Industrial Engineering

James S. Noble, Chair
College of Engineering
E3437 Lafferre Hall
(573) 882-2691
https://engineering.missouri.edu/ise (https://engineering.missouri.edu/ise/)

Industrial and Systems Engineering builds on a foundation of science, mathematics, computing and data analytics in order to address a wide range of issues in the socio-technical system (complex combinations of people and technology) and environmental (sustainability) domains. With this unique blend of skills, industrial engineering bring optimization-based approaches to a variety of problems in manufacturing, healthcare, supply chain/logistics, sustainability and service organizations.

Industrial engineers in manufacturing organizations address many issues including designing workplaces, considering both the capabilities of machines and humans. They may design computer-integrated manufacturing systems that include automation and robotics. They may also control production, optimize inventory, design quality systems, evaluate new product proposals and build new or improved production facilities.

Industrial engineers working in the supply chain/logistics domain address issues ranging from supplier selection, demand forecasting, inventory systems, facility location, distribution network design, and transportation.

Industrial engineers are also involved in sustainable systems design where they seek to minimize environmental impact while cost-effectively delivering the goods and services demanded by humanity. Issues addressed range from optimizing the environmental performance of an individual product to quantitatively assessing the performance of energy systems.

Industrial engineering skills are used to design better healthcare delivery where they increase the efficiency of the healthcare system. They also work to reduce errors in a wide range of human-centered systems with expertise from data-driven science and ergonomics.

Finally, industrial engineering skills can help facilitate the judicial process, provide faster and more accurate mail distribution, and optimize airline routing and reservation methods. In summary, the industrial engineer may be involved in the design and operation of a range of systems that provide services at a cost that society can afford at the quality that is required.

The MU ISE department offers a Bachelor of Science degree with a major in Industrial Engineering (BSIE), an accelerated Industrial Engineering BSIE/MSIE and a five-year BSIE/MBA program. At the graduate level, the department offers the Master of Science in Industrial Engineering (MSIE) and the Doctor of Philosophy in Industrial Engineering (PhD IE) degrees. The department also offers students the opportunity to obtain Lean Six Sigma Green Belt certification and/or an interdisciplinary Global Supply Chain Management certification.

Faculty

Professor J. S. Noble**
Associate Professor J. H. Kim**
Assistant Professor H. Na*, S. Rajendran**, K. Seo**, S. Srinivas**, Y. Wang**
Teaching Professor B. Wu*
Assistant Teaching Professor O. Shahvari*
Professor Emeritus C. Klein
Associate Professor Emeritus L. Occeña

* Graduate Faculty Member - membership is required to teach graduate-level courses, chair master's thesis committees, and serve on doctoral examination and dissertation committees.
** Doctoral Faculty Member - membership is required to chair doctoral examination or dissertation committees. Graduate faculty membership is a prerequisite for Doctoral faculty membership.

Undergraduate

- BSIE in Industrial Engineering (http://catalog.missouri.edu/collegeofengineering/industrialengineering/bsie-industrial-engineering/)

Advising Contact
Engineering Advising Office
Phone: 573-884-6961
Email: muengradvising@missouri.edu
Website: https://engineering.missouri.edu/student-services/advising/

James S. Noble, Director of Undergraduate Studies

Scholarship Information Contact
Bin Wu, PhD (departmental contact)
wubi@missouri.edu

Molly Horn (college contact)
mphorn@missouri.edu

Industrial engineering undergraduates complete a core engineering curriculum during the first two years. The objective of this curriculum is to give the student a rigorous foundation in mathematics, natural sciences, basic engineering sciences, applied probability, and computer science, as well as a complementary and meaningful exposure to the humanities and social sciences.

Building on the core courses, students gain knowledge of optimization methodologies, human factors, data analytics and systems modeling. They also learn to model and evaluate integrated systems of people, technology and information in the areas of production and service system design, supply chain design and management, control systems, quality systems, sustainability, data engineering, product and process design.

These fundamental skills provide the foundation from which students learn to develop systematic, integrated, and optimal solution approaches to large-scale enterprise problems. In order to be successful as they begin their careers (or graduate study) students learn to communicate effectively in both oral and written forms, and become proficient in working in diverse teams of individuals. Lastly, the curriculum introduces the student to ethical and professional issues in engineering practice.

Industrial engineering design experiences are integrated throughout the curriculum, most often in a team-based environment. Industrial engineering design is the process of developing and improving integrated systems that include people, materials, information, equipment and energy.

Admission Requirements

- Students pursuing a BS in Industrial Engineering must meet MU's General Admission Standard to be considered a Direct Program Admit.

Program Educational Objectives

The IE Program educational objectives have been developed to address the needs of our constituencies and to be consistent with the University of Missouri mission. Within 3-5 years of graduation from the industrial engineering program in the Industrial and Manufacturing Systems Engineering Department at the University of Missouri:

- Graduates will create value for their employers, demonstrating entrepreneurial initiative, and make contributions that benefit society.
- Graduates will expand their capabilities through professional development and advanced education.
- Graduates will provide leadership and be agents of change in their profession and/or communities.

The objectives are based on a few key concepts: value, entrepreneurial initiative, expanding capability, leadership, and being agents of change. "Value" creation is defined as what a graduate's employer requires in order to achieve its stated objectives. The ISE graduate adds value to the organization by taking entrepreneurial initiative that contributes to the greater good of society. Graduates face an environment where technology is advancing at an ever increasing pace, therefore, they will need to expand their knowledge and capabilities through professional development and advanced education. Due to their systems view of the enterprise, industrial engineers are often called upon to provide leadership within an enterprise and, as such, are required to manage the change that is inherent in today's dynamic environment.

Student Outcomes

Student Outcomes (SO) are defined as the abilities the department's BSIE graduates will have upon graduation that will enable them to achieve the program's educational objectives. The student objectives reflect the assimilation of what has been taught in the curriculum upon completion of the undergraduate education.

All MU BSIE graduates should have:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics

2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors

3. an ability to communicate effectively with a range of audiences

4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts

5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions

7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

In summary, graduates of the Department of Industrial and Manufacturing Systems Engineering (IMSE) will possess a strong foundation upon which they can grow professionally, and continue to build a focused set of fundamental and engineering knowledge and skills that are integrated and applicable to real-world problems in any enterprise setting.

ISE Honors Program

The ISE Honors Program follows the regulations and philosophy of the College of Engineering Honors Program, and as such is intended to encourage, facilitate and reward independent study by high-ability undergraduate students.

The heart of the program is an undergraduate honors project, undertaken and completed by the time of graduation while enrolling in 3 to 6 credits of IMSE 4995 Undergraduate Research Industrial Engineering - Honors. The academic credit for the honors project (3-6 credits in IMSE 4995 replaces an equivalent number of credits of ISE or Technical electives. The project is conducted under the direction of an ISE professor (honors advisor) who is selected by the student, with agreement by the professor. The project culminates in an honors thesis, which is read and approved by the honors advisor and a second reader. A finished copy of the honors thesis, signed by the honors advisor and second reader, is required for satisfactory completion of the project.

Academic Qualifications for the Honors Program
Honors students must maintain and graduate with a 3.0 overall GPA. In the case of a transfer student, their transferred credit plus their MU credit will average 3.0/4.0. Students must have a minimum of 60 credit hours.

The successful honors scholar has a degree of flexibility in their program of study. Honors scholars may reduce the credits required for degree completion to the University minimum (i.e., 120 credits) by substituting graduate course credits through dual enrollment (undergraduate/graduate at MU) during the last two semesters of the undergraduate program. Any 8000 level course may be substituted, but only courses at the 7000 level that are not required for the BSIE degree at the 4000 level (eg. ISE elective courses, technical electives) may be substituted.

Lean Six Sigma Green Belt Certification

ISE students have the opportunity to obtain a Lean Six Sigma Green Belt certification either during their degree program or after. Certification requires students to obtain a GPA average of 2.5 or better in IMSE 4110, IMSE 4310, and IMSE 4610, then they must successfully complete IMSE 4385- Lean Six Sigma Green Belt Project (a 1 credit hour course where DMAIC is used to improve a process within an organization).

Global Supply Chain Management Certificate

ISE students have the opportunity to obtain an interdisciplinary undergraduate Certificate in Global Supply Chain Management (GSCM) which is jointly offered by the Department of Management and the Department of Industrial and Manufacturing Systems Engineering. Certification requires students to complete 15 credit hours with a 3.0

GPA. There are nine required credit hours (MANGMT 4070, IMSE 4350 and IMSE 4910), plus six elective hours from a list of courses.

Graduate

- MS in Industrial Engineering (http://catalog.missouri.edu/collegeofengineering/industrialengineering/ms-industrial-engineering/)
- PhD in Industrial Engineering (http://catalog.missouri.edu/collegeofengineering/industrialengineering/phd-industrial-engineering/)

Industrial & Systems Engineering Graduate Programs
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Director of Graduate Studies: Sharan Srinivas

About ISE

The graduate program in industrial engineering provides a scholarly environment in which highly qualified, creative students may obtain the knowledge and develop the skills necessary to solve complex industrial, governmental and societal system design problems. These systems are required to operate within increasingly complex constraints, thus requiring the use of sophisticated and creative designs. The industrial engineer responsible for such designs must be capable of applying a broad spectrum of scientific tools if the most effective systems are to be obtained.

Our master of science program is designed to provide a basic understanding of these tools and experience in the application of these tools in the design process. The doctor of philosophy program is designed to provide the specialized knowledge and skills necessary to develop new tools or methods for solving complex systems design problems. Graduate students are able to obtain an interdisciplinary Global Supply Chain Management certificate as part of their academic program.

General Admission Guidelines

Acceptance for advisement in the department's graduate programs is available to students with an ABET accredited undergraduate engineering degree. Students with baccalaureate degrees in mathematics, physics, chemistry or computer science may be accepted if they have completed 13 hours of calculus, and six hours of calculus-based probability and statistics. Several factors are considered in evaluating an applicant's capability, such as overall GPA, grade trends and major area grades. In addition, each applicant is encouraged to take the general test of the GRE and international students must take the TOEFL or IELTS.

Facilities and Resources

Laboratory facilities in several major application areas, both within the department and in the college, support the academic program. Neighboring industries, city, county and state government agencies, local hospitals and nearby large metropolitan centers provide a reservoir of research and design opportunities.

Computing and Reference Materials

The department has access to the University of Missouri System computing network and maintains its own computing facilities for student use. Besides Ellis Library facilities, an excellent collection of mathematical, statistical and engineering books and reference materials are housed in the Engineering Library.

Funding

Fellowships, scholarships and teaching and research assistantships are available to qualified graduate students. These forms of financial assistance are supported by funds made available through state, federal and industrial graduate support programs and through research grants from various industrial and governmental agencies

IMSE 1000: Introduction to Industrial Engineering
Introduction to industrial engineering profession, the Industrial and Manufacturing Systems Engineering department, and the core topics of industrial engineering. Introduction to problem solving, ethics and industrial engineering design and analysis techniques.

Credit Hour: 1

IMSE 2030: Fundamentals of Systems Design and Analysis
Develop an understanding of a systems approach to the design and operation of modern industrial organizations: systems structure and function, system specification, structured problem solving and system design methodology.

Credit Hours: 3

IMSE 2110: Probability and Statistics for Engineers
Introduction to data analysis, probability concepts, random variables, parameter estimation and hypothesis testing.

Credit Hours: 3
Prerequisites: MATH 1500. Restricted to Engineering Students who are non-IMSE majors

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IMSE 2210: Linear Algebra for Engineers
Study of quantitative methods necessary for analysis, modeling and design of optimal industrial systems.

Credit Hours: 3
Prerequisites: MATH 1700

IMSE 2710: Engineering Economic Decision-Making
Fundamentals of economic decision-making from an engineering perspective. Includes conceptual basis of economic analysis (interest, inflation), principles for decision making (cost/benefits, breakeven analysis, risk and uncertainty, multi-objectives/attributes), generation of engineering economic parameters (life-cycle analysis), and the application of economic decision making in different context (governmental policy, time-phased, and scarce capital).

Credit Hours: 3
Prerequisites: sophomore standing

IMSE 3030: Manufacturing and Supply Systems
Provide a structured approach for the design and optimization of a system throughout its lifecycle: techniques following the logical sequence of strategic analysis, system design, implementation, and monitoring.

Credit Hours: 3
Prerequisites: IMSE 2030

IMSE 3110: Probability Models for Engineers
Introduction to probability concept and theory, random variables, discrete and continuous probability distributions, joint probability distributions. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: Grade of C or better in MATH 1500

IMSE 3110H: Probability Models for Engineers - Honors
Introduction to probability concept and theory, random variables, discrete and continuous probability distributions, joint probability distributions. Honors eligibility required

Credit Hours: 3
Prerequisites: MATH 1500. Restricted to IMSE students only

IMSE 3500: Introduction to Manufacturing Methods
(same as MAE 3500). This course is an introduction to the engineering principles of manufacturing processes, ranging from traditional to state-of-the-art. The course will emphasize material processing, selection, and design considerations for manufacturing. The course introduces critical aspects of manufacturing process engineering through a combination of lectures, videos, class discussions, and case studies to engage students. By the end of the course, students are expected to learn the fundamentals of manufacturing and manufacturing processes. Graded on A-F basis only.

Credit Hours: 2
Prerequisites: MAE 1100, ENGR 2200

IMSE 3505: Computer Aided Design and Manufacturing Processes Laboratory
This course covers the product realization process from design, process planning, to manufacturing, including CE, DFA/DFM, CAD, CAPP, CAM, CNC. The course uses active learning with hands-on laboratory projects, videos, and class discussions. By the end of the course, students will learn the fundamentals of manufacturing and manufacturing processes, and the product realization process from CAD to CAM, primarily through concept learning and hands-on laboratory exercises. Graded on A-F basis only.

Credit Hours: 2
Prerequisites: Junior standing; restricted to IMSE students
Corequisites: IMSE 3500 or MAE 3500

IMSE 3810: Ergonomics and Workstation Design
Ergonomics and human factors theories applied to the design of man-machine systems. Discussion of ergonomic methods for measurement, assessment, and evaluation, with major topics including workstation design, environmental stresses, and workplace safety. Includes lab.

Credit Hours: 3
Prerequisites: Restricted to IMSE students. ENGINR 1200 and IMSE 4110

IMSE 3810W: Ergonomics and Workstation Design - Writing Intensive
Ergonomics and human factors theories applied to the design of man-machine systems. Discussion of ergonomic methods for measurement, assessment, and evaluation, with major topics including workstation design, environmental stresses, and workplace safety. Includes lab. Prerequisites:

Credit Hours: 3
Prerequisites: Restricted to IMSE students. ENGINR 1200 and IMSE 4110

IMSE 4001: Topics in Industrial and Manufacturing Systems Engineering
Current and new technical developments in industrial engineering.

Credit Hours: 3

IMSE 4085: Problems in Industrial Engineering
Supervised investigation in industrial engineering presented in form of an engineering report.

Credit Hour: 1-4

IMSE 4110: Engineering Statistics
(cross-leveled with IMSE 7110). Understanding and application of statistical analysis techniques. Emphasis on hypothesis testing, regression analysis, analysis of variance (ANOVA) and design of experiments (DOE).

Credit Hours: 3
Prerequisites: Restricted to IMSE students or by Departmental consent. Grade of C- or better in IMSE 3110

IMSE 4210: Linear Optimization
(cross-leveled with IMSE 7210). Theory and application of linear optimization.

Credit Hours: 3
Prerequisites: Restricted to IMSE students. Grade of C- or better in IMSE 2210

IMSE 4220: Optimization Modeling and Computational Methods
(cross-leveled with IMSE 7220). Modeling and solution techniques for mathematical optimization, including linear, nonlinear, integer, and stochastic programming. Emphasis on formulation of models for most-efficient use of solution algorithms. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: IMSE 3110, IMSE 4210

IMSE 4230: Operations Research Models
(cross-leveled with IMSE 7230). Formulates probabilistic models and determines optimal control policies for queuing and inventory systems. Introduces Markov chains and dynamic programming.

Credit Hours: 3
Prerequisites: Restricted to IMSE students or by Departmental consent. Grade of C- or better in IMSE 2210 and IMSE 3110

IMSE 4280: Systems Simulation
(cross-leveled with IMSE 7280). Discrete-event stochastic systems modeling and experimentation using simulation software. Statistical design and analysis including distribution fitting and alternative comparison methodologies.

Credit Hours: 3
Prerequisites: Restricted to IMSE students. Grade of C- or better in IMSE 4110

IMSE 4310: Integrated Production Systems Design
(cross-leveled with IMSE 7310). Design and operation of production systems, including lean six sigma concepts, just-in-time/kanban, facility layout and material flow issues.

Credit Hours: 3
Prerequisites: Restricted to IMSE students or by Departmental consent. IMSE 2030, IMSE 2710, IMSE 4210, IMSE 4280

IMSE 4330: Material Flow and Logistics System Design
(cross-leveled with IMSE 7330). Modeling and analysis of structural and operational issues associated with material-flow system design including facility location, warehouse/inventory systems, and distribution/transportation systems.

Credit Hours: 3
Prerequisites: IMSE 4210 and IMSE 4280

IMSE 4350: Production and Operations Analysis
(cross-leveled with IMSE 7350). Quantitative methods for forecasting, scheduling, and production control in manufacturing and service systems. Use of Enterprise Resource Planning (ERP) systems.

Credit Hours: 3
Prerequisites: Restricted to IMSE students or by Departmental consent. IMSE 4210 and IMSE 4230

IMSE 4360: Supply Chain Engineering
(cross-leveled with IMSE 7360). Modeling and analysis of supply chain network design and management issues including integration of production, inventory control, supplier selection, risk management and logistics network design. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: IMSE 4350

IMSE 4370: Service Systems Engineering and Management
(cross-leveled with IMSE 7370). Service systems contribute to more than 75% of US GDP and provide close to 80% employment. This course introduces students to service system engineering and management and will discuss models, concepts and solution methods important in the design, control, and operation of service systems. In addition, this course will provide students the ability to apply industrial engineering and operations research tools for analyzing service enterprises, including supply chain engineering, financial engineering and revenue management. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: IMSE 4210 or instructor's consent

IMSE 4380: Six Sigma Methodology
(cross-leveled with IMSE 7380). An overview of the Six Sigma DMAIC methodology for analyzing and improving processes. Requires completing a Six Sigma Green Belt project. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: Grade of C or better in IMSE 2110 or IMSE 4110 or STAT 4710

IMSE 4385: Lean Six Sigma Green Belt Project
(cross-leveled with IMSE 7385). Application of the Lean Six Sigma methodology in an industry-based project.

Credit Hour: 1
Prerequisites: IMSE 4310

IMSE 4410: Data Engineering and Predictive Modeling
(cross-leveled with IMSE 7410). Introduces the science of processing data using expert systems for faster and smarter decision-making. Topics covered include descriptive analytics, statistical learning algorithms, tree-based algorithms, artificial neural networks, association rule mining, and k-means clustering.

Credit Hours: 3
Prerequisites: INFOTC 4401 or CMP_SC 1050, and IMSE 4110

IMSE 4420: Web-Based Information Systems
(cross-leveled with IMSE 7420). Data models, design of databases using E-R, UML (Access/Oracle), web databases, web servers and interfaces (Visual Basic, JavaScript), E-commerce infrastructure (PDM, STEP, XML), data mining for management information and services.

Credit Hours: 3
Prerequisites: IMSE 4410 and instructor's consent

IMSE 4500: Introduction to Manufacturing Processes
(cross-leveled with IMSE 7500). An introduction to the engineering principles of manufacturing processes, ranging from traditional (casting, forming, cutting, welding) to the state-of-the-art (additive). The course will emphasize material selection, process analysis and selection, and product design considerations for manufacturing. Graded on A-F basis only.

Credit Hours: 3
Prerequisites or Corequisites: ENGINR 2200 or MAE 2200
Prerequisites: MAE 1100

IMSE 4550: Computer Aided Design and Manufacturing
(cross-leveled with IMSE 7550). Product realization process from design, process planning, to manufacturing. Includes CE, DFS/DFM, CAD, CAPP, CNC, and survey of manufacturing methods.

Credit Hours: 4
Prerequisites: Restricted to IMSE students; Junior Standing
Corequisites: ENGINR 2200

IMSE 4560: Introduction to Rapid Prototyping
(cross-leveled with IMSE 7560). Course covers all five MU systems: FDM, SLS, SLA, Polyjet, 3DP. Students will learn fundamental rapid prototyping and related concepts, and design and produce models from each system. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: IMSE 4550

IMSE 4565: Smart Manufacturing Systems
(cross-leveled with IMSE 7565). An introduction to smart manufacturing systems design and operation with respect to Industry 4.0. The course will cover modeling approaches, smart devices and sensors, big data analysis, system security, and advanced manufacturing processes. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: Junior standing

IMSE 4570: Computer Integrated Manufacturing Control
(cross-leveled with IMSE 7570). Implementation of computer integrated manufacturing (CIM) and automation at the shop floor level. Covers essential components of machine sensing and actuation (including programmable robots), information representation and processing, data communication and networking.

Credit Hours: 3
Prerequisites: IMSE 4550

IMSE 4580: Industrial Energy Efficiency and Management
(cross-leveled with IMSE 7580). Introduction to the fundamentals of industrial energy efficiency and management. Covers the essential concepts, best practices, management systems and current standards to achieve and improve energy efficiency in industrial settings, and utilizes hands-on experiences involving real assessment and analysis of industrial site visits and projects.

Credit Hours: 3
Prerequisites: IMSE 2030 or instructor's consent

IMSE 4610: Quality Engineering and Analytics
(cross-leveled with IMSE 7610). Introduces concepts, theory, and analytical methodologies for quality planning, improvement, and control in manufacturing and service systems. Topics covered include process quality modeling, hypothesis testing, control charts, capability analysis, data visualization, text analytics.

Credit Hours: 3
Prerequisites: Restricted to IMSE students or by Departmental consent. IMSE 4110. INFOTC 4401

IMSE 4720: Introduction to Life Cycle Analysis
(cross-leveled with IMSE 7720). Introduction to life cycle thinking, application of ISO standards for conducting an LCA. Students learn process, input-output and hybrid LCA modeling basics, in addition to the application of LCA skills and thinking to improve the performance of systems and processes. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: Junior standing

IMSE 4750: Entrepreneurial Innovation Management: Enterprise Conception
(same as MANGMT 4750). Develop a new business and technology plan including marketing, finance, engineering, manufacturing, and production concepts in this joint College of Engineering and College of Business course.

Credit Hours: 3
Prerequisites: sophomore standing

IMSE 4755H: Entrepreneurial Innovation Management: Enterprise Conception-Honors
Develop a new business and technology plan including marketing, finance, engineering, manufacturing, and production concepts in this joint College of Engineering and College of Business course.

Credit Hours: 3
Prerequisites: sophomore standing. Honors eligibility required

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IMSE 4810: Cognitive Ergonomics
(cross-leveled with IMSE 7810). This course will cover the study of empirical research in Cognitive ergonomics and Human-Computer Interaction (HCI). Students will learn cognitive information processing, mental workload, human reliability, and empirical methods in HCI research. Graded on A-F basis only.

Credit Hours: 3
Recommended: Junior or senior level undergraduate students

IMSE 4910: Industrial Engineering Internship
An industry-based learning experience that provides opportunities to apply industrial engineering skills, concepts and theories in a practical context. Requires submission of an internship plan for prior approval and a final oral presentation / written report at the completion of the internship. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: instructor and departmental consent
Recommended: junior standing

IMSE 4920: Industrial Engineering COOP
An industry-based learning experience that provides opportunities to apply industrial engineering skills, concepts and theories in a practical context. Requires submission of a COOP plan for prior approval and a final oral presentation / written report at the completion of the COOP. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: instructor and departmental consent
Recommended: junior standing

IMSE 4970: Capstone Design I
Overview of professional engineering issues such as ethics, team dynamics, communication, and project management. Includes team-based industrial assessments to develop skills in problem/opportunity identification. Graded on A-F basis only.

Credit Hour: 1
Prerequisites or Corequisites: IMSE 4310
Prerequisites: Restricted to IMSE students; Senior Standing

IMSE 4970W: Capstone Design I - Writing Intensive
Overview of professional engineering issues such as ethics, team dynamics, communication, and project management. Includes team-based industrial assessments to develop skills in problem/opportunity identification. Graded on A-F basis only.

Credit Hour: 1

Prerequisites or Corequisites: IMSE 4310
Prerequisites: Restricted to IMSE students; Senior Standing

IMSE 4980: Capstone Design II
Industry-based team design experience structured to integrate material presented throughout the Industrial and Manufacturing Systems Engineering curriculum. Must immediately follow IMSE 4970.

Credit Hours: 3
Prerequisites: Restricted to IMSE student; IMSE 3810, IMSE 4310, and IMSE 4970

IMSE 4980W: Capstone Design II - Writing Intensive
Industry-based team design experience structured to integrate material presented throughout the Industrial and Manufacturing Systems Engineering curriculum. Must immediately follow IMSE 4970.

Credit Hours: 3
Prerequisites: Restricted to IMSE student;. IMSE 3810, IMSE 4310, and IMSE 4970

IMSE 4990: Undergraduate Research in Industrial Engineering
Independent investigation or project in industrial engineering. May be repeated to 6 hours.

Credit Hour: 0-6

IMSE 4995: Undergraduate Research Industrial Engineering - Honors
Independent investigation or project in industrial engineering. May be repeated to 6 hours. Enrollment limited to receiving departmental honors

Credit Hour: 0-6
Prerequisites: Restricted to IMSE students only

IMSE 4995H: Undergraduate Research Industrial Engineering - Honors
Independent investigation or project in industrial engineering. May be repeated to 6 hours. Enrollment limited to receiving departmental honors

Credit Hour: 0-6
Prerequisites: Restricted to IMSE students only

IMSE 7001: Topics in Industrial and Manufacturing Systems Engineering
Current and new technical developments in industrial engineering.

Credit Hours: 3

IMSE 7110: Engineering Statistics
(cross-leveled with IMSE 4110). Understanding and application of statistical analysis of techniques. Emphasis on hypothesis testing, regression analysis, analysis of variance (ANOVA) and design of experiments (DOE).

Credit Hours: 3
Prerequisites: grade of C- or better in IMSE 3110

IMSE 7210: Linear Optimization
(cross-leveled with IMSE 4210). Theory and application of linear optimization.

Credit Hours: 3
Prerequisites: IMSE 2210

IMSE 7220: Optimization Modeling and Computational Methods
(cross-leveled with IMSE 4220). Modeling and solution techniques for mathematical optimization, including linear, nonlinear, integer, and stochastic programming. Emphasis on formulation of models for most-efficient use of solution algorithms. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: IMSE 3110, IMSE 4210

IMSE 7230: Operations Research Models
(cross-leveled with IMSE 4230). Formulates probabilistic models and determines optimal control policies for queuing and inventory systems. Introduces Markov chains and dynamic programming.

Credit Hours: 3
Prerequisites: grade of C- or better in IMSE 2110 and IMSE 3110

IMSE 7280: Systems Simulation
(cross-leveled with IMSE 4280). Discrete-event stochastic systems modeling and experimentation using simulation software. Statistical design and analysis including distribution fitting and alternative comparison methodologies. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: Restricted to IMSE students. Grade of C- or better in IMSE 4110

IMSE 7310: Integrated Production Systems Design
(cross-leveled with IMSE 4310). Design and operation of production systems, including lean production concepts, just-in-time / kanban, facility layout and material flow issues.

Credit Hours: 3
Prerequisites: IMSE 2030, IMSE 2710, IMSE 4210, IMSE 4280

IMSE 7330: Material Flow and Logistics System Design
(cross-leveled with IMSE 4330). Modeling and analysis of structural and operational issues associated with material-flow system design including facility location, warehouse/inventory systems, and distribution/transportation systems.

Credit Hours: 3
Prerequisites: IMSE 4210, IMSE 4280

IMSE 7350: Production and Operations Analysis
(cross-leveled with IMSE 4350). Quantitative methods for forecasting, scheduling, and production control in manufacturing and service systems. Use of Enterprise Resource Planning (ERP) systems.

Credit Hours: 3
Prerequisites: IMSE 4210 and IMSE 4230

IMSE 7360: Supply Chain Engineering
(cross-leveled with IMSE 4360). Modeling and analysis of supply chain network design and management issues including integration of production, inventory control, supplier selection, risk management and logistics network design. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: IMSE 4350

IMSE 7370: Service Systems Engineering and Management
(cross-leveled with IMSE 4370). Service systems contribute to more than 75% of US GDP and provide close to 80% employment. This course introduces students to service system engineering and management and will discuss models, concepts and solution methods important in the design, control, and operation of service systems. In addition, this course will provide students the ability to apply industrial engineering and operations research tools for analyzing service enterprises, including supply chain engineering, financial engineering and revenue management. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: IMSE 4210 or Instructor's consent

IMSE 7380: Six Sigma Methodology
(cross-leveled with IMSE 4380). An overview of the Six Sigma DMAIC methodology for analyzing and improving processes. Requires completing a Six Sigma Green Belt project. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: Grade of C or better in IMSE 2110 or IMSE 4110 or STAT 4710

IMSE 7385: Lean Six Sigma Green Belt Project
(cross-leveled with IMSE 4385). Application of the Lean Six Sigma methodology in an industry-based project.

Credit Hour: 1
Prerequisites: IMSE 4310

IMSE 7410: Data Engineering and Predictive Modeling
(cross-leveled with IMSE 4410). Introduces the science of processing data using expert systems for faster and smarter decision-making. Topics covered include descriptive analytics, statistical learning algorithms, tree-based algorithms, artificial neural networks, association rule mining, and k-means clustering. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: INFOTC 4401, CMP_SC 1050 and IMSE 4110

IMSE 7420: Web-Based Information Systems
(cross-leveled with IMSE 4420). Data models, design of databases using E-R, UML (Access/Oracle), web databases, web servers and interfaces (Visual Basic, JavaScript), E-commerce infrastructure (PDM, STEP, XML), data mining for management information and services.

Credit Hours: 3
Prerequisites: IMSE 4410 and instructor's consent

IMSE 7500: Introduction to Manufacturing Processes
(cross-leveled with IMSE 4500). An introduction to the engineering principles of manufacturing processes, ranging from traditional (casting, forming, cutting, welding) to the state-of-the-art (additive). The course will emphasize material selection, process analysis and selection, and product design considerations for manufacturing. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: MAE 1100, and ENGINR 2200 or MAE 2200

IMSE 7510: CAD/CAM Laboratory
A laboratory that includes the product realization process from design, process planning, to manufacturing. Includes CE, DFS/DFM, CAD, CAPP, CNC, and the application of applicable manufacturing methods. Graded on A-F basis only.

Credit Hour: 1
Corequisites: IMSE 7500

IMSE 7550: Computer Aided Design and Manufacturing
(cross-leveled with IMSE 4550). Product realization process from design, process planning, to manufacturing. Includes CE, DFS/DFM, CAD, CAPP, CNC, and survey of manufacturing methods.

Credit Hours: 4

IMSE 7560: Introduction to Rapid Prototyping
(cross-leveled with IMSE 4560). Course covers all five MU systems: FDM, SLS, SLA, Polyjet, 3DP. Students will learn fundamental rapid prototyping and related concepts, and design and produce models from each system. Graded on A-F basis only.

Credit Hours: 3

IMSE 7565: Smart Manufacturing Systems
(cross-leveled with IMSE 4565). An introduction to smart manufacturing systems design and operation with respect to Industry 4.0. The course will cover modeling approaches, smart devices and sensors, big data analysis, system security, and advanced manufacturing processes. Graded on A-F basis only.

Credit Hours: 3

IMSE 7570: Computer Integrated Manufacturing Control
(cross-leveled with IMSE 4570). Implementation of computer integrated manufacturing (CIM) and automation at the shop floor level. Covers essential components of machine sensing and actuation (including programmable robots), information representation and processing, data communication and networking.

Credit Hours: 3
Prerequisites: IMSE 4550

IMSE 7580: Industrial Energy Efficiency and Management
(cross-leveled with IMSE 4580). Introduction to the fundamentals of industrial energy efficiency and management. Covers the essential concepts, best practices, management systems and current standards to achieve and improve energy efficiency in industrial settings, and utilizes hands-on experiences involving real assessment and analysis of industrial site visits and projects.

Credit Hours: 3
Prerequisites: IMSE 2030 or instructor's consent

IMSE 7610: Quality Engineering and Analytics
(cross-leveled with IMSE 4610). Introduces concepts, theory, and analytical methodologies for quality planning, improvement, and control in manufacturing and service systems. Topics covered include process

quality modeling, hypothesis testing, control charts, capability analysis, data visualization, text analytics. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: IMSE 4110 or IMSE 7110. INFOTC 4401 or other Python programming course

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IMSE 7720: Introduction to Life Cycle Analysis
(cross-leveled with IMSE 4720). Introduction to life cycle thinking, application of ISO standards for conducting an LCA. Students learn process, input-output and hybrid LCA modeling basics, in addition to the application of LCA skills and thinking to improve the performance of systems and processes. Graded on A-F basis only.

Credit Hours: 3

IMSE 7750: Entrepreneurial Innovation Management: Advanced Enterprise Conception
Develop a new business and technology plan (including marketing, finance, engineering, manufacturing, and production concepts) in this joint College of Engineering/College of Business course.

Credit Hours: 3

IMSE 7810: Cognitive Ergonomics and Decision Making
(cross-leveled with IMSE 4810). This course will cover the study of empirical research in cognitive ergonomics and Human-Computer Interaction (HCI). Students will learn cognitive information processing, mental workload, human reliability, decision-making, and empirical methods in HCI research. Graded on A-F basis only.

Credit Hours: 3

IMSE 8001: Advanced Topics in Industrial & Manufacturing Systems Engineering
Current and new technical developments in industrial engineering.

Credit Hours: 3

IMSE 8030: Advanced Manufacturing and Supply Systems
The design, regulation, and optimization of manufacturing and supply systems through systems analysis.

Credit Hours: 3

IMSE 8085: Problems in Industrial and Manufacturing Systems Engineering
Supervised investigation in industrial engineering to be presented in the form of an engineering report.

Credit Hour: 1-99

IMSE 8087: Industrial Engineering Graduate Seminar
Selected topics in industrial engineering; oral presentations and engineering reports. Graded on S/U basis only.

Credit Hours: 0

IMSE 8110: Design and Analysis of Engineering Experiments
Application of advanced statistical methods for the design and analysis of experiments, including two-level factorial designs and fractional factorial designs, response surface methods, and random effects models. Graded on A-F basis only.

Credit Hours: 3
Prerequisites: IMSE 4110 or IMSE 7110 or equivalent

IMSE 8210: Linear and Network Optimization
Applications of discrete operations research methods, including linear programming, network models, fuzzy sets, integer programming, and meta-heuristics. Graded on A-F basis only.

Credit Hours: 3

IMSE 8220: Nonlinear Optimization
Introduces computational non-linear mathematical programming procedures their use in solving complex industrial systems design problems. Graded on A-F basis only.

Credit Hours: 3

IMSE 8230: Stochastic Processes and Models
Theory and applications of stochastic processes; includes continuous time Markov chain, Markov decision process, queueing theory, and stochastic manufacturing systems. Graded on A-F basis only.

Credit Hours: 3

IMSE 8310: Advanced Integrated Production Systems
Advanced study of the design and operation of flow shop, job shop, and cell-based production systems, including scheduling, layout and material flow issues. Graded on A-F basis only.

Credit Hours: 3

IMSE 8370: Supply Chain Modeling and Analysis
Theory and application of supply chain networks, integration of production and inventory control methods. Graded on A-F basis only.

Credit Hours: 3

IMSE 8410: Advanced Analytics with Engineering Applications
Introduces the core principles, methods, and tools associated with data analytics and provides hands-on training using Python and R. The course covers advanced tools/techniques for data summarization, visualization, predictive modeling, association mining, clustering, and natural language processing. Graded on A-F basis only.

Credit Hours: 3

IMSE 8550: Advanced CAD/CAM
Covers the state-of-the-art in CAD/CAM and explores the latest developments, residual problems, and new direction in CAD/CAM. Includes sculptured surface modeling, rapid prototyping and manufacturing, integrated process planning, shape analysis, machine intelligence. Graded on A-F basis only.

Credit Hours: 3

IMSE 8560: Advanced Manufacturing Technologies
The fundamental theory, design, fabrication, and analysis of state-of-the-art manufacturing technologies will be covered in this course. The course will emphasize production design, CAD/CAM, material selection,

and material processing technologies, including traditional machining methods, rapid prototyping and manufacturing, integrated process planning, shape analysis, and cutting-edge Micro/Nanofabrication techniques. The course uses active learning with hands-on projects, videos, and class discussions to help students understand manufacturing principles and product realization methods. Graded on A-F basis only.

Credit Hours: 3

IMSE 8730: Strategic Enterprise Management
Topics including enterprise strategies, process and content models, strategy implementation, value chain analysis, business processes, systems engineering approaches, business process reengineering, and dynamic systems modeling.

Credit Hours: 3

IMSE 8810: Human Factors
Human factors inputs, outputs and environment and their influence on design and evaluation of man and machine systems.

Credit Hours: 3

IMSE 8990: Research-Masters Thesis in Industrial Engineering
Independent investigation in field of industrial engineering to be presented as a thesis. Graded on S/U basis only.

Credit Hour: 1-99

IMSE 9990: Research-Doctoral Dissertation in Industrial Engineering
Independent investigation in field of industrial engineering to be presented as a dissertation. Graded on S/U basis only.

Credit Hour: 1-99
