

# INDUSTRIAL AND SYSTEMS ENGINEERING (ISE)

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## **ISE 102. Introduction to Project Management and Work Design Systems. 3 Credit Hours.**

This introductory course is designed to expose high school students to Industrial and Systems engineering. The course will introduce Project Management and it will be woven throughout the 3-week course culminating in a final project presentation. All students enrolled in this course will gain experience in problem solving, engineering design, computer applications, and hands-on activities. The course content includes topics on work design, methods analysis, time studies, human factors engineering, and project management. The students will be provided with an understanding and some hands-on experience on topics relative to the discipline of industrial and systems engineering. The laboratory and field trip experiences will enhance the classroom experience and provide an insight to the depth and breadth of the discipline. Summer Scholar Students only.

Requisite: Summer Scholars/ UM Academy only.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Summer.

## **ISE 111. Introduction to Engineering I. 3 Credit Hours.**

Use of engineering tools and computer techniques for problem solving, data acquisition, analysis, presentation, software design, and computer aided drafting. Development of design skills through several design and building competitions. Introduction to professional ethics, intellectual property, ethics, intellectual property rights, and an introduction to use of MATLAB, AutoCAD, and programming in C++.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall & Spring.

## **ISE 112. Introduction to Engineering II. 2 Credit Hours.**

Continuation of IEN 111. An overview of Industrial Engineering concepts and issues important to the design and operation of industrial and service systems. Students will learn the use of software tools developed to enhance the Industrial Engineer's ability such as database management, high level programming languages, electronic spreadsheets, and computer graphics.

Prerequisite: IEN 111.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

## **ISE 201. Work Design Systems. 3 Credit Hours.**

This course will show the design of improved methods for doing work based on effective human effort. Time standardization of productive operations by work measurement, predetermined time systems, and activity sampling are discussed. Labor estimation techniques will be discussed. Tools and charts for methods analysis are discussed and the use of Microsoft Visio and Microsoft Excel is emphasized and reviewed.

Prerequisite: EGN 123 or IEN 112.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall & Spring.

## **ISE 224. Python for Engineers. 3 Credit Hours.**

Programming plays an important role in engineering. This course aims to establish the foundations for basic programming with focus on python. It comprehensively discusses the fundamental topics in programming, such as Data types, Variables, Iterators, Control flows, Functions, Modules, Class, Objects, and Object-Oriented Design.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

## **ISE 306. Manufacturing Processes. 3 Credit Hours.**

Basic and applied sciences in processing of materials. Effects of processing on the manufactured parts, selection of processing methods, and their relation with material properties. Contemporary and non-traditional processes used in manufacturing are also covered.

Prerequisite: CHM 121 or CHM 151 and PHY 221.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

## **ISE 310. Introduction to Engineering Probability. 3 Credit Hours.**

Axioms of probability, discrete and continuous random variables, probability density functions, cumulative distribution function, expectation, conditioning, independence, functions of random variables, multiple random variables, sums of random variables, introduction to statistical analysis, estimation, and hypothesis testing. Cross-listed with EEN 310.

Prerequisite: MTH 162 and Requisite: Junior Standing.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall & Spring.

**ISE 311. Applied Probability and Statistics. 3 Credit Hours.**

This course covers fundamental probability concepts, random variables, mathematical expectation, discrete and continuous probability distributions, sampling distributions, point and interval estimation, hypothesis testing, and simple linear regression and correlation. The use of Minitab, a statistical software application, is emphasized. Examples are drawn from various disciplines.

Prerequisite: MTH 162.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall & Spring.

**ISE 312. Foundations of Data Analysis. 3 Credit Hours.**

This course aims to establish a solid background for data analysis. It covers fundamental topics, such as Data Properties, Estimation, Hypothesis and Testing, Regression and Classification, Design of Experiments, and Clustering, to establish the foundations of data analysis. This course not only builds up the theoretical knowledge but also relies on useful computer software (e.g., EXCEL, Minitab, and R) to enable the capability to handle large-scale problems.

Prerequisite: IEN 310 or ECE 310 or IEN 311 or MAS 311 or equivalent.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**ISE 351. Safety and Ethics in Engineering. 3 Credit Hours.**

This course will address basic principles of accident prevention and safety engineering approaches to the design of facilities, manufacturing processes and organizational systems. Ethical decision making and analysis will be explored as a function of designing organizational safety plans. It also includes the analysis and design of safety procedures and accident control procedures in industry.

Requisite: Junior Status or Permission of Instructor.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**ISE 361. Industrial Cost Analysis. 3 Credit Hours.**

Analysis of financial statements and cost factors in manufacturing and service systems. Cost accounting methods, job order costing and process costing approaches. Deterministic and probabilistic estimates of cost.

Prerequisite: MTH 162. And IEN 201.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**ISE 363. Project Management for Engineers. 3 Credit Hours.**

This course guides students through fundamental project management concepts and behavioral skills needed to successfully launch, lead, and realize benefits from projects in profit and nonprofit organizations. In this course, students explore project management with a practical, hands-on approach through case studies and class exercises. In addition, you will participate in a project as a project manager and as a resource.

Requisite: Junior Status or Permission of Instructor.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**ISE 372. Emerging Technologies and the Creation of Technological Innovations. 3 Credit Hours.**

A variety of emerging technologies will be discussed (nanotechnology, energy technologies, information technologies, biotechnologies, etc). The process of utilization in innovations will be covered.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**ISE 380. Engineering Economic Analysis. 3 Credit Hours.**

This course will explore engineering economy fundamentals. Interest and money-time relationship, methods of making economic decisions, risk and uncertainty, and sensitivity analysis. In addition, analysis will include selections among multiple alternatives, depreciation, after tax analysis, benefit-cost analysis, replacement studies, cost analysis techniques.

Prerequisite: MTH 162.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**ISE 399. Internship. 1 Credit Hour.**

Practical application of classroom theory through employment with firms offering positions consistent with the student's field of study. Course may be repeated.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall, Spring, & Summer.

**ISE 406. Computer-Aided Manufacturing. 3 Credit Hours.**

A comprehensive view of manufacturing with a focus on design, automation, and the use of computers in manufacturing. The topics include computer-aided design, communications, programmable logic controllers, CNC machining, industrial robots, process planning, and computer-integrated manufacturing. Laboratory projects are an integral part of the course.

Prerequisite: CHM 121 or CHM 151 and PHY 221.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**ISE 407. Product Design for Manufacturing. 3 Credit Hours.**

The different phases of engineering design process. Guided Iteration Methodology for product design. Topics include design for manufacturing (DFM), best practices of product realization, solid modeling using SolidWorks, quality in design, issues in patents, liability and ethics. Engineering design specifications, evaluation methods for design alternatives.

Prerequisite: IEN 406.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**ISE 441. Deterministic Models in Operations Research. 3 Credit Hours.**

Introduction to deterministic mathematical models with applications to operational problems. Topics include the methodology of operations research, mathematical programming, game theory, network flow-theory, and dynamic programming. Cross-listed with MAS 441.

Prerequisite: MTH 210.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall & Spring.

**ISE 442. Stochastic Models in Operations Research. 3 Credit Hours.**

Probabilistic models in operations research. Topics include probabilistic inventory models, queuing theory, Markov chains, and probabilistic dynamic programming. Cross-listed with MAS 442.

Prerequisites: IEN 310 or ECE 310 or IEN 311 or MAS 311 and IEN 441 or MAS 441.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall & Spring.

**ISE 465. Inventory and Supply Chain Management. 3 Credit Hours.**

This course consists of production and inventory management techniques such as forecasting methods, inventory control subject to both known and uncertain demand, aggregate planning, introduction to scheduling, materials requirement planning (MRP), and an introduction to quantitative modeling of supply chain management systems.

Prerequisite: IEN 310 or ECE 310 or IEN 311 or MAS 311 or equivalent.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**ISE 494. Senior Design Project. 3 Credit Hours.**

This course includes the integration of Industrial and Systems Engineering principles and techniques in the design and improvement of production and service systems. Included in the course is a culminating design experience with the preparation of a project proposal, data collection, analysis, comprehensive final report, and formal presentations to stakeholders.

Prerequisite: IEN 547. And Requisite: Senior Standing.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall & Spring.

**ISE 501. Manufacturing Analysis and Design I. 3 Credit Hours.**

Analysis of Production Systems stressing diagnosis of problems associated with work measurement, manufacturing methodologies, and their interaction with cost factors.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**ISE 502. Manufacturing Analysis and Design II. 3 Credit Hours.**

Analysis of production systems stressing diagnosis of problems of quality and production control, utilizing quantitative techniques and analytical methods.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**ISE 505. Robotics. 3 Credit Hours.**

Fundamentals of robotics including kinematics and dynamics, trajectory planning, sensors and actuators, robotic vision, and case studies. Building your own robot is an integral part of hands-on laboratory exercises. Matlab controltoolbox and image analysis toolbox will be extensively used for design and analysis.

Prerequisite: IEN 406.

**Components:** LEC.

**Grading:** GRD.

**ISE 507. Design of Manufacturing Systems. 3 Credit Hours.**

State-of-the-art techniques and tools relevant to the design, analysis, and control of modern manufacturing systems. Topics include modeling of manufacturing systems, tools for manufacturing system analysis, manufacturing system planning and scheduling, and lean manufacturing systems.

Prerequisite: IEN 465.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**ISE 509. Automated Assembly. 3 Credit Hours.**

Fundamentals of automated assembly including parts transfer systems and feeders, parts orientation and grasping techniques, product design for automated assembly (DFA), assembly robots, and performance and economics of assembly systems.

Prerequisite: IEN 406.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**ISE 512. Quality Management Systems. 3 Credit Hours.**

This course addresses the concepts, theories, tools and methodologies employed in the management and improvement of quality. The course examines many of the advance topics in statistical quality control including control charts, process capability studies, acceptance sampling and Quality Function Deployment (QFD). Also covered in the course are Lean Six Sigma methodology, tools and concepts.

Prerequisite: IEN 311 or MAS 311 or IEN 312 or MAS 312 or equivalent.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**ISE 513. Quality Management in Service Organizations. 3 Credit Hours.**

Course examines the issues of quality and productivity management in the service sector. Topics covered include the development and use of questionnaires, service industry applications of quality such as in banking, insurance, healthcare, transportation, government, public utilities, and retail trade.

Requisite: Senior Standing.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**ISE 516. Introduction to Applied Data Analytics. 3 Credit Hours.**

This course focuses on some of the most commonly-used data analytics models and covers the basics of data analytics using the open source software R (which is one of the fastest growing open source software platforms). Specific course topics include Data Preprocessing and Cleaning, Fundamentals of R (for basic data analytics tasks), Regression Analysis, Discriminant Analysis & Classification, Segmentation/Clustering, Model Tuning/Selection, Performance Measurement in Data Analytics, and Decision Making with Data. This course provides hands-on skills to engineering graduate students with performing statistical data analysis and decision-making utilizing common types of data sets.

Prerequisite: IEN 442 And IEN 312.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**ISE 524. Decision Support Systems in Industrial Engineering. 3 Credit Hours.**

Theory and application of decision support systems in industrial engineering. Topics include the study of model-based, data-based, knowledge-based, and communication-based decision support systems. Emphasis is placed on the selection process of the appropriate systems for various decision problems in industrial environments.

Requisite: Senior Standing.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall & Spring.

**ISE 547. Simulation Modeling and Systems Analysis. 3 Credit Hours.**

The objective of this course is to develop student's ability to model real systems and carry out effective and successful analysis of these systems using discrete event simulation. In this course, students will learn the basic concepts and algorithms of modeling and analysis. Students will get familiar with (1) formulating an appropriate simulation model for a system, (2) implementing the model as a computer program, and (3) evaluating the output of the model. Theoretical topics include random variable generation, model verification and validation, statistical input and output analysis

Prerequisites: IEN 442 or MAS 442.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall & Spring.

**ISE 548. Games and Decision Making. 3 Credit Hours.**

This course covers fundamentals of decision theory and game theory. The course is research oriented and a significant part of the grading will be based on students' research. Topics include optimization with multiple variables, constrained optimization, Lagrange relaxation, utility theory, decision making under uncertainty, simultaneous move (Nash) games, sequential decision making, sequential (Stackelberg) games, games with imperfect information, contracting and coordination, and bargaining. This course is composed of lectures, in-class discussions and problem solving, homework assignments, and research paper assignments.

Prerequisite: IEN 310. And IEN 441.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**ISE 554. Applied Computational Biomechanics. 3 Credit Hours.**

Students will become familiarized with current tools in the field of computational biomechanics for applications in ergonomics, sports performance, simulations of occupational activities and human movement in general. Through the presentation of case studies and the completion of assignments, students will gain hands-on experience on full-body simulation environments (e.g., OpenSim), biomechanically oriented finite elements packages (e.g., FEBio), and software for reconstruction of human anatomy from medical images (Seg3D).

Prerequisite: IEN 557. Or BME 375.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**ISE 557. Ergonomics and Human Factors Engineering. 3 Credit Hours.**

The study of human capacities and limitations with emphasis on human performance in system design. Topics include design of displays and controls, workload, job design, human information processing, anthropometry, workplace design, biomechanics, task analysis, and research techniques in human factors engineering. Lecture, 3 hours.

Prerequisite: IEN 312 or MAS 312.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall, Spring, & Summer.

**ISE 568. Facilities Planning and Logistics. 3 Credit Hours.**

This course focuses on the analysis and design of production and service facilities, including materials handling, facilities layout, warehouse and distribution systems, as well as logistics and supply chain.

Requisite: Senior Standing.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**ISE 570. Engineering Management. 3 Credit Hours.**

This course teaches the numerical techniques of management science for engineering problems. It covers a variety of solutions to practical problems using Microsoft Excel, Matlab and other solvers. This is a hands-on course utilizing practical examples that require the use of a number of methods but focuses not only on finding the optimal solution but analyzing the result in a manner that allows us to understand the sensitivity of the solution to different parameters. The course also includes the use of financial ratios and analysis.

Prerequisite: IEN 311 or MAS 311 or IEN 312 or MAS 312.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**ISE 571. Engineering Entrepreneurship. 3 Credit Hours.**

This course teaches an integrated strategy framework for entrepreneurs. The course will explore various strategies and how to position a startup group against competition in an advantageous manner. In addition, you will learn tools for analyzing ongoing ventures to improve the competitive edge. The final project will emphasize the structured approach to strategy selection and evaluating alternatives.

Requisite: Senior Standing.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**ISE 572. Management of Technological Innovation. 3 Credit Hours.**

Engineering, Science and Management Principles contributing to the development of a successful framework for Managing technology with an organization, nationally or internationally. The process of technological innovations, technological planning and forecasting, and socio-economic changes. Prerequisite: Senior or graduate standing.

Requisite: Senior Standing.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**ISE 590. Special Topics in Industrial Engineering. 1-3 Credit Hours.**

Sub-titles describing the topics are shown in parentheses in the class schedule, following the title "Special Topics".

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall, Spring, & Summer.

**ISE 594. Master's Capstone Design Project. 0-3 Credit Hours.**

A capstone design project for students in the five-year BSIE/MSIE program. Integration of Industrial Engineering principles and techniques in the design and improvement of production and service systems is emphasized. Offered for students in this program only.

Prerequisite: IEN 547. Requisite: Senior Standing.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**ISE 595. Special Problems. 1-3 Credit Hours.**

Project course introducing methods of research through an individual investigation of current problems. Offered by special arrangement only.

**Components:** THI.

**Grading:** GRD.

**Typically Offered:** Fall, Spring, & Summer.

**ISE 596. Special Problems. 1-3 Credit Hours.**

Project course introducing methods of research through an individual investigation of current problems. Offered by special arrangement only.

**Components:** THI.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**ISE 599. Cooperative Education. 1 Credit Hour.**

Practical application of classroom theory through alternating semester or summer employment with industries offering positions consistent with the student's field of study. Course may be repeated. Periodic reports and conferences are required.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**ISE 601. Manufacturing Analysis and Design I. 3 Credit Hours.**

Analysis of Production Systems stressing diagnosis of problems associated with work measurement, manufacturing methodologies, and their interaction with cost factors.

Prerequisite: IEN 301.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**ISE 602. Manufacturing Analysis and Design II. 3 Credit Hours.**

Analysis of production systems stressing diagnosis of problems of quality and production control, utilizing quantitative techniques and analytical methods.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**ISE 605. Robotics. 3 Credit Hours.**

Fundamentals of robotics including kinematics and dynamics, trajectory planning, sensors and actuators, robotic vision, and case studies. Building your own robot is an integral part of hands-on laboratory exercises. Matlab controltoolbox and image analysis toolbox will be extensively used for design and analysis.

**Components:** LEC.

**Grading:** GRD.

**ISE 607. Design of Manufacturing Systems. 3 Credit Hours.**

State-of-the-art techniques and tools relevant to the design, analysis, and control of modern manufacturing systems. Topics include modeling of manufacturing systems, tools for manufacturing system analysis, manufacturing system planning and scheduling, and lean manufacturing systems.

Requisite: Graduate Standing.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**ISE 612. Statistical Quality Control and Quality Management. 3 Credit Hours.**

This course addresses the concepts, theories, tools and methodologies employed in the management and improvement of quality. The course examines many of the advance topics in statistical quality control including control charts and process capability studies, acceptance sampling, as well as Quality Function Deployment (QFD) and introduction to reliability. Also covered in the course are Lean Six Sigma methodology, tools and concepts.

Prerequisite: IEN 311 or MAS 311 or IEN 312 or MAS 312 or equivalent.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**ISE 613. Quality Management in Service Organizations. 3 Credit Hours.**

Course examines the issues of quality and productivity management in the service sector. Topics covered include the development and use of questionnaires, service industry applications of quality such as in banking, insurance, healthcare, transportation, government, public utilities, and retail trade.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**ISE 616. Introduction to Applied Data Analytics. 3 Credit Hours.**

This course focuses on some of the most commonly-used data analytics models and covers the basics of data analytics using the open source software R (which is one of the fastest growing open source software platforms). Specific course topics include Data Preprocessing and Cleaning, Fundamentals of R (for basic data analytics tasks), Regression Analysis, Discriminant Analysis & Classification, Segmentation/Clustering, Model Tuning/Selection, Performance Measurement in Data Analytics, and Decision Making with Data. This course provides hands-on skills to engineering graduate students with performing statistical data analysis and decision-making utilizing common types of data sets.

Prerequisite: IEN 442 And IEN 312.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**ISE 624. Decision Support Systems in Industrial Engineering. 3 Credit Hours.**

Theory and application of decision support systems in industrial engineering. Topics include the study of model-based, data-based, knowledge-based, and communication-based decision support systems. Emphasis is placed on the selection process of the appropriate systems for various decision problems in industrial environments.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall & Spring.

**ISE 647. Computer Simulation Systems. 3 Credit Hours.**

Computer simulation and the development of simulation models. Application of discrete and continuous system simulation languages to systems studies is also included.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall & Spring.

**ISE 648. Games and Decision Making. 3 Credit Hours.**

This course covers fundamentals of decision theory and game theory. The course is research oriented and a significant part of the grading will be based on students' research. Topics include optimization with multiple variables, constrained optimization, Lagrange relaxation, utility theory, decision making under uncertainty, simultaneous move (Nash) games, sequential decision making, sequential (Stackelberg) games, games with imperfect information, contracting and coordination, and bargaining. This course is composed of lectures, in-class discussions and problem solving, homework assignments, and research paper assignments.

Prerequisite: IEN 310. And IEN 441.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**ISE 651. Accident Prevention Systems. 3 Credit Hours.**

Introduction to the basic principles of accident prevention and how to apply the safety engineering approach to the design of industrial accident prevention systems

Prerequisites: IEN 311 and IEN 351.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**ISE 654. Applied Computational Biomechanics. 3 Credit Hours.**

Students will become familiarized with current tools in the field of computational biomechanics for applications in ergonomics, sports performance, simulations of occupational activities and human movement in general. Through the presentation of case studies and the completion of assignments, students will gain hands-on experience on full-body simulation environments (e.g., OpenSim), biomechanically oriented finite elements packages (e.g., FEBio), and software for reconstruction of human anatomy from medical images (Seg3D).

Prerequisite: IEN 557. Or BME 375.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**ISE 657. Ergonomics and Human Factors Engineering. 3 Credit Hours.**

The study of human capacities and limitations with emphasis on human performance in system design. Topics include design of displays and controls, workload, job design, human information processing, anthropometry, workplace design, biomechanics, task analysis, and research techniques in human factors engineering. Lecture, 3 hours.

Requisite: Graduate Standing.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall, Spring, & Summer.

**ISE 658. Industrial Hygiene I. 3 Credit Hours.**

Recognition of occupational chemical health hazards. Evaluation methods and analytical procedures used to determine level of exposure to chemical and toxic hazards. Control measures and compliance with OSHA requirements with special emphasis on industrial ventilation, and other methods of control are included.

Prerequisite: IEN 557.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**ISE 668. Materials Handling and Facilities Planning. 3 Credit Hours.**

Analysis and design of production and service facilities, emphasis on material handling requirements. Capacity requirements, facility location, layout, storage systems and warehousing are discussed

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.



**ISE 670. Engineering Management. 3 Credit Hours.**

Integrating engineering discipline into the social and economic considerations of managing systems. Tools and techniques used by engineering managers including engineering project life cycle, role playing, communication, decision-making in engineering management, and managing change in engineering organizations are discussed.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**ISE 671. Engineering Entrepreneurship. 3 Credit Hours.**

The conversion of technological know-how and engineering theories into business enterprises. The role of technology in creating wealth, connecting technology with market, the role and characteristics of entrepreneurs, starting a business and the business plan, innovation, industrial and service organizations, and the new business environment.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**ISE 672. Management of Technological Innovation. 3 Credit Hours.**

Engineering, Science and Management Principles contributing to the development of a successful framework for Managing technology with an organization, nationally or internationally. The process of technological innovations, technological planning and forecasting, and socio-economic changes. Prerequisite: Senior or graduate standing.

Prerequisite: IEN 572.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**ISE 690. Special Topics in Industrial Engineering. 3 Credit Hours.**

Sub-titles describing the topics are shown in parentheses in the class schedule, following the title "Special Topics".

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall, Spring, & Summer.

**ISE 694. Master's Capstone Design Project. 3 Credit Hours.**

A capstone design project for students in the five-year BSIE/MSIE program. Integration of Industrial Engineering principles and techniques in the design and improvement of production and service systems is emphasized. Offered for students in this program only.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall & Spring.

**ISE 695. Special Problems. 1-3 Credit Hours.**

Project course introducing methods of research through an individual investigation of current problems. Offered by special arrangement only.

**Components:** THI.

**Grading:** GRD.

**Typically Offered:** Fall, Spring, & Summer.

**ISE 696. Special Problems. 1-3 Credit Hours.**

Project course introducing methods of research through an individual investigation of current problems. Offered by special arrangement only.

**Components:** THI.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**ISE 699. Cooperative Education. 1 Credit Hour.**

Practical application of classroom theory through alternating semester or summer employment with industries offering positions consistent with the student's field of study. Course may be repeated. Periodic reports and conferences are required.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**ISE 703. Graduate Research Seminar. 1 Credit Hour.**

Attendance and active participation in a designated semester seminar series.

Requisite: Must be a registered Doctoral student.

**Components:** SEM.

**Grading:** SUS.

**Typically Offered:** Fall & Summer.

**ISE 704. Graduate Teaching. 1-3 Credit Hours.**

Teaching or assisting in a course with a substantial level of instructional responsibility. Only open to doctoral students.

Requisite: Must be a registered Doctoral student.

**Components:** EXP.

**Grading:** SUS.

**Typically Offered:** Fall & Summer.

**ISE 712. Design of Experiments. 3 Credit Hours.**

Design and analysis of experiments, randomized blocks, Latin Squares, factorials, multiple correlation and regression, and application to response surfaces are discussed. 3 hours.

Prerequisite: IEN 311 or MAS 311 or equivalent.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**ISE 713. Applied Regression Analysis. 3 Credit Hours.**

Theory and applications of regression based models. Focus will be on empirical model building, estimation, inference and prediction with emphasis on interpretation of results and understanding model assumptions. Key Topics will be linear regression, panel data and time series analysis.

Prerequisite: IEN 311.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**ISE 715. Quality Through Planned Experimentation. 3 Credit Hours.**

Sequential experimentation and guidance on how to build the sequence and use graphical methods to ascertain how much the planned changes contribute to the variation in the data. Experimentation is presented as a system in the context of a model to improve quality and integrate statistical process control (SPC) with methods of design. Examples presented contain problems often encountered in actual experimentation in a manufacturing or a service facility. Not open to students with credit in IEN 712.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**ISE 716. Advanced Quality Control. 3 Credit Hours.**

Advanced topics in variables and attributes acceptance sampling and control charting. Statistical and economical design of control chart and sampling plan, sampling design and analysis with inspection and measurement errors, product liability prevention, value engineering, quality costs, Metrology, military standards, quality manuals, customer and vendor relations, and total quality control concepts are discussed.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**ISE 742. Linear Programming and Extensions. 3 Credit Hours.**

Formulation, solution, postoptimality analysis of linear programming problems; revised simplex, parametric programming, decomposition of large-scale systems. Use of computer packages. Introduction to integer programming, network flows, and nonlinear programming applications.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**ISE 747. Data Driven Multi-paradigm Simulation Systems. 3 Credit Hours.**

The goal of this course to familiarize the students with current research problems in the simulation field including 1) various modeling paradigms (discrete event, system dynamics, agent-based approach, O-O modeling, Petri-net), 2) modeling enhancement in discrete event simulation, 3) standards, methods, techniques, and cyber-infrastructures (web services and grid computing) enabling distributed simulation, 4) algorithms for partitioning a large scale simulation into smaller pieces, and 5) real-time simulation and simulation based control. If time permits, the course will also cover 6) simulation optimization techniques using search algorithms and 7) deadlock detection and resolution in simulation. This course will help graduate students identify potential research topics in simulation principles for the application areas in design and control for complex data driven systems.

Prerequisite: IEN 547 or IEN 647.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**ISE 757. Ergonomics and Occupational Biomechanics. 3 Credit Hours.**

Effects of human factors in the improvement of performance of systems. Human capacities, capabilities, and limitations as derived from anatomical, physiological, and psychological principles are applied to the design of tools and equipment. Incorporation of all factors into systems design to achieve better system performance is emphasized

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**ISE 758. Ergonomics and Special Populations. 3 Credit Hours.**

Ergonomic issues relevant to design for older adults and special populations such as the handicapped. Primary emphasis is placed on work environments, transportation and communication systems, and home environments. Topics include cognitive and physiological characteristics of special populations, workplace design, job and equipment design, rehabilitation engineering, clinical ergonomics, and legislation such as the ADA. Lecture, 3 hours.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**ISE 760. Productivity Measurement and Evaluation. 3 Credit Hours.**

Basic concepts. Productivity measurement approaches at international, national, industry, and company levels. Latest measurement models for manufacturing companies. Relationships between total and partial productivities, profit and total productivity. Productivity evaluation: theory and methodology.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**ISE 761. Engineering Cost Management. 3 Credit Hours.**

Issues of cost management, including activity based costing of engineering projects. A detailed study of how to separate, identify, understand and manage the major activities performed, and how these activities relate to customer needs. Overall view of costs associated with products, processes, and customers.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**ISE 763. Project Management Techniques. 3 Credit Hours.**

Techniques and Tools in Project Management. Use of network flow techniques including PERT/CPM, planning, systems concepts, time management, conflicts, cost and resource control, tradeoff analysis.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall.

**ISE 764. Supply Chain Management. 3 Credit Hours.**

Supply Chain Management focuses on the flow of products, information, and money throughout the supply chain. An overview of issues, opportunities, tools, and approaches is provided. Emphasis is placed on business processes, system dynamics, control, design and re-engineering, and on the relationship between the supply chain and the company's strategic position relative to its clients and its competition. The dimensions of inter-organizational relationships with partners, including decision-making, incentives, and risk are also covered.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**ISE 765. Advanced Production Systems. 3 Credit Hours.**

Quantitative, heuristic and computer methods applied to problems of production planning, work force balancing and capacity expansion. Sequencing and scheduling models. Advanced Material Requirements Planning (MRP II). Just In Time production systems (JIT). Master Production Scheduling (MPS). Optimize Production Technology (OPT). KANBAN production planning system. Learning curve theory. Advanced forecasting and time-series analysis.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Spring.

**ISE 772. Strategic Management of Technological Innovation.. 3 Credit Hours.**

Advanced topics in the management of technology emphasizing the relationship between technology and competitiveness in the global marketplace. Technology development in the U.S., Japan, and Europe, industrial R & D, strategic technological planning, and conditions for successful implementations. Case studies are used with individual and group assignments. Prerequisite: IEN 572 - Management of Technology or permission of Instructor.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Offered by Announcement Only.

**ISE 792. Professional Communications Skills for Engineering Grad Students. 0 Credit Hours.**

This course covers fundamental areas in professional communication for Engineering graduate students. Topic areas include: presenting research at conferences, writing manuscripts for publication, preparing the dissertation, the PhD comprehensive exams, effective teaching and mentoring, and obtaining positions in academia. Through interactive workshops, in-class exercises, brief presentations and assignments, students will have an opportunity to practice and strengthen necessary communication skills, developing collaborations, and developing effective presentation skills.

**Components:** LEC.

**Grading:** SUS.

**Typically Offered:** Offered by Announcement Only.

**ISE 794. Master's Project. 3 Credit Hours.**

A capstone project for M.S. students in the non-thesis option.

**Components:** THI.

**Grading:** GRD.

**Typically Offered:** Fall, Spring, & Summer.

**ISE 795. Special Problems. 1-3 Credit Hours.**

Research and/or design projects through an individual investigation of current problems. Offered by special arrangement only.

**Components:** THI.

**Grading:** GRD.

**Typically Offered:** Fall, Spring, & Summer.

**ISE 796. Special Problems. 1-3 Credit Hours.**

Research and/or design projects through an individual investigation. of current problems. Offered by special arrangement only.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall, Spring, & Summer.

**ISE 799. Advanced Topics. 1-3 Credit Hours.**

Subject matter offerings based upon student demand and availability of faculty. Subtitles describing the topics to be offered will be shown in parentheses in the printed class schedule, following the title "Advanced Topics".

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall, Spring, & Summer.

**ISE 810. Master's Thesis. 1-6 Credit Hours.**

The student working on his/her master's thesis enrolls for credit, in most departments not to exceed six, as determined by his/her advisor. Credit is not awarded until the thesis has been accepted.

**Components:** THI.

**Grading:** SUS.

**Typically Offered:** Fall, Spring, & Summer.

**ISE 820. Research in Residence. 1 Credit Hour.**

Used to establish research in residence for the thesis for the master's degree after the student has enrolled for the permissible cumulative total in IEN 710 (usually six credits). Credit not granted. May be regarded as full time residence.

**Components:** THI.

**Grading:** GRD.

**Typically Offered:** Fall, Spring, & Summer.

**ISE 825. Continuous Registration--Master's Study. 1 Credit Hour.**

To establish residence for non-thesis master's students who are preparing for major examinations. Credit not granted. Regarded as full time residence.

**Components:** LEC.

**Grading:** GRD.

**Typically Offered:** Fall, Spring, & Summer.

**ISE 830. Pre-Candidacy Doctoral Dissertation. 1-12 Credit Hours.**

Doctoral dissertation credits taken prior to Ph.D. student's candidacy. The student will enroll for credit as determined by his/her advisor. Not more than 12 hours of IEN 730 may be taken in a regular semester, nor more than six in a summer session.

**Components:** THI.

**Grading:** SUS.

**Typically Offered:** Fall, Spring, & Summer.

**ISE 840. Post-Candidacy Doctoral Dissertation. 1-12 Credit Hours.**

Doctoral dissertation credits taken after Ph.D. student has been admitted to candidacy. The student will enroll for credit as determined by his/her advisor. Not more than 12 credits in IEN 740 may be taken in a regular semester, nor more than six credits in a summer session.

**Components:** THI.

**Grading:** SUS.

**Typically Offered:** Fall, Spring, & Summer.

**ISE 850. Research in Residence. 1 Credit Hour.**

Used to establish research in residence for the Ph.D. and D.A., after the student has been enrolled for the permissible cumulative total in appropriate doctoral research. Credit not granted. May be regarded as full-time residence as determined by the Dean of the Graduate School.

**Components:** THI.

**Grading:** SUS.

**Typically Offered:** Fall, Spring, & Summer.