INDUSTRIAL ENGINEERING AND MANAGEMENT SCIENCES

mccormick.northwestern.edu/industrial

Northwestern's industrial engineering students graduate with the skills needed to create, design, analyze, and improve the operation of complex organizational systems, e.g., financial systems, information systems, production systems, logistics, and transportation. All students acquire an understanding of statistics, economics, optimization, computing, and simulation techniques. Elective opportunities include advanced courses in analytics, data science, financial engineering, management science, service operations, and production and supply-chain management. Realistic (i.e., open-ended and ill-defined) problems are used to help students refine the application of these principles as well as their ability to work in teams and to communicate their results effectively. These are the experiences that employers find most valuable in our graduates regardless of the field they enter.

Students may pursue an optional concentration using technical electives and other courses from one or more of the following areas: graduate preparation; data science and engineering; human-centered engineering; operations, transportation & logistics; and product management.

In preparation for future careers, students take full advantage of the additional academic, business, and leadership programs available at Northwestern: a minor in machine learning and data science, computer science or economics; the Kellogg Certificate Program for Undergraduates; study abroad; and the co-op program. The IE Client Project Challenge experience allows students to integrate these experiences with their IE course work to address a current application for a real client.

Program of Study

- Industrial Engineering Degree (https://catalogs.northwestern.edu/undergraduate/engineering-applied-science/industrial-engineering-management-sciences/industrial-engineering-degree/)

IEMS 201-0 Introduction to Statistics (1 Unit) Collecting data; summarizing and displaying data; drawing conclusions from data; probability background, confidence intervals, hypotheses tests, regression, correlation. Not open to industrial engineering degree candidates. May not receive credit for both IEMS 201-0 and any of BMD_ENG 220-0, IEMS 303-0, or CHEM_ENG 312-0. Prerequisite: MATH 218-2 or MATH 220-2 or equivalent.

IEMS 225-0 Principles of Entrepreneurship (1 Unit) Introduction to essential elements of building one's own business, from brainstorming ideas and assessing opportunities to pitching a business idea. History of entrepreneurship and the entrepreneurial psyche. Business plan fundamentals, including strategy, finance, accounting, marketing, operations, and choosing the ideal management team. Taught with ENTREP 225-0; may not receive credit for both courses. May not be taken after IEMS 325-0 or ENTREP 325-0.

IEMS 295-0 Introductory Special Topics in IEMS (0-1 Unit) Introductory topics suggested by faculty and approved by the department. Credit dependent on topic and length of course.

IEMS 301-0 Introduction to Statistical Learning (1 Unit)
This course offers a modern treatment of statistical learning, focusing on modeling data for prediction and insight. It blends theoretical foundations with practical programming applications to prepare students for both advanced study and real-world data analysis. May not receive credit for both IEMS 301-0 and IEMS 304-0.
Prerequisite: IEMS 201-0 or IEMS 303-0 or BMD_ENG 220-0 or CHEM_ENG 312-0 or MATH 314-0; COMP_SCI 110 or COMP_SCI 150; GEN_ENG 205-1 or equivalent.

IEMS 302-0 Probability (1 Unit) Introduction to probability theory and its applications. Conditional probabilities and expectation values. Random variables and distributions, including binomial, Poisson, exponential, and normal. Joint distributions and limit laws for foundation of and connection to statistics. Examples in reliability, inventory, finance, and statistics. May not receive credit for both IEMS 302-0 and any of the following: ELEC_ENG 302-0; MATH 310-1, MATH 314-0, MATH 385-0; STAT 320-1, STAT 383-0. Prerequisite: prior completion of or concurrent enrollment in MATH 228-2.

IEMS 303-0 Statistics (1 Unit)
Introduction to the foundations of statistics and statistical computing for data analysis and their applications. Descriptive statistics and statistical inference for estimation, testing, and prediction. May not receive credit for both IEMS 303-0 and any of IEMS 201-0, BMD_ENG 220-0, CHEM_ENG 312-0, or STAT 320-2.
Prerequisites: IEMS 302-0 or equivalent; COMP_SCI 150-0 or equivalent.

IEMS 304-0 Statistical Learning for Data Analysis (1 Unit)
Predictive modeling of data using modern regression and classification methods. Multiple linear regression; logistic regression; pitfalls and diagnostics; nonparametric and nonlinear regression and classification such as trees, nearest neighbors, neural networks, and ensemble methods.
Prerequisites: IEMS 303-0, COMP_SCI 150-0, and ES_APPM 245-0 or equivalents.

IEMS 305-0 Foundations of Modern Machine Learning (1 Unit)
This course introduces the theoretical foundations and practical implementation of machine learning methods, with an emphasis on modern algorithmic developments. The curriculum spans classical statistical learning techniques—including regression, classification, regularization, and clustering—as well as contemporary deep learning architectures such as feedforward and convolutional neural networks, recurrent models, and transformers. Core algorithmic principles, including backpropagation, optimization, regularization, and representation learning, are developed both analytically and through software implementation. Students engage with the material through coding-based projects and by examining the computational foundations of large-scale language models. Prerequisites: IEMS 301-0 or IEMS 304-0 or equivalent.

IEMS 307-0 Quality Improvement by Experimental Design (1 Unit)
Methods for designing and analyzing industrial experiments. Blocking; randomization; multiple regression; factorial and fractional factorial experiments; response surface methodology; Taguchi's robust design; split plot experimentation. Homework, labs, and project.
Prerequisite: IEMS 201-0, IEMS 303-0, or equivalent.

IEMS 308-0 Data Science and Analytics (1 Unit)
Focuses on select problems in data science, in particular clustering, association rules, web analytics, text mining, and dimensionality reduction. Lectures will be completed with exercises and projects in open source framework R. Prior knowledge of classification techniques and R is required.
Prerequisites: IEMS 304-0; COMP_SCI 217-0.

IEMS 310-0 Operations Research (1 Unit)

Survey of operations research techniques. Linear programming, decision theory, stochastic processes, game theory. May not be taken for credit with or after IEMS 313-0.
Prerequisites: IEMS 201-0 or IEMS 302-0; GEN_ENG 205-1 or GEN_ENG 206-1 or MATH 240-0.

IEMS 313-0 Foundations of Optimization (1 Unit)
Formulation and solution of applicable optimization models, including linear, integer, nonlinear, and network problems. Efficient algorithmic methods and use of computer modeling languages and systems. Homework, exams, and project.
Prerequisites: GEN_ENG 205-1 or GEN_ENG 206-1; MATH 228-1; COMP_SCI 110-0 or COMP_SCI 111-0 or COMP_SCI 150-0; sophomore standing.

IEMS 315-0 Stochastic Models (1 Unit)
Fundamental concepts of probability theory; modeling and analysis of systems having random dynamics, particularly queueing systems.
Prerequisites: IEMS 302-0; COMP_SCI 150-0; GEN_ENG 205-1 or GEN_ENG 206-1; ES_APPM 245-0; and prior completion of or concurrent enrollment in IEMS 303-0.

IEMS 317-0 Discrete Event Systems Simulation (1 Unit)
Computer simulation of discrete-change systems subject to uncertainty. Choice of input distributions; development of models; design and analysis of simulation experiments. Mini-projects, exams, and computer labs.
Prerequisites: IEMS 303-0; IEMS 310-0 or IEMS 315-0.

IEMS 325-0 Engineering Entrepreneurship (1 Unit)
Overview of the entrepreneurial process from an engineering perspective. Idea generation, planning, financing, marketing, protecting, staffing, leading, growing, and harvesting. Business models for startups. Lectures, guest speakers, and case studies. Taught with IEMS 325-0; may not receive credit for both courses.
Prerequisite: 1 course in accounting or finance such as CIV_ENV 205-0 or ENTREP 330-1.

IEMS 340-0 Qualitative Methods in Engineering Systems (1 Unit) Use of field research methods to solve management problems. Students define projects, design field studies and pilot tests of data collection instruments, and present results. Prerequisites: DSGN 106-1 and DSGN 106-2, or consent of instructor for non-McCormick students.

IEMS 341-0 Social Networks Analysis (1 Unit)
The use of social network analysis to understand the growing connectivity and complexity in the world around us on different scales, ranging from small groups to the World Wide Web. How we create social, economic, and technological networks, and how they enable and constrain attitudes and behaviors.

IEMS 341-SA Social Networks Analysis (1 Unit) The use of social network analysis to understand the growing connectivity and complexity in the world around us on different scales, ranging from small groups to the World Wide Web. How we create social, economic, and technological networks, and how they enable and constrain attitudes and behaviors.

IEMS 342-0 Organizational Behavior (1 Unit)
Manager's view of tools available to recruit, develop, appraise, compensate, organize, and lead a team going through change. Application of psychological principles relating to human dynamics, motivation, teams, power, and organizational culture. Lectures, guest speakers, and exams. Work experience recommended.

IEMS 343-0 Project Management for Engineers (1 Unit)
A case study-based exploration of the body of project management knowledge. Key topics include project scheduling, risk management, project leadership, small-group dynamics, project methodologies, lifecycle concepts, and project controls. A Socratic approach is taken to exploring various case studies in the context of established and leading-edge project management concepts.
Prerequisites: CIV_ENV 205-0 and IEMS 303-0.

IEMS 344-0 Whole-Brain Leadership (1 Unit)
This course examines whole-brain thinking and leading. Students will draw upon previous work and leadership experience to identify their own thinking and leading preferences and those of team member, and will examine contrasting thinking and leading styles in an effort to appreciate and combine these to produce optimal outcomes. A number of leadership theories and ways of leading will be examined including creative and agile leadership. Analytical thinkers/leaders will be challenged to spend more time with innovation and creativity, while creative thinkers/leaders will be presented with opportunities to engage in analytical problem-solving. Work experience recommended.
Prerequisite: Junior standing.

IEMS 345-0 Negotiations and Conflict Resolution for Engineers (1 Unit)
In this highly interactive class, students participate in negotiation and dispute resolution simulations that range in complexity from single-party/single-issue to multiparty/ multi-issue cases. In addition students explore the role of agents and third parties in the managing conflict. Throughout all of the simulations integrative and distributive strategies are emphasized that can be applied across a variety of contexts.
Prerequisite: Junior standing.

IEMS 348-SA Leading & Leveraging Networks (1 Unit)
Networks play a pivotal role in the success of people, projects, and organizations in all facets of life. They shape how we build and manage our careers, leverage entrepreneurship, mobilize for strategic partnerships, assemble dream teams to maximize innovation, optimize implementation, hone marketing strategies, and enhance customer engagement. Developments in the digital realm offer unprecedented opportunities to reimagine the creative enterprise based on fluid and diverse networks. The ability to design and leverage these networks will differentiate leaders in future enterprises. This course offers concepts, insights, and techniques to give you a competitive edge. It includes a range of case studies, review articles on networking, and hands-on activities, some of which utilize user-friendly Generative AI-based tools to help leverage network visual analytics for design and decision-making.

IEMS 349-0 Organizational Leadership (1 Unit)
This course enables students to think critically about leadership in organizations by understanding five facets of leadership. The five facets are areas of theorizing that explain what makes leadership effective: features, functions, form, fit, and focus. We will learn to answer questions about who is influential, what makes for good leadership, when (under what conditions?), and why (through what mechanisms?) is leadership successful. We explore leadership concepts using a set of illustrative case studies of interesting people who have led interesting lives of impact. Students may not receive credit for both IEMS 349-0 and COMM_ST 350-SA.

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impact. Students may not receive credit for both IEMS 349-0 and COMM_ST 350-SA.

IEMS 351-0 Optimization Methods in Data Science (1 Unit)
Introduction to nonlinear mathematical optimization with applications in data science. The theoretical foundation and the fundamental algorithms for nonlinear optimization are studied and applied to supervised learning models, including nonlinear regression, logistic regression, and deep neural networks. Students write their own implementation of the algorithms in the Python programming language and explore their performance on realistic data sets.
Prerequisites: COMP_SCI 111-0 and IEMS 303-0 and IEMS 313-0, or equivalent.

IEMS 365-0 Analytics for Social Good (1 Unit) Challenges and opportunities in using analytics to pursue social good. Application of data-analysis and decision-making tools and frameworks to such case studies as disaster response and community-based healthcare. For juniors and seniors with interests in humanitarian and nonprofit operations. Prerequisites: IEMS 303-0 and IEMS 313-0. *Social Behavioral Sciences Distro Area*

IEMS 373-0 Intro to Financial Engineering (1 Unit)
Financial markets, derivative securities, risk management, mathematical models in finance. Foreign exchange, debt, equity, commodity markets. Investing, trading, hedging, arbitrage. Forwards, futures, options, swaps, exotic derivatives. Models of price dynamics, binomial model, introduction to Black-Scholes theory and Monte Carlo simulation. Homework, projects, and guest speakers.
Prerequisites: CIV_ENV 205-0, IEMS 302-0, IEMS 303-0 or equivalents, or consent of instructor.

IEMS 381-0 Supply Chain Modeling and Analysis (1 Unit)
Application and development of mathematical modeling tools for the analysis of strategic, tactical, and operational supply-chain problems, including facility location, customer assignment, vehicle routing, and inventory management. Related topics including the role of information and decision support systems in supply chains. Homework, exams, and project.
Prerequisite: IEMS 313-0.

IEMS 382-0 Operations Engineering and Management (1 Unit)
Applications of operations research methods in managing and control of operations processes in manufacturing and service systems: including operations strategy; process-flow analysis; forecasting; capacity management; variability analysis; flow time and inventory management; flexible operations; lean operations; and production and workforce scheduling in manufacturing and service systems. Case studies, homework, and exams.
Prerequisites: IEMS 302-0; IEMS 310-0 or IEMS 313-0.

IEMS 383-0 Service Engineering and Management (1 Unit)
Exploration of service industries: cost-reduction and service-enhancement models, location planning, workforce scheduling, yield management, queuing analysis, and call-center management.
Prerequisites: IEMS 313-0, IEMS 315-0.

IEMS 385-0 Introduction to Health Systems Management (1 Unit)
Health systems, lean concepts, patient-flow analysis, inference, and data-driven knowledge generation, decisions, and change. Forecasting, operations, and optimization of health resources.
Prerequisites: IEMS 303-0, IEMS 313-0.

IEMS 394-0 Industrial Engineering Client Project Challenge (1 Unit)
Open-ended client projects involving application of operations research techniques to complex data analysis and decision problems. Typically taken at the end of junior year or at the start of senior year. Closed to seniors in spring quarter. Prerequisites: IEMS 302-0, IEMS 303-0, IEMS 304-0, IEMS 313-0, IEMS 315-0, and IEMS 317-0.

IEMS 395-0 Special Topics in Industrial Engineering (1 Unit)
Topics suggested by students or faculty members and approved by the department.

IEMS 395-SA Special Topics in Industrial Engineering (1 Unit)
Topics suggested by students or faculty members and approved by the department. Restricted to students participating in Northwestern study abroad programs.

IEMS 399-0 Independent Study in Industrial Engineering (1 Unit)
Independent study on an industrial engineering topic supervised by a faculty member.