

Industrial and Systems Engineering

Chair

Yong Chen

Undergraduate major: industrial engineering (BSE)

Graduate degrees: MS in industrial engineering; PhD in industrial engineering

Faculty: <https://engineering.uiowa.edu/people/ise-people>

Website: <https://engineering.uiowa.edu/ise>

Courses

Industrial and Systems Engineering Courses

- ISE:1000 First-Year Seminar** **0-1 s.h.**
Small discussion class taught by a faculty member; topics chosen by instructor; may include outside activities (e.g., films, lectures, performances, readings, visits to research facilities). Requirements: first- or second-semester standing.
- ISE:2000 Industrial Engineering Sophomore Seminar** **0 s.h.**
Curriculum and profession; ethics and professionalism in classroom and workplace. Requirements: sophomore or transfer standing in engineering.
- ISE:2360 Design for Manufacturing** **3 s.h.**
Fundamentals of design, engineering graphics, and manufacturing processes; computer graphics using Creo for CAD/CAM; typical industrial processes, including machining, casting, forming; prototype fabrication using additive manufacturing techniques; next generation manufacturing and design tools; laboratory exercises and projects. Topics include engineering design, computer graphics, computer-aided design, engineering materials, traditional and non-traditional manufacturing techniques, numerically controlled machine tools, additive manufacturing and process planning.
- ISE:2500 Engineering Economy** **3 s.h.**
Basic concepts of engineering economy: time value of money, cash flow equivalence, depreciation, tax considerations, continuous cash flows, cost accounting overview; main analysis techniques—present worth, uniform annual cost, rate of return, benefit/cost ratio, replacement and break-even analysis. Corequisites: STAT:2020.
- ISE:3000 Professional Seminar: Industrial Engineering** **0 s.h.**
Professional aspects of industrial engineering presented through lectures and discussions by guest speakers, field trips, films, panel discussions. Requirements: junior standing.
- ISE:3300 Manufacturing Systems** **3 s.h.**
Manufacturing and logistics systems, supply chain management, MRP/ERP systems, lean manufacturing, concurrent engineering, value stream mapping and six sigma. Offered spring semesters. Prerequisites: ISE:2360 and ISE:3700.
- ISE:3350 Process Engineering** **3 s.h.**
Methodologies, algorithms, and tools for processing modeling, analysis, and reengineering; modeling issues in product and component design, product and process modularity, quality, reliability, and agility. Prerequisites: ISE:3700.
- ISE:3400 Human Factors** **3 s.h.**
Design of human-machine systems; development of optimum work environments by applying principles of behavioral science and basic knowledge of human capacities and limits. Offered fall semesters. Prerequisites: PSY:1001.
- ISE:3450 Ergonomics** **3 s.h.**
Ergonomic design of jobs and products in an industrial and consumer market setting; principles of good design, examples of poor design; consequences of poor job and product design; principles of work sampling, usability studies, performance rating, sizing and planning of workstations, hand tool design, ergonomic design in transportation; related group project.
- ISE:3500 Information Systems Design** **3 s.h.**
Structure and design of computer-based information systems; concepts of information systems, decision-making; computer hardware, software, data structures; methods for determining system requirements; designing, implementing, evaluating, managing information systems; applied projects. Prerequisites: ENGR:1300.
- ISE:3600 Quality Control** **3 s.h.**
Basic techniques of statistical quality control; application of control charts for process control variables; design of inspection plans and industrial experimentation; modern management aspects of quality assurance systems. Offered fall semesters. Prerequisites: STAT:2020 or BAIS:9100 or (STAT:3100 and STAT:3101 and STAT:3200). Same as CEE:3142, STAT:3620.
- ISE:3610 Stochastic Modeling** **3 s.h.**
Fundamental probabilistic models and applications of industrial engineering; overview of probability and distributions, stochastic processes and Markov chains, queuing theory, inventory theory, decision theory under uncertainty, and elements of risk management. Prerequisites: STAT:2020. Corequisites: ISE:3700.
- ISE:3660 Data Analytics With R** **3 s.h.**
Basics of data analytics and data mining; how to implement a variety of popular data mining methods in R to tackle business and engineering problems; focus on process of turning raw data into intelligent decisions and algorithms commonly used to build predictive models and find relevant patterns in data. Prerequisites: STAT:2020.
- ISE:3700 Operations Research** **3 s.h.**
Operations research models and applications; emphasis on deterministic model (linear programming, duality). Offered fall semesters. Prerequisites: MATH:2550. Corequisites: STAT:2020.
- ISE:3750 Digital Systems Simulation** **3 s.h.**
Simulation modeling and analysis; emphasis on construction of models, interpretation of modeling results; input and output analysis; hands-on usage of ARENA simulation software, manufacturing, health care, and service. Offered spring semesters. Prerequisites: ISE:3610 and ISE:3700.

- ISE:3760 Applied Linear Regression** **3 s.h.**
Regression analysis with focus on applications; model formulation, checking, and selection; interpretation and presentation of analysis results; simple and multiple linear regression; logistic regression; ANOVA; polynomial regression; tree models; bootstrapping; hands-on data analysis with computer software. Prerequisites: STAT:2020 or STAT:2010 or STAT:3120. Same as DATA:3200, IGPI:3200, STAT:3200.
- ISE:3998 Individual Investigations: Industrial Engineering** **arr.**
Independent projects in industrial engineering for undergraduate students, including laboratory study, an engineering design project, analysis and simulation of an engineering system, computer software development, CAD/CAM applications, or research.
- ISE:4116 Manufacturing Processes Simulations and Automation** **3 s.h.**
Material processing, metal cutting theories, forming, micro/nano fabrication, programmable logic controller, computer numerical controllers, discrete control system, DC and AC servo motors, Command generation. Prerequisites: ME:2300 or ISE:2360. Same as ME:4116.
- ISE:4172 Big Data Analytics** **3 s.h.**
Principles of data mining and machine learning in context of big data; basic data mining principles and methods—pattern discovery, clustering, ordering, analysis of different types of data (sets and sequences); machine learning topics including supervised and unsupervised learning, tuning model complexity, dimensionality reduction, nonparametric methods, comparing and combining algorithms; applications of these methods; development of analytical techniques to cope with challenging and real "big data" problems; introduction to MapReduce, Hadoop, and GPU computing tools (Cuda and OpenCL). Prerequisites: STAT:2020 or BAIS:9100. Requirements: basic programming skills in C, C++, Java, or Python; knowledge of Matlab, Octave, or R; and knowledge of a word processor. Recommendations: ISE:3760 and CS:4400 and CS:3330 and MATH:2550.
- ISE:4175 Safety Engineering** **3 s.h.**
Systems safety principles and methods, occupational safety, product safety and liability, accident investigation and prevention methods and analysis, hazard analysis, and standards and regulations.
- ISE:4600 Industrial Engineering Design Project** **1-4 s.h.**
Projects involving product and related operational system design in an industrial or service organization; associated entrepreneurial or intrapreneurial planning. Corequisites: ISE:2500 and ISE:3300 and ISE:3350 and ISE:3400 and ISE:3450 and ISE:3500 and ISE:3600 and ISE:3750, if not taken as prerequisites. Requirements: completion of all ISE coursework.
- ISE:4620 Design of Experiments for Quality Improvement** **3 s.h.**
Development of skills necessary to efficiently and effectively design and analyze experiments for quality improvement; topics include experiment planning, design, and statistical analysis of the results; experimentation is beneficial in all phases of industrial processes including new product design, process development, and manufacturing process improvement; students develop successful experiments that can lead to reduced development lead time, enhanced process performance, and improved product quality. Prerequisites: STAT:2020. Requirements: junior (third year) standing.
- ISE:4900 Introduction to Six Sigma** **3 s.h.**
Six Sigma techniques for the DMAIC cycle (Define, Measure, Analyze, Improve, Control); what is needed for data collection (process inputs and outputs, measurement tools), conduct analysis (hypothesis testing, process capability studies), and conduct process improvement studies (design of experiments, response surface methodology); overview of Six Sigma, process and project management skills; application of the DMAIC model to a real-life improvement projection (a "learn-by-doing" approach). Prerequisites: ISE:3600.
- ISE:5000 Graduate Seminar: Industrial Engineering** **1 s.h.**
Recent advances and research in industrial engineering presented by guest lecturers, faculty, students. Requirements: graduate standing.
- ISE:5310 Advanced Computational Design and Manufacturing** **3 s.h.**
Provides understanding and practical experience in application of computational techniques to solve design and manufacturing problems; introduction to underlying concepts behind 3D geometry representations, algorithms, and underlying mathematical foundations essential to solving a wide variety of problems in computer-aided design (CAD), computer-aided manufacturing (CAM), and computer-aided engineering (CAE); hands-on computational skills working on team-based course projects. Requirements: knowledge of basic C/C++ programming concepts.
- ISE:5420 Automated Vehicle Systems** **3 s.h.**
Overview of vehicle technologies (HAV) and advanced driver assistance systems (ADAS) including a historical perspective, testing, policy and regulation, algorithm design, and human factors. Recommendations: ISE:3400.
- ISE:5460 User Experience Design** **3 s.h.**
Introduction to user experience (UX) research and design fundamentals; UX design as a critical first step in user research, designing products and services for users (e.g., digital, physical, hybrid), and validating products and services; UX theory, methods, and design; examination of user research techniques to facilitate UX design; UX design to achieve user engagement when using products and services; how demand for UX professionals has increased; lectures, readings, hands-on UX design activities, and UX design project.
- ISE:5520 Renewable Energy** **3 s.h.**
Introduction to different sources of renewable energy generation including wind, solar, fuel cells, and bioenergy; design of energy solutions for different stand-alone applications (i.e., factories, data centers, hospitals) and system-wide solutions powering transportation systems, cities, or states; application-specific topics such as energy storage, control of energy generators, operations and maintenance, performance optimization, equipment health monitoring, predictive engineering, and integration of renewable energy with a grid.
- ISE:5620 Design of Experiments** **3 s.h.**
Principles and methods of statistical design of experiments for product and process improvement; students develop skills necessary for planning, analysis, and optimization of experimental data, which can be applied across various fields of research including engineering, medicine, and the physical sciences. Prerequisites: STAT:2020.

- ISE:5650 Mechatronics Engineering for Smart Device Design** 3 s.h.
Introduction to basic mechatronics system components and design principles using mechatronics to meet functionality requirements of products, processes, and systems; lab-oriented assignments and team-based projects presented with innovative case studies in diverse application domains; labs require students to use a micro-controller kit to finish hardware development assignments; for students who plan to have a career in areas such as product development, robotics, design and manufacturing automation, technology management and innovations. Prerequisites: ENGR:2120 and ISE:2360.
- ISE:5730 Digital Industry** 3 s.h.
Modeling methodologies, analysis, and optimization of digital enterprise models; autonomous building of models from data stores; introduction to different application-as-a-service models embedded in edge, fog, and cloud architectures and solutions; science of process modeling and analysis illustrated with case studies. Prerequisites: ISE:3700.
- ISE:5740 Design and Analysis of Computer Experiments** 3 s.h.
Introduction to basic concepts of computer experiments; differences between computer and physical experiments; three technical contents including parametric and nonparametric prediction/inference models for computer experiments, space filling design for computer experiments, and criterion-based experiment design. Requirements: coding capability in at least one popular software (e.g., R, MATLAB, Python). Recommendations: STAT:4540, BAIS:9100 or MBA:8150, ISE:6790, or coding capability in R, MATLAB, or Python.
- ISE:5995 Contemporary Topics in Industrial Engineering** arr.
New topics or areas of study not offered in other industrial engineering courses; topics based on faculty/student interest.
- ISE:5998 Individual Investigations: Industrial Engineering** arr.
Individual projects for industrial engineering graduate students: laboratory study, engineering design, analysis and simulation of an engineering system, computer software development, research. Requirements: graduate standing.
- ISE:5999 Research: Industrial Engineering MS Thesis** arr.
Experimental and/or analytical investigation of an approved topic for partial fulfillment of requirements for MS with thesis in industrial engineering. Requirements: graduate standing.
- ISE:6211 Human Factors in Healthcare Systems** 3 s.h.
Solving human factors problems in health care work systems; cognitive systems engineering, interface design, health care productivity, patient safety; specific research including decision-making, information transfer, and communication; discrete event and dynamic systems simulation modeling; human computer interaction; health information technology/systems; usability; business models of organizational, technical, and social elements of health care systems.
- ISE:6220 Cognitive Engineering** 3 s.h.
Cognitive engineering principles; decision-making and judgment; distributed cognition; cognitive work; human system interaction; cognitive work analysis; situated action and ecological models; mental models and representation; cognitive engineering methods and applications.
- ISE:6300 Innovation Science and Studies** 3 s.h.
Innovative typology and sources, classical innovation models, measuring innovation, innovation discovery from data, evolutionary computation in innovation, innovation life cycle.
- ISE:6350 Computational Intelligence** 3 s.h.
Concepts, models, algorithms, and tools for development of intelligent systems; data mining, expert systems, neural networks for engineering, medical and systems applications. Same as NURS:6900.
- ISE:6380 Deep Learning** 3 s.h.
Basic principles of deep neural networks for various engineering applications; skill sets to design and implement deep learning algorithm for engineering applications; essential topics of deep learning for its practical use and exploring diverse methods and architectures for different types of applications.
- ISE:6410 Research Methods in Human Factors Engineering** 3 s.h.
Logic and methods for research and for analysis and evaluation of complex human-machine systems; advanced techniques for enhancement of human interaction with advanced information technology; emphasis on cognitive task analysis techniques for innovative design, understanding of how technology affects safety, performance, user acceptance.
- ISE:6420 Human/Computer Interaction** 3 s.h.
Development of projects using human factors principles in the design of computer interfaces.
- ISE:6450 Human Factors in Aviation** 3 s.h.
Measuring, modeling, and optimizing human visual performance; display design for optimal legibility, research in visibility, legibility, conspicuity, and camouflage; visibility model development.
- ISE:6460 The Design of Virtual Environments** 3 s.h.
Development of techniques for designing and creating three-dimensional representations of information for simulation, scientific visualization, and engineering; emphasis on human factors issues, software.
- ISE:6480 Unmanned Aircraft Systems** 3 s.h.
Applications and research in unmanned aircraft systems (UAS) with focus on engineering aspects; new era of aviation and how UAS are fast emerging as a disruptive technology in aviation; applications ranging from film production, photography, precision agriculture, remote sensing, and infrastructure inspections to military applications; problem space of UAS from a variety of angles including engineering controls design, data links, UAS types, human factors, regulatory aspects.
- ISE:6600 Linear Programming** 3 s.h.
Mathematical programming models; linear and integer programming, transportation models, large-scale linear programming, network flow models, convex separable programming. Requirements: calculus and linear algebra. Same as BAIS:6600, IGPI:6600.
- ISE:6650 Human Analytics and Behavioral Operations** 3 s.h.
Introduction to several quantitative applications related to determining workforce size, skills-sets, and multifunctionality in service and manufacturing systems, based on measurable quality and productivity performance at the intersection of human factors engineering and production planning; modeling and solving problems in a context of speed and accuracy trade-off; models include learning, forgetting, teamwork, fatigue, procrastination, and individual difference measures.

ISE:6760 Pattern Recognition for Financial Data 3 s.h.

Modeling and harvesting useful information and patterns for financial data; topics include basic concepts of financial data, financial data visualization, modeling and forecasting of financial time series, seasonal models, volatility models, value at risk, principal component analysis, and factor models.

ISE:6780 Financial Engineering and Optimization 3 s.h.

Quantitative methods of modeling various financial instruments (i.e., stocks, options, futures) and tools for measurement and control of risks inherent to financial markets; fundamentals of interest rates; options and futures contract valuation, including weather and energy derivatives; risk management and portfolio optimization; emphasis on modeling and solution techniques based on optimization and simulation approaches traditional to industrial engineering and operations research. Recommendations: basic knowledge of probability and statistics, numerical methods, and optimization.

ISE:6790 Advanced Data Analytics and Informatics 3 s.h.

Advanced analytics techniques (i.e., linear mixed effects model, Gaussian process model, Bayesian analytics); team project on selected data analytics topics from Kaggle using real industrial data for performance demonstration; emphasis on understanding methodology and technology applications; application of each analytics technique on various industrial data context. Recommendations: STAT:4540 or MBA:8150; working knowledge of important discrete and continuous distributions, joint distributions, linear regression, random process, hypotheses testing, and analysis of variance; and programming capability in any language (e.g., Matlab, R, Python).

ISE:6810 Advanced Topics on Additive Manufacturing 3 s.h.

Review of critical challenges facing 3D printing; emphasis on techniques and practical experience in developing novel additive manufacturing processes and applications; topics include 3D content creation and preparation, CAD systems for additive manufacturing, additive manufacturing processes, fabrication speed and improvements, rapid tooling and indirective processes.

ISE:7998 Special Topics in Industrial Engineering arr.**ISE:7999 Research: Industrial Engineering PhD Dissertation arr.**

Experimental and/or analytical investigation of an approved topic for partial fulfillment of requirements for PhD in industrial engineering.