

INDUSTRIAL AND SYSTEMS ENGINEERING

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Chairperson: Leslie Monplaisir

<http://www.engineering.wayne.edu/ise/index.php>

Industrial Engineering is a broadly-based integrated field concerned with enabling complex systems to function effectively. Managing the inventory of a production facility, for example, involves issues of production and stocking policy, manufacturing equipment, human resources, customer demand, and supplier relationships. The industrial engineer must understand the interaction of the components of a system, and coordinate the flow of materials and information to effectively manage the operation. He/she plays an important role in defining information needs and developing strategies for improving decision making in existing systems. The skills of the industrial engineer, however, can be applied in more than just the traditional production environment. In the growing service sector of the economy including health care delivery, public safety, air transportation, energy, and banking issues of resource management, scheduling, quality of service, and systems design are of increasing importance.

Manufacturing Systems Engineering was traditionally involved in developing process capabilities to realize the output of design engineering. Today, design and manufacturing systems engineering is becoming reciprocally integrated and both groups work together in teams to assure the soundness of design and producibility of goods and services. The manufacturing systems engineer must have an understanding of the design process as well as special expertise in the knowledge and understanding of the production process, which is now computer-based and provides flexibility through numerical control. The manufacturing systems engineer is responsible for designing and implementing the cells and production lines which become the basic units of manufacture. Increasingly, such production units are becoming parts of an integrated factory system, and are not simply islands of automation. The manufacturing systems engineer must understand the multi-layered control architecture of the integrated factory, and the computer-based technologies which enable it.

Engineering Management has grown in importance as today's engineer must possess the necessary tools for effective technical management. Inherent in successful leadership is an understanding of the business functions of an organization, tools used in the decision-making process, and skills for efficient project management, among others. An effective engineering manager will utilize industrial engineering skills to develop strategies that improve the product development process, manage quality and productivity, and advance techniques in world-class manufacturing. More often, a business overview is critical to developing and improving these processes.

Systems Engineering is an interdisciplinary approach and means to enable the realization of successful systems. It focuses on defining customer needs and required functionality early in the development cycle, documenting requirements, then proceeding with design synthesis and system validation while considering the complete problem.

Data Science & Business Analytics is an interdisciplinary program with Computer Science and Mike Ilitch School of Business that is designed to provide a broad range of data science and analytics knowledge and skills. This fast growing field is quickly becoming a key facet of business strategy with increasing need for employees who can think uniquely

across disciplines to transform data into relevant insights for making better decisions.

Facilities: The Department maintains laboratories in systems simulation, computer-aided manufacturing, smart engineering systems, big data, design, and concurrent engineering.

Master's Degree Programs of this department offer the flexibility of full or part-time study. Most of the courses are offered in the evening, allowing students to continue full-time employment in local industries. Some program classes are offered at off-campus sites. Many of the graduate-level courses are also offered in the evening, allowing graduate students also to continue full-time employment in local industries. To further accommodate the working student population, several engineering courses are offered online (refer to the schedule of classes to determine availability).

All incoming M.S. students must demonstrate competency in undergraduate probability and statistics, through successful completion of BE 2100, or equivalent courses. If the student fails to show competency, he or she may be required to complete a pre-requisite course in probability and statistics.

AGUWA, CELESTINE C.: Ph.D., University of Pittsburgh; M.S., University of Massachusetts; B.Arch., University of Nigeria; Associate Professor (Research)

CHELST, KENNETH R.: Ph.D., Massachusetts Institute of Technology; M.S., New York University School of Engineering and Sciences; B.A., Yeshiva University; Professor

CHINNAM, RATNA BABU: Ph.D., M.S., Texas Tech University; B.S., Manipal Institute of Technology; Professor

DALKIRAN, EVRIM: Ph.D., Virginia Polytechnic Institute & State University; M.S., B.S., Bogazici University; Associate Professor

ELLIS, R. DARIN: Ph.D., M.S., G.M.I., B.S.I.E., Pennsylvania State University; Professor

KIM, KYOUNG-YUN: Ph.D., University of Pittsburgh; M.S., B.S., Chonbuk National University; Professor

LIU, YANCHAO: Ph.D., University of Wisconsin; M.S., University of Arkansas; B.S., Huazhong University of Science and Technology; Assistant Professor

MEJABI, OLUGBENGA: Ph.D., Lehigh University; M.Sc., University of Manchester Institute of Science and Technology; B.Eng, Ahmadu Bello University; Associate Professor

MONPLAISIR, LESLIE: Ph.D., University of Missouri-Rolla; M.S., University of Birmingham; Professor and Chair

MURAT, ALPER: Ph.D., McGill University; M.S., B.S., Bogazici University; Associate Professor

PICHETTE, DEAN: M.S., Wayne State University; Senior Lecturer

RICKLI, JEREMY: Ph.D., Virginia Tech; M.S., B.S., Michigan Technological University; Assistant Professor

SINGH, NANUA: Ph.D., M.E., B.E., University of Rajasthan; Professor Emeritus

TREWN, JAYANT SINGH: Ph.D., M.B.A., Wayne State University; B.E., Madras University; Lecturer

VENKATACHALAM, SARAVANAN: Ph.D., M.S., Texas A&M University; B.E., PSG College of Technology; Assistant Professor

WITUS, GARY: Ph.D., Wayne State University; M.S., B.S., University of Michigan; Associate Professor (Research)

YANG, KAI: Ph.D., M.S., University of Michigan; B.S., China Petroleum University; Professor

YANG, QINGYU: Ph.D., M.S., University of Iowa; B.S. University of Science and Technology of China; Associate Professor

YILDIRIM, MURAT: Ph.D., M.S., B.S., Georgia Institute of Technology; Assistant Professor

YILDIRIM, MURAT: Ph.D., M.S., B.S., Georgia Institute of Technology; Assistant Professor

- Systems Engineering (Bridge Graduate Certificate)
- Systems Engineering (Bridge Graduate Certificate) (<https://bulletins.wayne.edu/graduate/college-engineering/industrial-systems-engineering/systems-engineering-bridge-graduate-certificate>)
- Industrial Engineering (M.S.) (<http://bulletins.wayne.edu/graduate/college-engineering/industrial-systems-engineering/industrial-engineering-ms>)
- Manufacturing Engineering (M.S.) (<http://bulletins.wayne.edu/graduate/college-engineering/industrial-systems-engineering/manufacturing-engineering-ms>)
- Engineering Management (M.S.) (<http://bulletins.wayne.edu/graduate/college-engineering/industrial-systems-engineering/engineering-management-ms>)
- Data Science & Business Analytics (M.S.) (<http://bulletins.wayne.edu/graduate/college-engineering/industrial-systems-engineering/data-science-business-analytics-ms>)
- Industrial Engineering (Ph.D.) (<http://bulletins.wayne.edu/graduate/college-engineering/industrial-systems-engineering/industrial-engineering-phd>)

Industrial Engineering

IE 5780 Products Liability Introduction for Engineers Cr. 1

Application of engineering practice to minimize products liability exposure. Stages of a products liability lawsuit; how engineers may be involved at different stages of the process. Offered Yearly.

Restriction(s): Enrollment limited to students with a class of Applicant Masters, Candidate Masters or Senior; enrollment limited to students in the College of Engineering.

Equivalent: ME 5780

IE 5995 Special Topics in Industrial Engineering Cr. 1-4

Special subject matter in industrial engineering. Topics to be announced in Schedule of Classes . Offered Intermittently.

IE 6000 Digital Automation Cr. 3

Fundamentals of digital control and logic; integration and automation solution technologies (barcode systems, vision systems, etc.); data acquisition. Offered Fall, Spring/Summer.

IE 6005 Automotive Engineering Statistics Cr. 3

Introduction to probability and statistics for engineering students: analysis of random component in problems, understanding probability and statistics, opportunities for application, analysis of data using statistical software. Offered for graduate credit only. Offered Winter.

Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

IE 6210 Applied Engineering Statistics Cr. 3

An applied statistics course for students in engineering that will build upon introductory statistical knowledge. Students will learn to identify the phenomena they would like to study, design, and run experiments; collect data and analyze it by applying statistical tools such as multiple regression, ANOVA, and non-parametric statistical tools; and report on the statistical results and their implication to engineering phenomena. No credit for AGRADE undergraduates after taking IE 4250. Offered Fall, Winter.

IE 6220 Value Engineering Cr. 3

Resource management; systematic approach to solving problems and making decisions; forcing latent capabilities to be applied to challenging assumptions; application of unbiased logic techniques to produce superior results. Offered Spring/Summer.

IE 6240 Quality Management Systems Cr. 3

Design of quality management systems. Topics include: QFD, quality planning, business operating systems, TQM, standards, and auditing. Quality management tools such as PDCA and root case analysis. Offered Winter.

IE 6270 Engineering Experimental Design Cr. 4

The design of engineering experiments for manufacturing process analysis, human factors experimentation, societal systems analysis and life testing; basic experimental design models, blocking, factorial experiments, nested designs, covariance analysis, response surface analysis, estimation of effects. Offered Fall.

Prerequisite: IE 6210 with a minimum grade of C

IE 6275 Reliability Estimation Cr. 3

The course is designed for graduate students specializing in quality engineering. These individuals play a significant role in designing and developing new products and manufacturing systems and processes. Topics include: reliability measures, failure distributions, reliability block diagrams, reliability estimation using exponential and Weibull distributions, sequential life testing, test planning, and Bayesian reliability. Offered Fall.

Prerequisite: IE 4250 with a minimum grade of C- or IE 6210 with a minimum grade of C

IE 6310 Lean Operations and Manufacturing Cr. 3

Fundamental theories and concepts in lean manufacturing, six-sigma, mistake proofing, problem solving, process management. Students develop competency in identifying causes and sources of waste in manufacturing, industrial, and business operations. Offered Fall, Winter.

Prerequisite: IE 4250 with a minimum grade of C- or IE 6210 with a minimum grade of C

IE 6315 Production and Service Systems Cr. 3

Fundamental theories and concepts in the design and operation of production systems for manufacturing and service organizations. Topics may include: Inventory Management, Production Planning (MRP, JIT, ERP), Factory Physics, Production Control, Introduction to Supply Chain Management Offered Winter.

Prerequisite: IE 6210 with a minimum grade of C and IE 6560 with a minimum grade of C

IE 6405 Integrated Product Development Cr. 3

Product development process: product architectures, concurrent engineering. Integration of marketing, design, and manufacturing functions for product development. How such processes are designed to account for various manufacturing and other business constraints to ensure that customer needs are met. Offered Fall.

Restriction(s): Enrollment limited to students in the College of Engineering.

Equivalent: AET 5600, EVE 5600

IE 6420 Computer Aided Manufacturing and Lab Cr. 3

Develops students into competent engineers capable of managing the process of product and service realization. Provides an understanding of product, service and workflow realization process from conception through market research and validation, to product/service design and production, and then distribution. Topics covered include business context, innovation and entrepreneurship, process planning, computer-aided manufacturing (CAM), integration of manufacturing equipment and material handling systems, manufacturing execution systems, manufacturing planning and control, and logistics and distribution. Offered Winter.

IE 6422 Flexible Manufacturing Systems Cr. 3

Flexible manufacturing systems are a highly automated group technology machine cell, consisting of a group of processing stations, interconnected by an automated material handling and storage system, and controlled by an integrated computer system. The analysis and design of flexible manufacturing systems will be covered, including: FMS control and communication architecture, FMS material handling architecture, flexibility analysis, and computer-integrated manufacturing (CIM). Offered Winter.

Restriction(s): Enrollment is limited to Graduate level students.

IE 6425 Product Lifecycle Management and Sustainable Design Cr. 3

The aim of this class is to familiarize the current principles, practices, and applications of Product Lifecycle Management (PLM). The sustainable design of products and processes, as well as the early consideration of constraints and factors, are important in the successful development of competitive products. PLM is an integrated, information driven approach to all aspects of a products life from its design inception, through its manufacture, deployment and maintenance, culminating in its removal from service and final disposal. PLM technology plays a critical role in most modern industries including aerospace, automobile, and medical. Effective integration of PLM technologies into the product development process can put the industry at a competitive advantage to deliver innovative products. Offered Winter.

IE 6430 Computer Simulation Methods Cr. 2

The application of discrete, continuous and combined simulation methods to the solution of a variety of production and service systems problems. Computer simulation and a term project involving an application are required. Offered Fall, Winter.

Prerequisite: IE 6310 (may be taken concurrently) with a minimum grade of C

IE 6435 Fundamentals of Sustainable Manufacturing Cr. 3

Sustainable manufacturing, as defined by the U.S.A. Department of Commerce, is "the creation of manufactured products that use processes that minimize negative environmental impacts, conserve energy and natural resources, are safe for employees, communities, and consumers and are economically sound." This course is designed to introduce the fundamental concepts of sustainable manufacturing. While the focus will be on sustainable manufacturing, topics will also include connections of sustainable design, environmental sciences, and the social sciences with sustainable manufacturing. Offered Every Other Fall.

Prerequisites: IE 3120 with a minimum grade of C- and IE 4850 with a minimum grade of C-

IE 6442 Facilities Design and Materials Flow Cr. 2

Plant location theory, analysis of models of plant location. Models for determining plant size and time phasing. Design of manufacturing warehouse and material handling facilities. Use of analytical and computer-aided methods in the facilities design process. Offered Winter.

IE 6470 Stochastic System Modeling: Queuing and Simulation Cr. 2

Description of queuing systems; analytical solutions; discrete events systems; modeling framework and object models; terminating and non-terminating systems; statistical analysis; case studies. Offered Yearly.

IE 6490 Introduction to Systems Engineering in Design Cr. 3

Provides an introduction to the engineering and analysis of human-made systems with an emphasis on the process of bringing systems into being. Includes an introduction to systems sciences and engineering and will follow the engineering process from conceptual systems design through concept selection, concept validation, life-cycle acquisition, life-cycle costing, software development, system architecture, and risk management. Addresses system engineering program evaluation including: evaluation requirements, evaluation of the system engineering organization, and program reporting, feedback, and control. Offered Fall.

Restriction(s): Enrollment limited to students in the College of Engineering.

IE 6510 Information Systems for the Manufacturing Enterprise Cr. 3

Information systems are used to make organizations leaner and more integrated across the entire Manufacturing Enterprise. A suite of information systems is to provide an environment that allows an engineer to consider both product and manufacturing requirements throughout the design, development, manufacturing cycle, resulting in a single unified concurrent engineering process, an integral knowledge management process, and rapid response to market changes. This course will teach information technologies and applications in the manufacturing industry. Offered Fall.

IE 6520 Negotiating in an IE Environment Cr. 3

Analytic and interpersonal skills needed to negotiate effectively. Students integrate the analytic and interpersonal skills necessary to be an effective negotiator in a rapidly-changing technical environment. Offered for graduate credit only. Offered Every Other Winter.

Restriction(s): Enrollment is limited to Graduate level students.

IE 6560 Deterministic Optimization Cr. 3

The primary goals are to develop the ability to formulate fairly complex optimization problems, provide an appreciation of the main classes of problems that are practically solvable, describe the available solution methods, and build an understanding of the qualitative properties of the solutions they provide. The class participant will develop skills in recognizing and formulating deterministic optimization models and gain an appreciation for the role of sensitivity analysis in analyzing a problem. Covers methods for quantifying the impact of specific constraints on the overall performance of the system. Application areas include production scheduling, product mix planning, manpower planning, routing and scheduling, financial planning, and prototype builds. Offered Fall, Winter.

IE 6580 Engineering Financial Practice Cr. 3

Combines the central concepts of engineering financial and engineering managerial economics. Demonstrates, from an engineering financial perspective, how engineering decisions can impact the economic goals of the company. Offered Every Other Winter.

Restriction(s): Enrollment is limited to Graduate level students.

IE 6590 Engineering Leadership: Strategic Communications Cr. 3

Leaders in an engineering work environment face unique team and organizational communication challenges. Strong and precise communication is key to effective leadership and organizational efficiency. Participants in this course will engage in the practical and theoretical aspects of verbal and nonverbal communications in leadership and in the workplace. Offered Every Other Winter.

Restriction(s): Enrollment is limited to Graduate level students.

IE 6611 Fundamentals of Six Sigma Cr. 3

The attraction of Lean Six Sigma is obvious – designs that work, fewer defects and wastes in manufacturing, faster processes, lowered production costs, and greater customer satisfaction. With these pluses, it's no wonder the world's leading companies are adopting the Six Sigma approach to product development in ever-growing numbers. This comprehensive course covers the fundamental aspects of Lean and Six Sigma, Lean operation principles and tools, and the Six Sigma process improvement, that is Define-Measure-Analyze-Improve-Control (DMAIC). Offered Winter, Spring/Summer.

Prerequisite: IE 6210 with a minimum grade of C or IE 4250 with a minimum grade of C- or IE 4260 with a minimum grade of C-

IE 6720 Engineering Risk and Decision Analysis Cr. 3

Structure, modeling and analysis of technical management decisions with emphasis on multiple objectives and trade-offs, and significant uncertainty. Explores barriers to rational decision making. Offered Spring/Summer.

Prerequisite: IE 6210 with a minimum grade of C

Restriction(s): Enrollment is limited to Graduate level students.

IE 6830 Management of Technology Change Cr. 3

Focuses on technology change and use of systems approach to plan for, manage and implement the diffusion and dynamics of product, process and business model innovation. Offered Fall.

Restriction(s): Enrollment is limited to Graduate level students.

IE 6840 Project Management Cr. 3

Provides an appreciation for the role and importance that project management has in delivering complex engineering projects on time, within budget, within performance specifications, and satisfying the customer. Reviews the fundamental content of the nine knowledge areas and five process groups included in the PMI's Project Management Body of Knowledge and how they apply to the general stages of a product development project with a look at some basic techniques and tools. Offered Winter.

IE 6850 Manufacturing Strategies Cr. 3

Manufacturing strategy is one aspect of a company's business strategy that also includes marketing, finance, and research and development. Each strategy development must coexist to achieve the company's goal, meet customer demands, and stay competitive. The objective of this course is to introduce and discuss key components of manufacturing strategy and how this fits within an overall business strategy. Offered Intermittently.

IE 6991 Industrial Internship Cr. 1-3

Offered Fall, Winter.

Repeatable for 99 Credits

IE 7100 Mathematical Modeling in Impact Biomechanics Cr. 4

Review of models created for impact simulations. Regional impact simulation models. Human and dummy models subject to various restraint systems. Offered Winter.

Prerequisite: BME 5010 with a minimum grade of B-

Restriction(s): Enrollment is limited to Graduate level students.

Equivalent: BME 7100, ECE 7100, ME 7100

IE 7125 Human Factors Engineering Cr. 4

Current methods and topics in engineering research on human capabilities and limitations as a system component. Advanced analysis, modeling and design of human-centered systems. Offered Winter.

Prerequisite: BE 2100 with a minimum grade of C-

Restriction(s): Enrollment is limited to Graduate level students.

IE 7220 Advanced Statistical Methods Cr. 3

Statistics is the science to collect, describe, analyze, interpret, and draw conclusions on data. This course introduces students to the conceptual underpinnings of statistical methods and how to apply them to address more advanced statistical questions than are covered in an introductory statistics course. The statistical methods covered in this course are useful for many types of questions that relate to multiple variables and/or multiple groups. Offered Every Other Winter.

Restriction(s): Enrollment is limited to Graduate level students.

IE 7250 Quality Engineering Cr. 4

Quality loss function; introduction to on-line and off-line quality control; product and process design optimization using Taguchi methods; fractional factorial designs using orthogonal arrays and linear graphs; robust design and signal to noise ratio. Offered Winter.

Prerequisite: IE 6210 with a minimum grade of C

Restriction(s): Enrollment is limited to Graduate level students.

IE 7290 Quality and Productivity Management Cr. 4

Topics in product assurance management including: definition, history, philosophy of quality. Strategic elements of proactive quality, design for quality, process project control, reliability program management. Offered Yearly.

Restriction(s): Enrollment is limited to Graduate level students.

IE 7325 Supply Chain Management Cr. 4

Fundamental theories and concepts in design and management of supply chains. Theories and applications of mathematical models in SCM. Logistics, advanced strategic and tactical planning, extended enterprise integration. Offered Fall.

Restriction(s): Enrollment is limited to Graduate level students.

IE 7400 Capstone: Integrated Product Engineering Cr. 4

Integration of product development tools and theory. Industry-based project to develop hands-on experience with integrated project design and development. Application to robust product development methodologies. Offered Winter.

Prerequisite: IE 6400 with a minimum grade of C and IE 6410 with a minimum grade of C and IE 6420 with a minimum grade of C

Restriction(s): Enrollment is limited to Graduate level students.

IE 7410 Agile Systems for the Manufacturing Enterprise Cr. 2

Factors that help define the agility of a system; greater workforce autonomy and changes in training and production of technical personnel. Main elements of operations management. Offered Yearly.

Restriction(s): Enrollment is limited to Graduate level students.

IE 7445 Manufacturing Analytics Cr. 3

Provides a deep understanding of the intersection of manufacturing and analytics and its application in current manufacturing industries to improve operations and gain competitive advantages. Covers fundamental concepts from data acquisition to analysis to decision making in manufacturing, specifically, manufacturing process and systems data acquisition; manufacturing data and information systems hierarchies and flows (IT/OT layers); manufacturing analytics, both real-time and historical; and data driven manufacturing decision making. Offered Every Other Fall.

Prerequisite: IE 6210 with a minimum grade of C

Restriction(s): Enrollment limited to students in a Doctor of Philosophy degree.

IE 7480 Knowledge-Based Design Cr. 3

Provides in-depth understanding of knowledge roles, knowledge elicitation techniques, knowledge based system and system modeling issues, and semantic modeling to support product design. Students will learn the concepts via lecture, articles, and semantic product model implementation projects. Offered Every Other Winter.

Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering.

IE 7511 Linear and Nonlinear Optimization Cr. 3

The primary goal of the course is to provide a solid foundation in the deterministic optimization field. The basic concepts in linear programming and nonlinear programming will be covered. Topics include: convex sets/functions, duality, and sensitivity from different perspectives; simplex algorithm for solving linear programming problems; unconstrained and constrained optimization, nonlinear duality theory, Lagrangian relaxation, and algorithmic methods for solving nonlinear programs (including descent methods, Newton's method, conjugate gradient methods, and penalty and barrier methods). Offered Every Other Fall.

Restriction(s): Enrollment is limited to Graduate level students.

IE 7520 Optimization Methods Cr. 4

Introduction to optimization theory and optimization problems. Necessary and sufficient conditions for optimality. Mathematics and algorithms of linear programming. Non-linear programming and integer programming. Research methods. Duality in optimization problems. Geometric programming. Offered Fall.

Restriction(s): Enrollment is limited to Graduate level students.

IE 7521 Large Scale Optimization and Integer Programming Cr. 3

Examines modeling and solution methodologies for large scale optimization and integer programming problems. Presents the theory and the exact and approximate techniques that have been developed to solve related models. Techniques include branch and bound, cutting planes, Lagrangian relaxation, Bender's decomposition, and column generation. Polyhedral theory will be discussed at some length. Offered Every Other Winter.

Prerequisite: IE 6560 with a minimum grade of C

Restriction(s): Enrollment is limited to Graduate level students.

IE 7535 Stochastic Programming and Robust Optimization Cr. 3

Introduction to models, theory and computational methods for stochastic programming and robust optimization. Methods include decomposition-coordination algorithms for large-scale mathematical programming such as Benders, regularized Benders, Dantzig-Wolfe, L-shaped and statistically motivated decomposition methods. Applications, theory and practical algorithm implementation and computational experimentation will be emphasized. Particular attention will be given to large-scale problems, and use of cluster and grid computing architectures to solve them to optimality. Offered Every Other Fall.

Restriction(s): Enrollment limited to students in a Doctor of Philosophy degree.

IE 7570 Deterministic System Models and Optimization Cr. 2

Methods for quantifying impact of specific constraints on overall performance of a system; use of journal articles on corporate use of these models. Offered Yearly.

Restriction(s): Enrollment is limited to Graduate level students.

IE 7620 Advanced Reliability and Survival Analysis Cr. 3

Focuses on general methods used to analyze the reliability and survival data. Introduces the methods to analyze the expected duration of time until one or more events happen, such as death in biological organisms and failure in mechanical systems. Illustrates the use of proven traditional techniques for reliability and survival data analysis and prediction, and brought up to date with modern computer-based graphical, analytical, and simulation-based methods. Offered Every Other Year.

Restriction(s): Enrollment is limited to Graduate level students.

IE 7710 Introduction to Stochastic Processes Cr. 4

Fundamental understanding of various probability models from applied and theoretical perspectives. Topics include: probability review, Markov chains, Poisson process, continuous time Markov chains, queuing processes, and inventory applications. Offered Every Other Year.

Restriction(s): Enrollment is limited to Graduate level students.

IE 7811 Data Mining: Algorithms and Applications Cr. 3

Application of various basic/advanced data mining techniques to real-world problems. Offered Winter.

Restriction(s): Enrollment is limited to Graduate level students.

Equivalent: CSC 7810

IE 7860 Intelligent Analytics Cr. 3

Computational intelligence methods used to solve complex analytics problems and develop decision support systems. Project-centric approach with the goal of developing several analytics solutions for real-world problems. Offered Fall.

Restriction(s): Enrollment is limited to Graduate level students.

IE 7870 Quality Leadership and Process Improvements Cr. 2

Quality philosophies used as basis for quality process improvements; discussions and journal articles used to examine re-engineering, supply chain management, and the human side of quality; team project included. Offered Yearly.

Restriction(s): Enrollment is limited to Graduate level students.

IE 7990 Directed Study Cr. 1-6

Student selects some field of industrial engineering for advanced study and instruction. An outline approved by the instructor must be presented before registration in this course. Offered Every Term.

Restriction(s): Enrollment is limited to Graduate level students.

Repeatable for 6 Credits

IE 7995 Graduate Special Topics Cr. 1-4

Special subject matter in industrial engineering. Topics to be announced in Schedule of Classes. Offered Yearly.

Restriction(s): Enrollment is limited to Graduate level students.

Repeatable for 12 Credits

IE 7996 Research Cr. 1-6

Advanced design, investigation or experimental work. Offered Every Term.

Restriction(s): Enrollment is limited to Graduate level students.

Repeatable for 6 Credits

IE 7999 Engineering Management Leadership Project Cr. 1-6

Integration of knowledge from individual courses in M.S. engineering management curriculum. Team-oriented focus on major industrial problem. Offered Every Term.

Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students with a class of Candidate Masters.

Repeatable for 10 Credits

IE 8920 Decision and Risk Analysis for Research Cr. 3

Structure, modeling, and analysis of technical global management decisions with emphasis on multiple objectives and trade-offs, and significant uncertainty. Explores current trends in decision analysis research. Offered Every Other Fall.

Restriction(s): Enrollment is limited to students with a major in Industrial Engineering GET or Industrial Engineering; enrollment limited to students in a Doctor of Philosophy degree.

IE 8930 Global Perspectives and Networks Cr. 3

Provides technical leaders with a system of frameworks to holistically understand and practically manage operations, to be technologically competitive in the global marketplace. Foundation for the Country Courses. Offered Winter.

Restriction(s): Enrollment is limited to Graduate level students; enrollment is limited to students with a major, minor, or concentration in Industrial Engineering GET or Industrial Engineering GET.

IE 8935 Global Engineering and Manufacturing Management: Eastern Europe Cr. 1

Country course designed to provide broad coverage about Eastern Europe to an industrial engineering cohort with considerable business experience. Offered Fall.

Restriction(s): Enrollment is limited to Graduate level students.

IE 8941 From Idea through Launch: Products and Services I Cr. 2-3

Course comprised of twelve modules; the processes and progression from product or service innovation to development and launch. Offered Winter.

Restriction(s): Enrollment is limited to Graduate level students; enrollment is limited to students with a major, minor, or concentration in Industrial Engineering GET or Industrial Engineering GET.

IE 8942 From Idea through Launch: Products and Services II Cr. 2-4

Course comprised of twelve modules; the processes and progression from product or service innovation to development and launch. Offered Fall.

Restriction(s): Enrollment is limited to Graduate level students; enrollment is limited to students with a major, minor, or concentration in Industrial Engineering GET or Industrial Engineering GET; enrollment limited to students in the PhD in Engineering program.

IE 8943 From Launch through Sustainability: Products and Services I Cr. 2-4

From when the finished product hits the market to all the steps necessary to make the product sustainable. Offered Winter.

Restriction(s): Enrollment is limited to Graduate level students; enrollment is limited to students with a major, minor, or concentration in Industrial Engineering GET or Industrial Engineering GET.

IE 8944 From Launch through Sustainability: Products and Services II Cr. 2-4

From when the finished product hits the market to all the steps necessary to make the product sustainable. Offered Fall.

Restriction(s): Enrollment is limited to Graduate level students; enrollment is limited to students with a major, minor, or concentration in Industrial Engineering GET or Industrial Engineering GET.

IE 8950 Advanced Engineering Statistics Cr. 3

Skill development in model building, ANOVA, multiple regression, multivariate statistics, forecasting, and time series modeling. Offered Fall.

Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering; enrollment is limited to students with a major, minor, or concentration in Industrial Engineering GET or Industrial Engineering GET; enrollment limited to students in the PhD in Engineering program.

IE 8951 Research Design Cr. 3

Focus on qualitative research design and methods. Discussion of conceptual and practical facets of the process of framing a research question, up to development of an instrument for data collection. Offered Winter.

Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering; enrollment is limited to students with a major, minor, or concentration in Industrial Engineering GET or Industrial Engineering GET.

IE 8952 Research Methods Cr. 3

Focus on quantitative research design and methods. Topics such as purpose of statistical models, mathematical representation, interpretation, and methods are covered. Typical methods include: multiple regression, multivariate analysis (including survey data), and structural equation modeling. Offered Fall.

Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering; enrollment is limited to students with a major, minor, or concentration in Industrial Engineering GET or Industrial Engineering GET.

IE 8960 Literature Review Cr. 1-2

Development of library skills for identifying key authors, articles, journals, books, dissertations, case studies, conferences, web sites, professional associations, and NSF funding for a scholarly area of interest. Offered Spring/Summer.

Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the College of Engineering; enrollment is limited to students with a major, minor, or concentration in Industrial Engineering GET or Industrial Engineering GET; enrollment limited to students in the PhD in Engineering program.

IE 8970 Leadership of the Global Technical Organization Cr. 3

Understanding the elements of leadership and the dynamics of leadership behavior; development of the skills necessary for leading in a global technical organization. Offered Winter.

Restriction(s): Enrollment is limited to Graduate level students; enrollment is limited to students with a major, minor, or concentration in Industrial Engineering GET or Industrial Engineering GET.

IE 8993 Graduate Seminar: Supply Chain Management Cr. 1

Research and development methods for Ph.D. students: literature review, identification of research opportunities, investigation of specific topics; assessment of major contributions and of gap between application and theory. Students present research findings and receive feedback. Offered Intermittently.

Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the PhD in Engineering program.

IE 8995 Graduate Seminar Cr. 1

Research and development methods. Leading-edge research topics. Platform for student to present preliminary research findings and obtain feedback. Offered Fall, Winter.

Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students in the PhD in Engineering program.

Repeatable for 99 Credits**IE 8999 Master's Thesis Research and Direction Cr. 1-8**

Offered Every Term.

Restriction(s): Enrollment is limited to Graduate level students; enrollment limited to students with a class of Candidate Masters.

Repeatable for 8 Credits**IE 9990 Pre-Doctoral Candidacy Research Cr. 1-8**

Research in preparation for doctoral dissertation. Offered Every Term.

Restriction(s): Enrollment is limited to Graduate level students.

Repeatable for 12 Credits**IE 9991 Doctoral Candidate Status I: Dissertation Research and Direction Cr. 7.5**

Offered Every Term.

Restriction(s): Enrollment is limited to Graduate level students.

IE 9992 Doctoral Candidate Status II: Dissertation Research and Direction Cr. 7.5

Offered Every Term.

Prerequisite: IE 9991 with a minimum grade of S

Restriction(s): Enrollment is limited to Graduate level students.

IE 9993 Doctoral Candidate Status III: Dissertation Research and Direction Cr. 7.5

Offered Every Term.

Prerequisite: IE 9992 with a minimum grade of S

Restriction(s): Enrollment is limited to Graduate level students.

IE 9994 Doctoral Candidate Status IV: Dissertation Research and Direction Cr. 7.5

Offered Every Term.

Prerequisite: IE 9993 with a minimum grade of S

Restriction(s): Enrollment is limited to Graduate level students.

IE 9995 Candidate Maintenance Status: Doctoral Dissertation Research and Direction Cr. 0

Offered Every Term.

Restriction(s): Enrollment is limited to Graduate level students.

Repeatable for 0 Credits

Systems Engineering

SYE 5470 Creative Problem Solving in Design and Manufacturing Cr. 4

Concepts of laws of natural development of engineering systems.

Algorithm for inventive (creative) problem-solving (AIPS-85). Creative use of physical and geometrical effects in design of mechanical and manufacturing systems. Concepts of strength, stiffness, vibratory effects, reliability in mechanical design. Offered Yearly.

Data Science & Business Analytics

DSA 6000 Data Science and Analytics Cr. 3

Basic data science and analytics concepts covered through case studies, success stories, and a semester project that cuts across all course modules. Offered Yearly.

Restriction(s): Enrollment is limited to students with a major in Data Sci & Business Analytics.

DSA 6100 Statistical Methods for Data Science & Analytics Cr. 3

Statistical methods and techniques required for data science and analytics applications covered through case studies, success stories, and a semester project that cuts across all course modules. Offered Yearly.

Restriction(s): Enrollment is limited to students with a major in Data Sci & Business Analytics.

DSA 6200 Operations Research Cr. 3

Mathematical optimization models that come into play in data science and analytics applications covered through case studies and a semester project. Heuristic solution approaches will also be addressed along with sensitivity analysis techniques. Offered Yearly.

Restriction(s): Enrollment is limited to students with a major in Data Sci & Business Analytics.

DSA 6300 Decision Analysis and Simulation Cr. 3

Coherent approach to decision making, developing rules of thought to transform complex decisions into simpler decision situations covered through case studies, success stories, and a semester project that cuts across all course modules. Discusses role of discrete-event simulation for improving decision support. Offered Yearly.

Restriction(s): Enrollment is limited to students with a major in Data Sci & Business Analytics.

DSA 7500 Practicum Cr. 6

Application of theoretical knowledge acquired during the Data Science and Business Analytics program to a project involving actual business problems/opportunities and data in a realistic setting. Engages the entire process of solving a real-world data science and business analytics project including: setting the project scope, collecting and processing data, applying analytic methods and presenting the developed solution platform. Both the problem statements for the project assignments and the datasets originate from real-world domains. Offered Yearly.

Restriction(s): Enrollment is limited to Graduate level students; enrollment is limited to students with a major in Data Sci & Business Analytics.

Equivalent: DSB 7500, DSE 7500