flow and minimal cost flow in networks. Relationship between network flows and linear programming developed as well as problems with nonlinear cost functions, multi-commodity flows and problem of network synthesis.

Prerequisite: OR(IE,MA) 505
Typically offered in Spring only
This course is offered alternate years

ISE 767 Upper Extremity Biomechanics (3 credit hours)
Gross and functional anatomy of upper extremity; properties of tendons and synovial fluid; epidemiology; disorders of shoulder, elbow, wrist, hands, fingers; biomechanical modeling; personal factors affecting cumulative trauma disorder (CTD) risk, diagnosis and treatment of upper extremity CTDs; wrist splints; workplace ergonomics to alleviate upper extremity CTDs.

Typically offered in Fall only
This course is offered alternate odd years

ISE 768 Spine Biomechanics (3 credit hours)
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.

Typically offered in Fall only
This course is offered alternate even years

ISE 772/OR 772 Advanced Stochastic Simulation (3 credit hours)
This course is methodologically focused and a continuation of ISE 762 in Monte Carlo methods. The topics include, but are not limited to, Quasi-Monte Carlo, importance sampling and other advanced variance reduction approaches, derivative estimation, and advanced simulation optimization in continuous and finite spaces. While the application of these techniques to actual simulations is practiced as assignments, the discussion on simulation software and programming will be minimal. A current topic research presentation/paper required.

Prerequisite: (CSC,ECE,IE,OR) 762 and ST 516
Typically offered in Spring only

ISE 789 Advanced Special Topics In Industrial Engineering (3-6 credit hours)
Advanced topics in some phase of industrial engineering using traditional course format. Identification of various specific topics and prerequisites for each section from term to term.

Typically offered in Fall and Spring

ISE 790 Advanced Special Topics System Optimization (1-6 credit hours)
Advanced topics in some phase of system optimization using traditional course format. Identification of various specific topics and prerequisites for each section from term to term.

Typically offered in Fall and Spring

ISE 794 Advanced Problems in Ergonomics (3 credit hours)
Exploration in depth of a problem area of contemporary interest involving man-machine-environment interface. Class discussion and analysis of research and theory, with special focus on human factors aspects of systems design and operation.

Typically offered in Fall only

ISE 796 Research Practicum in Human-Systems Engineering (3 credit hours)
Human-systems engineering research topic development, literature evaluation, experimental design, use of research instrumentation, data collection, basic data interpretation, statistical analysis, manuscript preparation.

Typically offered in Spring only

ISE 801 Seminar (1 credit hours)
Seminar discussion of industrial engineering problems for graduate students. Case analyses and reports.

Typically offered in Fall and Spring

ISE 812/MA 812 Special Topics in Mathematical Programming (1-6 credit hours)
Study of special advanced topics in area of mathematical programming. Discussion of new techniques and current research in this area. The faculty responsible for this course select areas to be covered during semester according to their preference and interest. This course not necessarily taught by an individual faculty member but can, on occasion, be joint effort of several faculty members from this university as well as visiting faculty from other institutions. To date, a course of Theory of Networks and another on Integer Programming offered under the umbrella of this course. Anticipation that these two topics will be repeated in future together with other topics.

Prerequisite: IE(MA,OR) 505
Typically offered in Spring only
This course is offered alternate years

ISE 816/MA 816 Advanced Special Topics Sys Opt (1-6 credit hours)
Advanced topics in some phase of system optimization. Identification of various specific topics and prerequisite for each section from term to term.

Typically offered in Fall and Spring

ISE 837 Directed Study in Industrial Engineering (1-3 credit hours)
Independent study providing opportunity for individual students to explore topics of special interest under direction of a member of faculty.

Typically offered in Fall, Spring, and Summer

ISE 839 Advanced Directed Study in Industrial Engineering (1-3 credit hours)
Independent study providing an opportunity for individual graduate students to explore advanced topics of special interest under the direction of a member of the faculty.

Typically offered in Fall, Spring, and Summer

ISE 861 The Design of Production Systems (3 credit hours)
The structure and operation of production planning, scheduling and
control systems; emphasis on system structure, capacity planning,
master production scheduling, shop loading and supply chain;
investigation of current trends.

Typically offered in Fall only
This course is offered alternate years

ISE 877 Industrial Engineering Projects (1-6 credit hours)
Investigation and written report on assigned problems germane to
industrial engineering. Maximum of six credits to be earned for MIE
degree.

Prerequisite: MIE candidates
Typically offered in Fall, Spring, and Summer

ISE 885 Doctoral Supervised Teaching (1-3 credit hours)
Teaching experience under the mentorship of faculty who assist the
student in planning for the teaching assignment, observe and provide
feedback to the student during the teaching assignment, and evaluate the
student upon completion of the assignment.

Prerequisite: Doctoral student
Typically offered in Fall, Spring, and Summer

ISE 890 Doctoral Preliminary Examination (1-9 credit hours)
For students who are preparing for and taking written and/or oral
preliminary exams.

Prerequisite: Doctoral student
Typically offered in Fall, Spring, and Summer

ISE 893 Doctoral Supervised Research (1-9 credit hours)
Instruction in research and research under the mentorship of a member
of the Graduate Faculty.

Prerequisite: Doctoral student
Typically offered in Fall, Spring, and Summer

ISE 895 Doctoral Dissertation Research (1-9 credit hours)
Dissertation Research

Prerequisite: Doctoral student
Typically offered in Fall, Spring, and Summer

ISE 896 Summer Dissertation Research (1 credit hours)
For graduate students whose programs of work specify no formal course
work during a summer session and who will be devoting full time to thesis
research.

Prerequisite: Doctoral student
Typically offered in Summer only

ISE 899 Doctoral Dissertation Preparation (1-9 credit hours)
For students who have completed all credit hour requirements, full-time
enrollment, preliminary examination, and residency requirements for the
doctoral degree, and are writing and defending their dissertations.

Prerequisite: Doctoral student
Typically offered in Fall, Spring, and Summer