Industrial, Manufacturing and Systems Engineering

Description

Industrial engineers focus on how to get the work done most efficiently, balancing many factors, such as time, number of workers needed, available technology, actions workers need to take, achieving the end product with no errors, workers' safety, environmental concerns, and cost. They also engage in supply chain management and conduct quality assurance activities.

Undergraduate Degree

- Industrial Engineering, B.S. (http://catalog.uta.edu/archives/2023-2024/engineering/industrial/undergraduate/)

Graduate Degrees

- Engineering Management, M.S. (http://catalog.uta.edu/archives/2023-2024/engineering/industrial/graduate/#msemtext)
- Industrial Engineering, M.S. (http://catalog.uta.edu/archives/2023-2024/engineering/industrial/graduate/#masterstext)
- Industrial Engineering, Ph.D. (http://catalog.uta.edu/archives/2023-2024/engineering/industrial/graduate/#doctoraltext)

Certificates

- Unmanned Vehicle Systems (Undergraduate, Graduate) (http://catalog.uta.edu/archives/2023-2024/engineering/industrial/graduate/#msemtext)
- Industrial Applications (Graduate) (http://catalog.uta.edu/archives/2023-2024/engineering/industrial/graduate/#msemtext)
- Decision Analytics (Graduate) (http://catalog.uta.edu/archives/2023-2024/engineering/industrial/graduate/#masterstext)
- Logistics (Graduate) (http://catalog.uta.edu/archives/2023-2024/engineering/industrial/graduate/#doctoraltext)

COURSES

IE 1104. INTRODUCTION TO ENGINEERING. 1 Hour. (TCCN = ENGR 1101)
Introduction to basic engineering concepts. Students will become familiar with engineering and its many sub-fields, ethical responsibilities, creativity and design.

IE 1110. FIRST SEMESTER INDUSTRIAL ENGINEERING SEMINAR. 1 Hour.
This class focuses on creating a collaborative and inclusive environment for both freshmen and transfer students to the Industrial Engineering program at UTA. This course uses team building exercises, introduces faculty to students through presentations about their classes and research, and presents the curriculum within the "big picture" of how the courses fit together to prepare students for a successful career. This course is intended to provide students the opportunity to form productive study groups and to meet and interact with their professors.

IE 1205. INTRODUCTION TO INDUSTRIAL ENGINEERING AND COMPUTING. 2 Hours.
Introduction to basic industrial engineering concepts and industrial engineering as a field. Microsoft Excel skills are stressed and the software is used to analyze collected data. Some College of Engineering requirements are satisfied by the content of this course.

IE 1325. INTRODUCTION TO DATA ANALYSIS. 3 Hours.
This course is an introduction to organizing, manipulating, analyzing, and visualizing data. Students will become proficient in using Microsoft Excel functions, pivot tables, advanced analytics modules, visualization tools and external data sources. This class will prepare students for success in future industrial engineering classes. Prerequisite: IE 1110 or concurrent enrollment.

IE 2000. UNDERGRADUATE RESEARCH. 0 Hours.
Sophomore level undergraduate research. May be taken a maximum of three times. Prerequisite: Departmental good standing and permission of instructor.

IE 2305. COMPUTER APPLICATIONS IN INDUSTRIAL ENGINEERING. 3 Hours.
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: IE 1325 (or IE 1205).

IE 2308. ECONOMICS FOR ENGINEERS. 3 Hours.
Methods used for determining the comparative financial desirability of engineering alternatives. Provides the student with the basic tools required to analyze engineering alternatives in terms of their worth and cost, an essential element of engineering practice. The student is introduced to the concept of the time value of money and the methodology of basic engineering economy techniques. The course will provide the student with the background to enable them to pass the Engineering Economy portion of the Fundamentals of Engineering exam. Prerequisites: MATH 1426 or concurrent enrollment.

IE 3000. UNDERGRADUATE RESEARCH. 0 Hours.
Junior level undergraduate research. May be taken a maximum of three times. Prerequisite: Departmental good standing and permission of instructor.

IE 3301. ENGINEERING PROBABILITY. 3 Hours.
Topics in engineering that involve random processes. Applications and backgrounds for topics in reliability, inventory systems, and queuing problems, including absolute and conditional probabilities, discrete and continuous random variables, parameter estimation, hypothesis testing, and an introduction to linear regression, experimental design, and analysis of variance. Prerequisite: MATH 2425.

IE 3312. ECONOMICS FOR ENGINEERS. 3 Hours.
Tools and methods used for determining the comparative financial desirability of engineering alternatives. Prerequisite: MATH 1426 or concurrent enrollment.

IE 3314. ENGINEERING RESEARCH METHODS. 3 Hours.
A continuation of IE 3301. Simple and multiple linear regression analysis, design of experiments, analysis of variance, and quality control statistics. Emphasis on the application of these methods to engineering data, with computerized data analysis. Prerequisite: IE 3301 and MATH 2326.

IE 3315. OPERATIONS RESEARCH I. 3 Hours.
An introduction to the major deterministic quantitative techniques of operations research and their application to decision problems. These techniques include linear programming, integer programming, network analysis, and nonlinear programming. Modeling with these techniques is emphasized. Appropriate solvers are used. Prerequisite: MATH 2326 or concurrent enrollment.

IE 3343. METRICS AND MEASUREMENT. 3 Hours.
This course presents methods for determining the most effective utilization of effort in the man-machine environment as well as systems and methods to measure enterprise performance. Prerequisite: MATH 2326, IE 2308 or concurrent enrollment, and IE 3301 or concurrent enrollment.

IE 4000. UNDERGRADUATE RESEARCH. 0 Hours.
Senior level undergraduate research. May be taken a maximum of three times. Prerequisite: Departmental good standing and permission of instructor.

IE 4191. SPECIAL PROBLEMS IN INDUSTRIAL ENGINEERING. 1 Hour.
The investigation of special individual problems in industrial engineering under the direction of a faculty member. Prerequisite: Consent of instructor and undergraduate advisor.

IE 4291. SPECIAL PROBLEMS IN INDUSTRIAL ENGINEERING. 2 Hours.
The investigation of special individual problems in industrial engineering under the direction of a faculty member. Prerequisite: Consent of instructor and undergraduate advisor.

IE 4300. TOPICS IN INDUSTRIAL ENGINEERING. 3 Hours.
A study of selected topics in industrial engineering. May be repeated when topics vary. Prerequisite: consent of instructor and undergraduate advisor.

IE 4302. ENGINEERING ADMINISTRATION AND ORGANIZATION. 3 Hours.
A survey of administration, control and organization of engineering and research activities. Strategic planning as well as project planning and control are discussed. Prerequisite: accepted in an UTA engineering professional program.

IE 4303. PRODUCTION AND INVENTORY CONTROL. 3 Hours.
Fundamental theory and design of systems for the control of production, inventories and their economic interaction, particularly in cases involving uncertainty of demand, of supply availability, and of production rates. Prerequisite: IE 2305, IE 3301 and IE 3315.

IE 4304. ENTERPRISE SYSTEMS. 3 Hours.
An extension of Production and Inventory Control (IE 4303), this course covers enterprise resource planning systems (ERP) in manufacturing, E-Commerce and supply chain environments. ERP software and case studies are reviewed. Prerequisite: IE 4303.

IE 4305. ENGINEERING DECISION MAKING WITH DATA USING PYTHON. 3 Hours.
This course utilizes statistical tools using Python to analyze real world data on engineering applications. Students explore file handling, database access, and various case studies using Machine Learning techniques. Machine Learning topics include Regression, Classification, Clustering, Dimensionality Reduction, Ensemble Methods, Neural Networks and Deep Learning. Some programming experience is required. Prerequisite: IE 3301 and accepted into an UTA engineering professional program.

IE 4308. QUALITY SYSTEMS. 3 Hours.
A comprehensive coverage of modern quality systems techniques to include the design of statistical process control systems, acceptance sampling, and process analysis and design. Prerequisite: IE 3301 or concurrent enrollment.

IE 4310. INDUSTRIAL AND PRODUCT SAFETY. 3 Hours.
Scientific, managerial, and legal aspects of safety hazard control and elimination in the industrial workplace. Methods for enhancing product safety. Prerequisite: accepted in an UTA engineering professional program.

IE 4314. DATA MINING AND ANALYTICS. 3 Hours.
This course provides an introduction to data mining and pattern recognition. The basic theories, algorithms, key technologies in data analytics and machine learning will be discussed. Topics include data processing and visualization methods, supervised learning methods (parametric/non-parametric algorithms, KNN, decision tree, discriminant functions, Bayesian classification models, support vector machines, neural networks), unsupervised learning methods (clustering, dimensionality reduction, recommender systems), ensemble learning methods (random forests and adaptive boosting), feature selection methods, and deep learning methods. Prerequisite: IE 3301 and accepted into an UTA engineering professional program.

IE 4315. OPERATIONS RESEARCH II. 3 Hours.
A continuation of IE 3315 that includes probabilistic techniques of operations research and their application to decision problems. Topics include Markov chains, game theory, decision analysis, multiple-objective decision making, and queuing theory. Modeling with these techniques is emphasized. Appropriate solvers are used. Projects are required. Prerequisite: IE 3301, IE 3315, and MATH 3319 (or concurrent enrollment).

IE 4318. ENTERPRISE DESIGN. 3 Hours.
This course provides students with an introduction to enterprise systems. Students will be exposed to the technology and analysis methodologies for enterprise resource planning, system design, supply chain management. Also, modern and next-generation enterprise systems will be introduced and basic data mining and machine learning methods will be covered. Prerequisite: Accepted in an UTA engineering professional program.

IE 4322. ENTERPRISE SIMULATION. 3 Hours.
The design and analysis of complex manufacturing and service systems using computer-based discrete event simulation techniques. Topics include an introduction to simulation methods, and the design, construction and analysis of discrete-event simulation models, as well as their computer applications. The course also covers the execution and management of simulation projects and the formal presentation of their findings. Prerequisite: IE 3314 and IE 4315.

IE 4323. AGENT-BASED MODELING AND SIMULATION. 3 Hours.
A series of agent-based modeling topics will be covered including the fundamental concepts of agent-based modeling approach, when to apply, and how to design and implement agent-based simulation to represent complex systems and solve decision problems. Some programming experience and Excel basic knowledge is required. Prerequisite: IE 3301 and accepted into an UTA engineering professional program.

IE 4325. AUTOMATION AND ROBOTICS I. 3 Hours.
Study of the use of industrial automation and robotics technologies in manufacturing industries. The course introduces the major classes of industrial automation. Issues associated with the successful deployment of automation are presented. Laboratory exercises focus on a practical introduction to various automation technologies. Prerequisite: IE 4303 or concurrent enrollment.

IE 4335. COGNITIVE SYSTEMS ENGINEERING. 3 Hours.
This course will discuss applications of psychological principles and computer and information sciences related to human-centered designs for both simple and complex systems. Emphasis will be placed on the design of advanced technological systems to support both individual and larger distributed work systems. In this class, you will learn about theories of human-machine systems, human perceptual and cognitive abilities/limitations, the role of technology and techniques in supporting decision-making and problem solving, and various interface evaluation methods that help to identify issues with how people interact with work and technologies. Prerequisite: Must be in a College of Engineering or College of Science professional program or approval of advisor.

IE 4339. MANUFACTURING PROCESS & SYSTEM ANALYSIS. 3 Hours.
This course provides students with an introduction to manufacturing systems and processes such as machining, welding, and the emerging technology of additive manufacturing. Students will learn to quantify and measure variabilities in the manufacturing system, describe the system's behavior, and improve the system's performance. The impact of quality and reliability on overall system performance sustainability will be explored. Prerequisite: Accepted in an UTA engineering professional program.

IE 4340. ENGINEERING PROJECT MANAGEMENT. 3 Hours.
Introduces engineering project management concepts and tools needed to form, develop and manage cross-disciplinary engineering design teams. Topics include: Understanding R&D organizations, teams and work groups, job design, organizational effectiveness, and leading technical professionals. Prerequisite: Admitted into an Engineering Professional Program.

IE 4343. FACILITIES PLANNING AND DESIGN. 3 Hours.
The course covers strategic facilities planning through detailed facilities layout design. Considerations include product flow, space and activity relationships, personnel requirements, material handling, and layout. Traditional and contemporary issues in manufacturing and their impact on facilities design including receiving, shipping, warehousing, and integration with manufacturing and supporting operations are explored. Facilities planning models and the process of evaluating, selecting, preparing, presenting, and implementing the facilities plan are covered. Prerequisite: IE 4303 or concurrent enrollment.

IE 4344. HUMAN FACTORS ENGINEERING. 3 Hours.
Study of the interactions between people and their work, workplace, and the environment. Involves identification, measurement, analysis, and evaluation of interactions via human physical and mental capacities and limitations, and social interactions. Prerequisite: IE 3301, IE 2308, and IE 3343.

IE 4345. DECISION ANALYSIS IN SYSTEM DESIGN. 3 Hours.
Application of decision theory principles and tools to evaluate alternative hardware/software system architectures based on technical design requirements such as mass, reliability, power and life cycle costs. Systems engineering trade study approaches are presented with applications in defense, aerospace, energy and related areas. Methods for dealing with technical data risk and uncertainty are presented. Prerequisite: Accepted into an engineering professional program at UTA.

IE 4349. INDUSTRIAL AUTOMATION. 3 Hours.
Project oriented course focusing on the design, implementation, and operation of technology. An in-depth study of the design and deployment of industrial technology to meet the needs of high-precision, multi-product environments. The laboratory activities associated with the course provide practical experience. Prerequisite: IE 4325.

IE 4350. INDUSTRIAL ENGINEERING CAPSTONE DESIGN. 3 Hours.
This course provides an open-ended design experience through the planning and design of an enterprise in which the student must demonstrate the ability to design, develop, implement, and improve integrated systems that include people, materials, information, equipment and energy. Contemporary project management techniques are utilized. The design experience project includes submittal of several written and oral presentations culminating in a written project report and oral presentation at the end of the semester. IE 4350 is the capstone design course and draws on material from the total industrial engineering curriculum. The impact of engineering design on society is discussed. Prerequisite: all required 4000 level IE courses or concurrent enrollment.

IE 4351. FUNDAMENTALS OF SYSTEMS ENGINEERING. 3 Hours.
This course includes a survey of concepts, principles and processes required to engineer complex systems throughout the life-cycle from concept through disposal. Topics include systems thinking, technical and management processes, life cycle models, sustainability, and model-based systems engineering. Prerequisite: Accepted into an engineering professional program at UTA.

IE 4378. INTRODUCTION TO UNMANNED VEHICLES SYSTEMS. 3 Hours.
Introduction to UVS (Unmanned Vehicle Systems) such as UAS (Unmanned Aircraft Systems), UGS (Unmanned Ground System) and UMS (Unmanned Maritime System), their history, missions, capabilities, types, configurations, subsystems, and the disciplines needed for UVS development and operation. UVS missions could include student competitions sponsored by various technical organizations. This course is team-taught by engineering faculty. Prerequisite: Admission to a professional engineering or science program.

IE 4379. UNMANNED VEHICLE SYSTEM DEVELOPMENT. 3 Hours.
Introduction to the technologies needed to create an UVS (Unmanned Vehicle System). Integration of these technologies (embodied as a set of sensors, actuators, computing and mobility platform sub-systems) into a functioning UVS through team work. UVS could be designed to compete in a student competition sponsored by various technical organizations or to support a specific mission or function defined by the instructors. This course is team-taught by engineering faculty. Prerequisite: B or better in IE 4378 and admission to the UVS certificate program.

IE 4391. SPECIAL PROBLEMS IN INDUSTRIAL ENGINEERING. 3 Hours.
The investigation of special individual problems in industrial engineering under the direction of a faculty member. Prerequisite: Consent of instructor and undergraduate advisor.

IE 5191. ADVANCED STUDIES IN INDUSTRIAL ENGINEERING. 1 Hour.
Individually approved research projects and reading courses in industrial engineering. Such individual studies will be graded A, B, C, D, F or X. Subject to the approval of the Graduate Advisor, IE 5191, IE 5291 and IE 5391 may be repeated as the topics change. In addition, work on a thesis substitute will be performed under IE 5391. In this case, IE 5391 is graded P/F/R.

IE 5291. ADVANCED STUDIES IN INDUSTRIAL ENGINEERING. 2 Hours.
Individually approved research projects and reading courses in industrial engineering. Such individual studies will be graded A, B, C, D, F or X. Subject to the approval of the Graduate Advisor, IE 5191, IE 5291 and IE 5391 may be repeated as the topics change. In addition, work on a thesis substitute will be performed under IE 5391. In this case, IE 5391 is graded P/F/R.

IE 5300. TOPICS IN INDUSTRIAL ENGINEERING. 3 Hours.
A study of selected topics in industrial engineering. May be repeated when topics vary. Prerequisite: consent of instructor and Graduate Advisor.

IE 5301. INTRODUCTION TO OPERATIONS RESEARCH. 3 Hours.
An introduction to the major quantitative techniques of operations research and their application to decision problems. These techniques include linear programming, integer programming, network analysis, nonlinear programming, game theory, Markov Chains, and queuing theory. Modeling with these techniques is emphasized. Appropriate solvers are used. Prerequisite: IE 3301 or equivalent, or IE 5317 concurrent, or DASC 5302 concurrent.

IE 5302. INTRODUCTION TO INDUSTRIAL ENGINEERING. 3 Hours.
An introduction to the fundamental principles of Industrial Engineering. Topics include Human Factors Engineering, Metrics and Measurement, Production and Inventory Control, Quality Systems, Simulation and Optimization, and Facilities Planning and Design. Prerequisite: Graduate standing.

IE 5303. QUALITY SYSTEMS. 3 Hours.
Principles and practices of industrial quality control. Topics include the Deming philosophy, process improvements, statistical process control, process capability analysis and product acceptance. Prerequisite: IE 3301, or IE 5317, or DASC 5302, or equivalent.

IE 5304. ADVANCED ENGINEERING ECONOMY. 3 Hours.
Analysis of capital investments in engineering and technical projects. Topics include decision analysis methods, cash flows, revenue requirements, activity-based analysis, multi-attribute decisions, probabilistic analysis and sensitivity/risk analysis. Prerequisite: graduate standing.

IE 5305. LINEAR OPTIMIZATION. 3 Hours.
Theory and applications of linear programming including linear programming formulation, the simplex method, duality, revised simplex, general linear programs, infeasibility, the dual simplex method, column generation, and network flow problems. Prerequisite: IE 3315, or IE 5301, or equivalent.

IE 5306. DYNAMIC OPTIMIZATION. 3 Hours.
Dynamic optimization methods including dynamic programming, the calculus of variations, and optimal control theory. Emphasis is on the modeling and solution of practical problems using these techniques. Prerequisites: IE 5317 or equivalent or IE 5318 concurrent.

IE 5307. QUEUEING THEORY. 3 Hours.
The fundamentals of queueing theory including Markovian birth-death models, networks of queues, and general arrival and service distributions. Prerequisites: IE 3301, or IE 5317, or equivalent.

IE 5309. STOCHASTIC PROCESSES. 3 Hours.
The study of probabilistic model building including the fundamentals of both discrete and continuous Markov chains, queueing theory and renewal theory. Prerequisite: IE 3301, IE 5317, or equivalent.

IE 5310. PRODUCTION SYSTEMS DESIGN. 3 Hours.
Methods for the design and analysis of manufacturing and logistics systems. Emphasis is placed on reducing cycle time, increasing throughput, lowering variation, and improving both quality and customer responsiveness through modeling techniques. Prerequisites: IE 3301, or IE 5317, or equivalent; IE 5301 current or equivalent; IE 5329 concurrent or equivalent.

IE 5311. DECISION ANALYSIS. 3 Hours.
A survey of methods for making optimal decisions. Topics include decision models, formal logic, fuzzy controls, statistical decision theory, game theory, multiobjective decisions, stochastic programming, information theory and qualitative aspects of the decisions. Prerequisites: IE 3301, or IE 5301, or equivalent.

IE 5312. PLANNING AND CONTROL OF ENTERPRISE SYSTEMS. 3 Hours.
A continuation of IE 5329 covering enterprise resource planning systems (ERP) and other advanced production control techniques. Computer modeling is emphasized. Prerequisite: Graduate standing.

IE 5313. RELIABILITY AND ADVANCED QUALITY CONTROL TOPICS. 3 Hours.
Includes advanced quantitative topics in reliability design and quality control. Management of reliability and quality control functions are also included. Prerequisites: IE 4308, or IE 5303, or equivalent.

IE 5314. SAFETY ENGINEERING. 3 Hours.
Methods to identify, measure, analyze, and evaluate safety hazards in the workplace. Scientific and managerial methods to prevent or control safety hazards. Prerequisite: graduate standing.

IE 5315. DATA SCIENCE PROJECT MANAGEMENT. 3 Hours.
Management and control of multifaceted science and engineering projects. Coordination and interactions between client and various service organizations. Project management selection. Typical problems associated with various phases of project life cycle. Case studies illustrate theories and concepts. Students will be expected to demonstrate an understanding of communication and collaboration, including workflow, reproducibility, codebase management, collaboration tools, oral and written communication, presentation, storytelling, and team management, as well as ethics, such as understanding bias, fairness, credibility and misinformation, security, privacy and codes of conduct. Prerequisite: Graduate standing.

IE 5317. INTRODUCTION TO PROBABILITY AND STATISTICS. 3 Hours.
Topics include descriptive statistics, set theory, combinatorics, mathematical expectation, probability distributions, confidence interval estimation, regression analysis, analysis of variance, and design of experiments. Prerequisite: Graduate standing in any program.

IE 5318. APPLIED REGRESSION ANALYSIS. 3 Hours.
An in-depth study of one predictor variable followed by the matrix approach to multiple linear regression. Topics include estimation, prediction, analysis of variance, residual analysis, transformations, multicollinearity, model selection, weighted least squares, ridge regression, and robust regression. Prerequisite: IE 3301, or IE 5317, or DASC 5302, or equivalent.

IE 5319. ADVANCED STATISTICAL PROCESS CONTROL AND TIME SERIES ANALYSIS. 3 Hours.
Design of control schemes for statistical monitoring and control of modern manufacturing systems. Topics include charts for process control, effect of autocorrelation on SPC charts, and sampling plans for acceptance inspection. Prerequisite: IE 3301 and IE 5303 or equivalent.

IE 5320. ENTERPRISE ENGINEERING METHODS. 3 Hours.
A survey of enterprise engineering methods. Topics include system development methodology, discussion of enterprise architectures, activity modeling, business modeling, activity-based performance analysis, and process improvement. Prerequisite: Graduate standing.

IE 5321. ENTERPRISE ANALYSIS AND DESIGN. 3 Hours.
An in-depth study of techniques useful for the analysis and design of the manufacturing enterprise. This course presents an advanced process description technique that is used, with simulation and activity based costing, to facilitate analysis and design. Prerequisites: Graduate standing.

IE 5322. SIMULATION AND OPTIMIZATION. 3 Hours.
An in-depth study of discrete event simulation theory and practice. Optimization and search techniques used in conjunction with simulation experiments are introduced. A commercial simulation software application is used. Prerequisite: IE 5317, DASC 5302, or equivalent, or IE 5318 concurrent.

IE 5323. AGENT BASED SIMULATION. 3 Hours.
Topics include the fundamental concepts of agent-based modeling and implementing agent-based simulation. Students are expected to be proficient in programming and Excel. Prerequisite: IE 3301, or IE 5317, or DASC 5302 or equivalent.

IE 5326. INDUSTRIAL BIOMECHANICS. 3 Hours.
The development and application of biomechanical models of physical work tasks, especially manual materials handling and hard-arm work activities. Prerequisite: Graduate Standing.

IE 5327. ADVANCED STATISTICS. 3 Hours.
Continuation of IE 5317. Topics include multiple linear regression analysis, design of experiments, analysis of variance, and quality control statistics. Prerequisite: IMSE advisor approval.

IE 5329. PRODUCTION AND INVENTORY CONTROL SYSTEMS. 3 Hours.
The fundamentals of production and inventory control systems. The economic impacts of fluctuating demand, supply availability and production rates are examined. Prerequisite: Graduate standing in IMSE, or permission of IMSE advisor.

IE 5330. AUTOMATION AND ADVANCED MANUFACTURING. 3 Hours.
The design of automated and advanced production processes for manufacturing. Topics include numerical control, robotics, group technology, just-in-time, automated inspection and flexible manufacturing systems. Prerequisite: Graduate standing in IMSE or permission of IMSE advisor.

IE 5331. INDUSTRIAL ERGONOMICS. 3 Hours.
The analysis and design of physical work, workplace, and hand tools using ergonomic principles for enhancing performance, health, and safety. Work refers mainly to whole body and hand-arm activities, while workplace refers to industrial and computerized office environments. Applications focus on people's anthropometric, musculoskeletal and psychological characteristics. Prerequisite: Graduate standing in IMSE or permission of IMSE advisor.

IE 5332. NONLINEAR PROGRAMMING. 3 Hours.
Methods for nonlinear optimization including classical theory; gradient methods; sequential unconstrained methods; convex programming; genetic algorithms; simulated annealing; and separable, quadratic, and geometric programming. Prerequisite: Graduate standing.

IE 5333. LOGISTICS TRANSPORTATION SYSTEMS DESIGN. 3 Hours.
The design and analysis of domestic and international transportation systems of people, processes, and technology. Topics include the role of transportation in the extended enterprise, transportation modeling and optimization techniques, value-added supply chain issues, and financial performance measures. Prerequisites: IE 3301, or IE 5317, or equivalent or IE 5318; IE 5301 concurrent or equivalent.

IE 5334. LOGISTICS DISTRIBUTION SYSTEMS DESIGN. 3 Hours.
The design and analysis of distribution systems of people, processes and technology. The focus is on distribution, warehousing and material handling. Topics include the role of the warehouse in the extended enterprise, warehouse planning, process design, layout, equipment selection, workforce and workplace issues, and financial performance measures. Prerequisites: IE 3301, or IE 5317, or equivalent.

IE 5335. COGNITIVE SYSTEMS ENGINEERING. 3 Hours.
This course will discuss applications of psychological principles and computer and information sciences related to human-centered designs for both simple and complex systems. Emphasis will be placed on the design of advanced technological systems to support both individual and larger distributed work systems. Topics include theories of human-machine systems, human perceptual and cognitive abilities/limitations, the role of technology and techniques in supporting decision-making and problem solving, and various interface evaluation methods that help to identify issues with how people interact with work and technologies. Prerequisite: IE 3301, or IE 5317, or DASC 5302, or equivalent. Some introductory programming knowledge is recommended.

IE 5338. HUMAN ENGINEERING. 3 Hours.
Human structural, physiological, psychological, and cognitive capacities and limitations in the workplace, and their effects on the design of work systems to enhance productivity, and maintain health and safety. Prerequisite: IE 3301, or IE 5317, or equivalent.

IE 5339. PRODUCT DESIGN, DEVELOPMENT, PRODUCIBILITY, AND RELIABILITY DESIGN. 3 Hours.
This course covers product development and engineering design process with a focus on collaborative design. Software, manufacturing, reliability, testing, logistical and product support considerations are emphasized. Prerequisite: graduate standing.

IE 5342. METRICS AND MEASUREMENT. 3 Hours.
Work measurement, methods improvements, and performance measurement. A survey of enterprise and management measurement systems is presented. Prerequisite: IE 3301, or IE 5317 or equivalent.

IE 5343. HEALTHCARE SYSTEMS ENGINEERING. 3 Hours.
Application of continuous process improvement tools in the analysis of healthcare systems. Plan and execute studies that impact healthcare quality and costs. Evaluates the effectiveness of healthcare and administrative processes and procedures. Prerequisite: graduate standing.

IE 5345. MANAGEMENT OF KNOWLEDGE AND TECHNOLOGY. 3 Hours.
Review of contemporary issues in knowledge management, databases, decision support systems, and intelligent systems. Topics include knowledge acquisition, intelligent database design, decision support systems, data mining, knowledge transfer, and collaborative development. Prerequisite: Graduate standing.

IE 5346. TECHNOLOGY DEVELOPMENT AND DEPLOYMENT. 3 Hours.
Review of management issues in developing and implementing new technologies and methodologies into an organization. Topics include technology forecasting, management of technology based projects, technological competitiveness, technology alliances, and collaboration. Prerequisite: Graduate standing.

IE 5350. GRADUATE DESIGN CAPSTONE. 3 Hours.
Practicum consisting of professional level experience in a relevant company, agency, or institution. Students will be expected to demonstrate an understanding of communication and collaboration, including workflow, reproducibility, management, collaboration tools, oral and written communication, presentation and storytelling, and team management, as well as ethics, such as understanding bias, fairness, credibility and misinformation, security, privacy, and codes of conduct. Prerequisite: 9 hours of graduate work.

IE 5351. INTRODUCTION TO SYSTEMS ENGINEERING. 3 Hours.
This course includes a survey of concepts, principles and processes required to engineer complex systems throughout the life-cycle from concept through disposal. Topics include systems thinking, technical and management processes, life cycle models, sustainability, and model-based systems engineering. Prerequisite: Graduate standing.

IE 5352. REQUIREMENTS ENGINEERING. 3 Hours.
This course focuses on system requirements engineering and related processes and methods. System verification will also be covered. Students will be introduced to model-based systems engineering related to the processes covered in the class. Prerequisite: graduate standing in engineering or consent of instructor.

IE 5353. SYSTEMS ARCHITECTURE & DESIGN. 3 Hours.
This course focuses on systems architecting and design for complex systems. Topics covered include logical and physical system architecture analysis, system design, implementation, transition to use, and enabling products. Students will be introduced to model-based systems engineering related to the processes covered in the class. Prerequisite: graduate standing in engineering or consent of instructor.

IE 5354. MANAGEMENT OF COMPLEX SYSTEMS. 3 Hours.
This course focuses on the management of the engineering of complex systems including key systems engineering management processes. Prerequisite: graduate standing in engineering or consent of instructor. Prerequisite: graduate standing in engineering or consent of instructor.

IE 5361. OPERATIONS RESEARCH FOR LOGISTICS. 3 Hours.
Quantitative techniques of operations research and their application to decision problems in logistics are explored via techniques such as linear programming, integer programming, network analysis, and applied simulation. Modeling with these techniques is emphasized. Prerequisite: Graduate standing.

IE 5362. LOGISTICS & PRODUCTION PLANNING. 3 Hours.
The economic impacts of fluctuating demand, supply availability and production rates are examined via design and analysis of manufacturing and logistics systems. Emphasis is placed on reducing cycle time, increasing throughput, lowering variation, and improving both quality and customer responsiveness through modeling techniques. Prerequisite: Graduate standing.

IE 5363. DISTRIBUTION & TRANSPORTATION SYSTEMS. 3 Hours.
The role of distribution centers and transportation in the extended enterprise are explored via transportation modeling and optimization techniques, value-added supply chain issues, distribution center process design, layout, equipment selection, workforce and workplace issues, and financial performance measures. Prerequisite: Graduate standing.

IE 5378. INTRODUCTION TO UNMANNED VEHICLE SYSTEMS. 3 Hours.
Introduction to UVS (Unmanned Vehicle Systems) such as UAS (Unmanned Aircraft Systems), UGS (Unmanned Ground System) and UMS (Unmanned Maritime System), their history, missions, capabilities, types, configurations, subsystems, and the disciplines needed for UVS development and operation. UVS missions could include student competitions sponsored by various technical organizations. This course is team-taught by engineering faculty. Prerequisite: Permission of instructor.

IE 5379. UNMANNED VEHICLE SYSTEM DEVELOPMENT. 3 Hours.
Introduction to the technologies needed to create an UVS (Unmanned Vehicle System). Integration of these technologies (embodied as a set of sensors, actuators, computing and mobility platform sub-systems) into a functioning UVS through team work. UVS could be designed to compete in a student competition sponsored by various technical organizations or to support a specific mission or function defined by the instructors. This course is team-taught by engineering faculty. Prerequisite: Permission of instructor.

IE 5391. ADVANCED STUDIES IN INDUSTRIAL ENGINEERING. 3 Hours.
Individually approved research projects and reading courses in industrial engineering. Such individual studies will be graded A, B, C, D, F or X. Subject to the approval of the Graduate Advisor, IE 5191, IE 5291 and IE 5391 may be repeated as the topics change. In addition, work on a thesis substitute will be performed under IE 5391. In this case, IE 5391 is graded P/F/R.

IE 5398. THESIS. 3 Hours.
Supervised research projects directed toward the thesis. Graded P, R, F, or W.

IE 5698. THESIS. 6 Hours.
Graded P, F, R.

IE 6197. RESEARCH IN INDUSTRIAL ENGINEERING. 1 Hour.
Supervised research projects directed toward the dissertation. Graded P, R, F.

IE 6297. RESEARCH IN INDUSTRIAL ENGINEERING. 2 Hours.
Supervised research projects directed toward the dissertation. Graded P, R, F.

IE 6301. ENTERPRISE ARCHITECTURES AND FRAMEWORKS. 3 Hours.
A survey of enterprise architectures and analysis frameworks that have been proposed for the integration of large complex enterprise systems. Emphasis is placed on state-of-the-art approaches. Prerequisite: IE 5320.

IE 6302. FACILITIES PLANNING AND DESIGN. 3 Hours.
Facilities planning through layout design. Product flow, space-activity relationships, personnel requirements, and material handling are considered, as well as receiving, shipping, warehousing, and integration with manufacturing. Facilities planning models are explored. Prerequisite: IE 3301, or IE 5317, or equivalent; IE 5301 concurrent or equivalent.

IE 6303. COMBINATORIAL OPTIMIZATION. 3 Hours.
A survey of problems and algorithms in combinatorial optimization. Topics include integer programming formulation, branch-and-bound and cutting plane algorithms, computational complexity, and polyhedral theory. Prerequisite: IE 5301 or consent of instructor.

IE 6305. ENGINEERING MANAGEMENT I. 3 Hours.
The management of the engineering function in high-technology industry with principal emphasis on the historical development of industrial management principles, decision-making and planning. Prerequisite: Graduate standing.

IE 6306. ENGINEERING MANAGEMENT II. 3 Hours.
The management of the engineering function in high-technology industry with principal emphasis on human resources and staffing, directing and leading, and controlling. Prerequisite: IE 6305.

IE 6308. DESIGN OF EXPERIMENTS. 3 Hours.
Introduction to statistical design and analysis of experiments with applications from engineering, health care and business. Analysis includes analysis of variance, multiple comparisons and model adequacy. Designs include complete factorial, complete block, incomplete block, Latin square, Youden, two-level fractional factorial and hierarchically nested. Prerequisite: IE 3301, or IE 5317, or equivalent, and IE 5318.

IE 6309. RESPONSE SURFACE METHODOLOGY AND COMPUTER EXPERIMENTS. 3 Hours.
Empirical model building and process optimization using experimental design and statistical modeling. The first half of the course covers first and second order models and designs, multiresponse experiments and mixture experiments. The second half introduces designs based on Latin hypercubes, orthogonal arrays, and number-based theoretic methods, plus models using kriging, multivariate adaptive regression splines and neural networks. Prerequisite: IE 6308.

IE 6310. INDUSTRIAL APPLICATIONS. 3 Hours.
Project oriented course focusing on the requirements and selection criteria for the integration of technology into simple and complex industrial activities. Prerequisite: IE 5330 or equivalent.

IE 6318. DATA MINING & ANALYTICS. 3 Hours.
An in-depth introduction to data mining and pattern recognition. Basic theories, algorithms, and key technologies in data analytics will be discussed. Case studies and real-world applications will be presented. Prerequisite: IE 3301, or IE 5317, or DASC 5302, or equivalent, and IE 5318.

IE 6397. RESEARCH IN INDUSTRIAL ENGINEERING. 3 Hours.
Supervised research projects directed toward the dissertation. Graded P, R, F.

IE 6399. DISSERTATION. 3 Hours.
Graded F, R.

IE 6697. RESEARCH IN INDUSTRIAL ENGINEERING. 6 Hours.
Supervised research projects directed toward the dissertation. Graded P, R, F.

IE 6699. DISSERTATION. 6 Hours.
Supervised research projects directed toward the dissertation. Graded P, R, F, or W.

IE 6997. RESEARCH IN INDUSTRIAL ENGINEERING. 9 Hours.
Supervised research projects directed toward the dissertation. Graded P, R, F.

IE 6999. DISSERTATION. 9 Hours.
Supervised research projects directed toward the thesis. Graded P, R, F, or W.

IE 7399. DOCTORAL DEGREE COMPLETION. 3 Hours.
This course may be taken during the semester in which a student expects to complete all requirements for the doctoral degree and graduate. Enrolling in this course meets minimum enrollment requirements for graduation, for holding fellowships awarded by The Office of Graduate Studies and for full-time GTA or GRA positions. Students should verify that enrollment in this course meets other applicable enrollment requirements. To remain eligible in their final semester of study for grants, loans or other forms of financial aid administered by the Financial Aid Office must enroll in a minimum of 5 hours as required by the Office of Financial Aid. Other funding sources may also require more than 3-hours of enrollment. Additional hours may also be required to meet to requirements set by immigration law or by the policies of the student's degree program. Students should contact the Financial Aid Office, other sources of funding, Office of International Education and/or their graduate advisor to verify enrollment requirements before registering for this course. This course may only be taken once and may not be repeated. Students who do not complete all graduation requirements while enrolled in this course must enroll in a minimum of 6 dissertation hours (6699 or 6999) in their graduation term. Graded P/F/R.