

# Industrial and Manufacturing Systems Engineering Graduate Programs

## Contact Information

College of Engineering  
E3437 Lafferre Hall  
573-882-2692

<http://imse.missouri.edu/imse/>

## About the Program

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.

## Degree Programs

In industrial engineering, the 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 pro-

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gram is designed to provide the specialized knowledge and skills necessary to develop new tools or methods for solving complex systems design problems. Information on engineering licensure is detailed under Professional Engineering Registration.

### **General Admission Guidelines**

Acceptance for advisement in the department's graduate programs is available to students with an ABET accredited undergraduate engineering degree. Engineering graduates who have not taken linear programming, linear algebra, statistical quality control or engineering economic analysis must complete 12 hours of additional course work before graduation.

Students with baccalaureate degrees in mathematics, physics, chemistry or computer science may be accepted if they have completed 13 hours of calculus, three hours of differential equations 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 required to take the general test of the GRE and international students must take the TOEFL and TWE.

### **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 and the industrial and manufacturing systems engineering departmental 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

## **Industrial and Manufacturing System Engineering Faculty**

### **Luis G. Ocoña**

interim chair and associate professor, PhD, Purdue University. Systems and information integration, computer-aided process modeling, product realization from design to manufacturing, industrial control and automation, artificial intelligence applications.

### **Larry G. David**

professor emeritus, PhD, Purdue University. Quality control systems, statistical applications to manufacturing, analysis of capital expenditures, human factors engineering, product liability and safety.

### **Owen W. Miller**

professor emeritus, DSc, Washington University. Statistical process control/statistical quality control, productivity enhancement for small business, IE/OR applications.

### **Cerry M. Klein**

professor, PhD, Purdue University. Integrated production systems, logistics systems, mathematical modeling, meta-heuristics, discrete and combinatorial optimization, multi-attribute decision making, fuzzy logic, enterprise resource planning systems.

### **Bin Wu**

professor, PhD, Brunel University. Manufacturing and supply systems design; life-cycle management of manufacturing and supply systems; systems theory; systems analysis and design methodologies; decision making, information systems, static and dynamic systems modeling.

### **C. Alec Chang**

associate professor, PhD, Mississippi State University. Automated measurement and inspection with computer vision, product design and quality engineering, multi-sensor fusion, management information systems.

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## Wooseung Jang

director of graduate studies, associate professor, PhD, University of California at Berkeley. Stochastic modeling and optimization, scheduling, production and quality control of manufacturing and service systems, supply chain management, enterprise resource planning systems.

## James S. Noble

director of undergraduate studies, associate professor, PhD, Purdue University. Integrated material flow systems analysis, scheduling systems, economic evolution of manufacturing systems, manufacturing systems ecology, performance modeling, mixed integer programming, meta-heuristics, economic evaluation, static and dynamic systems modeling, industrial ecology.

## Master's in Industrial & Manufacturing Systems Engineering

### Admission Contact Information

Sally Schwartz

[schwartzs@missouri.edu](mailto:schwartzs@missouri.edu)

E3437 Thomas and Nell Lafferre Hall

Columbia, MO 65211

573-882-2692

### Admission Criteria

Fall deadline: April 15

Spring deadline: October 15

- Minimum TOEFL score: 550/213/80 (paper/computer/internet) (international applicants)  
- Minimum GRE score: V: 350, Q:700

- Minimum GPA: 3.0/4.0

- Test of Written English: (TWE) of 4.0 (international applicants)

### Required Application Materials To the Graduate School:

All required Graduate School documents.

### Required Application Materials To the IMSE Graduate Program:

- 3 letters of recommendation
- Statement of Purpose
- Curriculum Vitae (CV)
- GRE scores

### Financial Aid from the Program

Some programs require an extra form or statement from those who wish to be considered for internal assistantships, fellowships or other funding packages. Check the program Web site or ask the program contact for details.

## About the Master's Programs

No foreign language is required in either program.

### Master of Science

The Master of Science in Industrial Engineering (MS) degree consists of two options: a 30-credit hour research oriented program requiring a thesis or a 33-credit hour project option. The MS Industrial Engineering thesis option curriculum is built upon the choice of a concentration area around which students can mold their overall academic effort including six hours of research. The three focus areas are Operations Research and Statistics, Manufacturing/Production/Service Systems and Enterprise Information Systems. The MS Industrial Engineering project option is a thirty-three credit hour program. Students are required to com-

plete thirty hours of approved course work and three hours of an approved project advised by a faculty member.

### Master of Engineering

The Master of Engineering (ME) degree is a non-research thirty-six-credit-hour program designed to be a terminal degree. The ME curriculum is based upon a seven-course core with the remaining 15 hours made up of courses appropriate to the student's concentration area.

## Dual Master's Degree Programs

### Master of Science and MBA

The Department of Industrial and Manufacturing Systems Engineering, in cooperation with the College of Business offers a dual master's degree program for those students who wish to combine the specialized skills of the industrial engineer with the general knowledge of the professional manager. The program was developed in recognition of the fact that solutions to organization problems often require that the engineer's analytical abilities be applied simultaneously with the manager's integrative perspective. This dual program has been carefully structured to provide the necessary academic background to obtain an MS in industrial engineering and an MBA simultaneously, in a minimum amount of time, usually two academic years.

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## Master of Science and MHA

The Department of Industrial and Manufacturing Systems Engineering, in cooperation with the health services management program of the School of Medicine, offers a dual master's degree program to prepare its graduates for careers in the design and administration of health-care delivery systems and organizations. The program was developed in recognition of the highly complex nature of health-care organizations. The program's basic objective is to fuse competencies in health-service management and in health-systems design. The required courses in the industrial engineering program serve as the area of specialization in the health services management program, and the required courses in the health-services management program are used as electives in the industrial engineering program. As a result, it is possible for the student to earn an MHA in health-services management and an MS in industrial engineering simultaneously.

## Doctorate in Industrial & Manufacturing Systems Engineering

### Admission Contact Information

Sally Schwartz

[schwartzs@missouri.edu](mailto:schwartzs@missouri.edu)

E3437 Thomas and Nell Lafferre Hall

Columbia, MO 65211

573-882-2692

### Admission Criteria

Fall deadline: April 15

Spring deadline: October 15

- Minimum TOEFL score: 550/213/80 (paper/computer/internet) (international applicants)
- Minimum GRE score: V: 350, Q:700
- Minimum GPA: 3.5/4.0
- Completed master's thesis or equivalent
- Compatible research interests or capabilities with a member of the faculty

Only highly qualified students are accepted for advisement in the PhD program. The faculty look for excellence in undergraduate and graduate work, high GRE scores and strong indications of research potential. An exceptional Bachelor of Science student may be accepted in the graduate program leading to the doctoral degree.

### Required Application Materials to the Graduate School:

All required Graduate School documents.

### Required Application Materials to the IMSE Graduate Program:

- 3 letters of recommendation
- Statement of Purpose
- Curriculum Vitae (CV)
- GRE scores

### Financial Aid from the Program

Some programs require an extra form or statement from those who wish to be considered for internal assistantships, fellowships or other funding packages. Check the program Web site or ask the program contact for details.

## About the Doctoral Degree

Programs are individually tailored to meet students' objectives and to culminate in an original research dissertation.

### Degree Requirements

The granting of a PhD requires completion of five major requirements:

- A qualifying examination,
- A course of study,
- Comprehensive examination,
- Acceptance of dissertation proposal,
- Final public defense of the completed dissertation.

The PhD builds upon the MS programmatic areas. The three focal areas are Operations Research and Statistics, Manufacturing/Production/Service Systems and Enterprise Information Systems. Fundamental IE knowledge in each is expected. The basic goals of the PhD program are to provide students with a solid understanding of the theoretical bases for the latest tools and techniques of systems analysis and design, an extensive experience in applying these analyses and design tools and techniques, and research experience in the development of new tools or applications of existing techniques to design or analyze problems.

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## Industrial & Manufacturing Systems Engineering Courses

### IMSE 7001

*Topics in Industrial and Manufacturing Systems Engineering (3).*

Current and new technical developments in industrial engineering. Prerequisite: graduate standing.

### IMSE 7110

*Engineering Statistics (3).*

Understanding and application of statistical analysis techniques. Emphasis on hypothesis testing, regression analysis, analysis of variance (ANOVA) and design of experiments (DOE). IMSE 2110.

### IMSE 7210

*Linear Optimization (3).*

Theory and application of linear optimization. Prerequisite: IMSE 2210.

### IMSE 7230

*Operations Research Models (3).*

Formulates probabilistic models and determines optimal control policies for queuing and inventory systems. Introduces Markov chains and dynamic programming. Prerequisites: IMSE 2110 and 2210.

### IMSE 7310

*Integrated Production Systems Design (3).*

Design and operation of flow shop, job shop, and cell-based production systems, including scheduling, layout and material flow issues. Prerequisites: IMSE 4210 or 7210, 3280.

### IMSE 7330

*Material Flow and Logistics System Design (3).*

Modeling and analysis of structural and operational issues associated with material-flow system design including facility location, warehouse systems, and distribution/transportation systems. Prerequisites: graduate standing and IMSE 4210/7210, 3280 or 8280.

### IMSE 7350

*Production and Operations Analysis (3).*

Quantitative methods for forecasting, scheduling, and production control in complex manufacturing systems. Use of Enterprise Resource Planning (ERP) systems. Prerequisite: IMSE 4230/7320.

### IMSE 7410

*Web-Based Information Systems (3).*

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. Prerequisites: IMSE 3410 and instructor's consent.

### IMSE 7550

*Computer Aided Design and Manufacturing (4).*

Product realization process, from design, process planning, to manufacturing. Includes CE, DFS/DFM, CAD, CAPP, CNC, and survey of manufacturing methods. Prerequisites: IMSE 4610/7610, 4310/7310.

### IMSE 7570

*Computer Integrated Manufacturing Control (3).*

Implementation of computer integrated manufacturing (CIM) at the shop floor level. Covers essential components of machine sensing and actuation, information representation and processing, data communication and networking.

### IMSE 7610

*Engineering Quality Control (3).*

Analysis of quality in manufacturing including control charts, sampling plans, process capability, experimental design; introduction to system reliability. Prerequisite: graduate standing and IMSE 4110/7110.

### IMSE 7650

*Reliability (3).*

Use of Boolean algebra in design and analysis of complex engineering systems; reliability of system in terms of component reliabilities; Poisson process as basic failure model; life testing techniques; maintainability; reliability demonstration procedures. Prerequisite: IMSE 4110/7110.

### IMSE 7750

*Entrepreneurial Innovation Management: Advanced Enterprise Conception (3).*

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.

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**IMSE 7760**

*Entrepreneurial Innovation Management: Advanced Enterprise Design (3).*

Expand on IMSE 7750 business and technology plan into a business operation plan: advertising designs, facilities layout, selling and distribution channels, product designs, accounting procedures, manufacturing processes, and product prototypes. Prerequisite: IMSE 7750.

**IMSE 7770**

*Entrepreneurial Innovation Management: Advanced Enterprise Operations (4).*

Perform the day-to-day operations for an enterprise conceived in IMSE 4750 and designed in IMSE 4760 by controlling and managing all operations business processes including finance, manufacturing, sales, and delivery. Prerequisite: IMSE 7760.

**IMSE 8001**

*Advanced Topics in Industrial & Manufacturing Systems Engineering (3).*

Current and new technical developments in industrial engineering.

**IMSE 8030**

*Advanced Manufacturing and Supply Systems (3).*

The design, regulation, and optimization of manufacturing and supply systems through systems analysis.

**IMSE 8070**

*Research Methods in Industrial & Manufacturing System Engineering (1).*

Development of research approach. Selection of topic area

including techniques of literature search with special emphasis on problem definition. Topics pertinent to planning, organizing and carrying out industrial engineering research or design project.

**IMSE 8085**

*Problems in Industrial and Manufacturing Systems Engineering (cr.arr.).*

Supervised investigation in industrial engineering to be presented in the form of an engineering report.

**IMSE 8087**

*Industrial Engineering Graduate Seminar (3).*

Selected topics in industrial engineering; oral presentations and engineering reports.

**IMSE 8110**

*Engineering Experimentation (3).* Application of advanced statistical methods for the analysis of engineering design and experimental problems. Prerequisite: IMSE 4110/7110.

**IMSE 8210**

*Operations Research-Discrete Models (3).*

Applications of discrete operations research methods, including linear programming, fuzzy sets, integer programming, and meta-heuristics. Prerequisite: IMSE 4210/7210.

**IMSE 8220**

*Nonlinear Optimization (3).*

Introduces computational nonlinear mathematical programming procedures their use in solving complex industrial systems design problems. Prerequisite: IMSE 4210/7210.

**IMSE 8230**

*Operations Research-Stochastic Models (3).*

Theory and applications of stochastic processes; includes continuous time Markov chain, Markov decision process, queuing theory, and stochastic manufacturing systems. Prerequisite: IMSE 4230/7230.

**IMSE 8280**

*Advanced Systems Simulation (3).* Theory and practice of dynamic modeling and statistical experimentation. Prerequisite: IMSE 3280.

**IMSE 8310**

*Advanced Integrated Production Systems (3).*

Advanced study of the design and operation of flow shop, job shop, and cell-based production systems, including scheduling, layout and material flow issues. Prerequisites: IMSE 4310/7310.

**IMSE 8330**

*Advanced Material Flow Systems (3).*

Advanced study and modeling of the design and operation material flow systems, including facilities design, material handling, inventory and warehousing issues; application of optimization and simulation techniques. Prerequisites: IMSE 4330, 4210, 3280.

**IMSE 8370**

*Supply Chain Modeling and Analysis (3).*

Theory and application of supply chain networks, integration of production and inventory control methods. Prerequisite: IMSE 8210, 8230.

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**IMSE 8410**

*Advanced Management Information Systems Design (3).*  
Develops requirements for management information, staffing, cost estimating, evaluation, and the design of management communication systems; includes case studies. Prerequisite: IMSE 3410.

**IMSE 8550**

*Advanced CAD/CAM (3).*  
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. Prerequisite: IMSE 4550/7550

**IMSE 8570**

*Advanced CIM Control Systems (3).*  
Architectures and problems faced by state-of-the-art computer integrated controls in both manufacturing and service systems; including hierarchical control, peer-to-peer, Petri nets, field-bus, RSVIEW, Web-mediated, and other. Project based format. Prerequisite: IMSE 4570/7570 or equivalent.

**IMSE 8610**

*Advanced Quality Systems (3).*  
Advanced process control charts, empirical model-building, fractional factorial designs and Taguchi techniques as tools for process and product improvement, professional ethics in quality management; TQM and ISO 9000. Prerequisite: IMSE 4610, 8110.

**IMSE 8650**

*Advanced Reliability Theory (3).*  
Development and application of quantitative models for planning and evaluation of the performance of engineering systems. Prerequisite: IMSE 4650/7560

**IMSE 8710**

*Financial Engineering and Economics Analysis (3).*  
Methodology and theory of financial engineering, capital allocation decision analyses.

**IMSE 8730**

*Strategic Enterprise Management (3).*  
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.

**IMSE 8740**

*Management of the Engineering Function (3).*  
Design and analysis of procedures for the planning, evaluation and control of engineering systems.

**IMSE 8810**

*Human Factors (3).*  
Human factors inputs, outputs and environment and their influence on design and evaluation of man and machine systems.

**IMSE 8850**

*Health Care Systems Design and Analysis (3).*  
Health care systems design principles and major problems, basic organization within health care system, alternative system de-

sign strategies, factors affecting design process success.

**IMSE 8860**

*Health Care Systems Operation and Management (3).*  
Solutions to specific health care systems design problems utilizing field work/case studies. Study areas, based on significance/existence of established methodologies, include nurse staffing, patient scheduling, procedure costing, blood banking, technology evaluation. Prerequisite: IMSE 8850.

**IMSE 8990**

*Research-Masters Thesis in Industrial Engineering (cr.arr.).*  
Independent investigation in field of industrial engineering to be presented as a thesis. Graded on S/U basis only.

**IMSE 9210**

*Advanced Linear Optimization (3).*  
Advanced study of linear programming, including optimization and its application including large-scale optimization, primal-dual methods, decomposition, interior point methods, convex analysis, and integer programming. Prerequisite: IMSE 4210/7210

**IMSE 9230**

*Stochastic Service Systems (3).*  
Development and application of stochastic models in the design of service systems in which either demands for service or services supplies, or both, have a probabilistic nature. Prerequisite: STAT 4750, IMSE 8230.

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**IMSE 9250**

*Dynamic Programming (3).*

Introduces theory and computational aspects of dynamic programming; its application to sequential decision problems.

Prerequisites: IMSE 4210/7210 and 4230/7230.

**IMSE 9260**

*Integer and Combinatorial Optimization (3).*

Theory, solution methodology, and application of integer and combinatorial optimization. Prerequisite: IMSE 8210.

**IMSE 9990**

*Research-Doctoral Dissertation in Industrial Engineering (cr.arr.).*

Independent investigation in field of industrial engineering to be presented as a dissertation. Graded on S/U basis only.

