INDUSTRIAL ENGINEERING

Undergraduate Program Information

Industrial engineers design, develop, install, and improve integrated systems. Integrated systems can involve people, equipment, information, financial resources, software, materials, or energy. Industrial engineers work in a variety of manufacturing, health care, utility, retail, government, and research settings, therefore the tools and methods of the industrial engineer are both varied and broad. Industrial Engineers use knowledge and skills in engineering, mathematics, and physical and social sciences. They also use principles and methods of engineering analysis and design to monitor and improve systems. New Mexico State University's undergraduate degree program in Industrial Engineering prepares students to join the workforce or pursue graduate education while setting the foundation for lifelong learning.

Specifically, within 2-3 years of graduation, graduates of the program will have:

- successfully applied various industrial Engineering techniques in an integrated fashion to solve real-world problems in process design and/or improvement;
- been engaged in a successful career sustained by life-long learning experiences

In addition, the Engineering Accreditation Commission of ABET, Inc. criteria in conjunction with the Institute of Industrial Engineers, requires that:

- baccalaureate degree graduates will be able to demonstrate the ability to design, develop, implement, and improve integrated systems that include people, materials, information, equipment, and energy;
- industrial engineering curricula include in-depth instruction allowing students to accomplish the integration of systems using appropriate analytical, computational, and experimental practices; and
- that faculty teaching in industrial engineering departments shows evidence of understanding professional practice and staying current in their respective professional areas. Program faculty must have a responsibility and sufficient authority to define, revise, implement, and achieve program objectives.

Master's Accelerated Program: The Master's Accelerated Program (MAP) option provides excellent opportunities for academically qualified undergraduate students to begin working on a master's degree during their junior year and senior year. The student must obtain prior approval from the department head before starting the MAP. Note that the MAP is only applicable if the student has not yet completed a bachelor's degree.

Graduate Program Information

The Department of Industrial Engineering offers graduate work leading to the degrees of Master of Engineering in Industrial Engineering (MEIE), Master of Science in Industrial Engineering (MSIE), and Doctor of Philosophy (Ph.D.) with a specialization in industrial engineering. Areas of emphasis include

- operations research and simulation analytics,
- manufacturing systems,
- quality and reliability engineering,
- engineering management and systems engineering.

Departmental admission requirements in addition to those of the Graduate School must be considered on an individual basis because of the diversity of backgrounds of applicants in the program. An applicant should meet or correspond directly with the department as a first step in determining his or her specific admission status. Applicants should present mathematics preparation equivalent to 9 credits of calculus for engineers, 3 credits of differential equations, and 3 credits of calculus-based probability and statistics.

The MEIE is a Professional Master's degree targeting a working professional who wants to pursue a Master's degree in Industrial Engineering. The minimum credit-hour requirements for the MEIE degree may be met in the following way:

- 30-semester credits of approved coursework.

The MSIE is a research-oriented degree. The minimum credit-hour requirements for the MSIE degree may be met in any of the following ways:

- 24-semester credits approved course work and 6-semester credits of thesis (I E 599 Master's Thesis) for a total of 30-semester credits or
- 27-semester credits approved course work and 3-semester credits of project (I E 598 Special Research Programs) for a total of 30-semester credits.

Approved coursework must meet all requirements of the Graduate School, represent a consistent master's program in relation to a student's graduate study goals as determined through consultation with the graduate program adviser, and be approved by a program committee of the graduate faculty of the department. Programs in the focus areas of operations research and simulation analytics, manufacturing systems, quality and reliability engineering, or engineering management and systems engineering can be developed with the aid of a faculty advisor.

Departmental facilities and equipment are available to support the research efforts of graduate students, including computer terminals and laboratories. In addition to departmental facilities, supporting facilities such as the Aggie Innovation Space (AIS) and interdisciplinary research clusters are available for research work.

The Ph.D. program is research-oriented with the final product being the dissertation. The general information (https://catalogs.nmsu.edu/nmsu/regulations-policies/) chapter in this catalog describes the Ph.D. degree program. The Ph.D. in Industrial Engineering also includes the following requirements:

- the coursework must include at least 12 credits at the 500 level in a related field,
- 6 credits of 600-level research courses covering two areas, and
- 18 credits of 700-level courses following successful completion of the comprehensive examination.

The department does not have any foreign language or research tool requirements. Interested individuals should correspond directly with the department to determine eligibility for admission.

Degrees for the Department

Bachelor Degree(s)

- Industrial Engineering - Bachelor of Science in Industrial Engineering (https://catalogs.nmsu.edu/nmsu/engineering/industrial-

engineering/industrial-engineering-bachelor-science-industrial-engineering/)

Master Degree(s)

The Master of Science in Industrial Engineering degree is a research-oriented degree. If you are interested in pursuing an advanced degree for a career in the engineering sciences or in preparation for a Ph.D., our MS degree is for you. The Master of Engineering in Industrial Engineering is the coursework-only degree. It is a **Professional Master's degree** targeting a working professional who wants to pursue a Master's degree in Industrial Engineering at New Mexico State University.

- Industrial Engineering - Master of Engineering in Industrial Engineering (https://catalogs.nmsu.edu/nmsu/graduate-school/industrial-engineering-master-engineering/)
- Industrial Engineering - Master of Engineering in Industrial Engineering (Online) (https://catalogs.nmsu.edu/global/nmsu-global/industrial-engineering-meie-online/)
- Industrial Engineering - Master of Science in Industrial Engineering (https://catalogs.nmsu.edu/nmsu/graduate-school/industrial-engineering-master-science-industrial-engineering/)
- Industrial Engineering - Master of Science in Industrial Engineering (Online) (https://catalogs.nmsu.edu/global/nmsu-global/industrial-engineering-msie-online/)

Doctoral Degree(s)

- Engineering (Industrial Engineering) - Doctor of Philosophy (https://catalogs.nmsu.edu/nmsu/graduate-school/engineering-industrial-engineering-doctor-philosophy/)

Minors for the Department

- Advanced Manufacturing - Graduate Minor (https://catalogs.nmsu.edu/nmsu/graduate-school/advanced-manufacturing-graduate-minor/)
- Entrepreneurship - Undergraduate Minor (https://catalogs.nmsu.edu/nmsu/engineering/industrial-engineering/entrepreneurship-undergraduate-minor/)
- Lean Manufacturing and Analytics - Undergraduate Minor (https://catalogs.nmsu.edu/nmsu/engineering/industrial-engineering/lean-manufacturing-analytics-ug-minor/)
- Supply Chain and Operations Research Analytics - Undergraduate Minor (https://catalogs.nmsu.edu/nmsu/engineering/industrial-engineering/supply-chain-operations-research-analytics-ug-minor/)
- Systems Engineering - Undergraduate Minor (https://catalogs.nmsu.edu/nmsu/engineering/industrial-engineering/systems-engineering-ug-minor/)

Graduate Certificates

- Systems Engineering - Graduate Certificate (https://catalogs.nmsu.edu/nmsu/graduate-school/systems-engineering-graduate-certificate/)
- Systems Engineering - Graduate Certificate (Online) (https://catalogs.nmsu.edu/global/nmsu-global/systems-engineering-gr-certificate-online/)

Hansuk Sohn, Department Head

Professors

Associate Professors Hansuk Sohn (Department Head), John Mullen, Raja Jayaraman

Assistant Professors Chaitanya Mahajan

Professor of Practices Manuel Ivan Rodriguez Borbon, Salvador Rodriguez, Edward Kennedy

Professor Emeritus Ed Pines

H. Sohn, Department Head, Ph.D. (University of Iowa)– Combinatorial optimization, Operations Research applications in logistics, transportation, and health systems; J. Mullen, Ph.D. (Iowa State)– Stochastic processes, quality, improvement, production system design; R. Jayaraman, Ph.D. (Texas Tech)- Digital supply chain, applied Operations Research, healthcare systems engineering; C. Mahajan, Ph.D. (Rochester Institute of Technology)- Additive manufacturing, computer integrated manufacturing, manufacturing systems; M. I. Rodriguez Borbon, Ph.D. (NMSU)- Experimental statistics, reliability, degradation analysis, survival analysis, lifecycle analysis; Salvador "Sal" Rodriguez, MS (NMSU)- Conceptual, Developmental and Operational Test & Evaluation, and Project Management; Edward "Eddie" Kennedy, Ph.D. (NMSU)- Machine learning, data analytics, supply chain management; E. Pines, Ph.D. (Penn State)– Quality and continuous improvement, technology policy;

Industrial Engineering Courses

I E 151. Computational Methods in Industrial Engineering
3 Credits (3)
History, social implications, and application of computers and an introduction to computer programming, word processing, and database management systems. Satisfies General Education computer science requirement.
Prerequisite: MATH 1220G.

I E 200. Special Problems-Sophomore
1-3 Credits
Directed individual projects. May be repeated for a total of 3 credits.
Prerequisite: consent of faculty member.

I E 217. Manufacturing Processes
3 Credits (2+3P)
Introduction to manufacturing and processing, including: casting, forming, and machining. Emphasis on creating products with the appropriate techniques. Crosslisted with: E T 217.
Prerequisite(s): A grade of C- or better in either E T 110 or ENGR 110 and C- or better in MATH 1220G.
Learning Outcomes

1. Identify the different manufacturing processes and their applications.
2. Use, set up, and calibrate measuring tools.
3. Apply geometric tolerances to engineering drawings.
4. Demonstrate basic knowledge of materials and material properties.
5. Demonstrate basic knowledge of GM codes and their application.
6. Proficiently use CAM packages such as SolidWorks CAM.
7. Identify different tooling, their use, and manufacturing application.

I E 300. Special Problems-Junior
1-3 Credits
Directed individual projects. May be repeated for a total of 3 credits.
Prerequisite: consent of faculty member.

I E 311. Engineering Data Analysis
3 Credits (3)
Methodology and techniques associated with identifying and analyzing industrial data.

Prerequisite: C- or better in MATH 1521G or MATH 1521H or ENGR 190.

Learning Outcomes

1. Ability to correctly interpret statistical reports
2. Ability to correctly identify and solve problems involving continuous and discrete probability and random variables.
3. Ability to correctly analyze random samples using methods that include: point estimates, confidence intervals, tests of hypothesis, analysis of variance (ANOVA), and linear regression.

I E 316. Methods Engineering
3 Credits (2+3P)
Methods analysis and design. Work measurement techniques. Job evaluation and wage incentive methods. May be repeated up to 3 credits.
Prerequisite(s): I E 217, ENGR 110.
Corequisite: I E 311.

Learning Outcomes

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 develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
5. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

I E 351. Applied Problem Solving in Industrial Engineering
3 Credits (3)
Application of computational techniques to engineering problems including the use of commercial programs in statistics and applied mathematics. Restricted to majors.
Corequisite(s): I E 311.

I E 365. Quality Control
3 Credits (3)
Statistical analysis of quality in manufacturing. Acceptance sampling and control charts.
Prerequisite: I E 311 or equivalent.

I E 375. Manufacturing Processes II
3 Credits (3)
Review of basic manufacturing processes. Advanced topics in casting, forming, machining and joining; major process parameters; economics of processes.
Prerequisite: I E 217 or E T 217.

I E 400. Undergraduate Research
1-3 Credits
May be repeated for a maximum of 6 credits.
Prerequisite: consent of faculty member.

I E 411. Occupational Safety
3 Credits (3)
Practical methods to improve safety in the workplace. Topics include OSHA and other regulations, hazard recognition, assessment and control, industry standards, risk assessment and safety management. Material is applicable to a variety of workplace settings. This course is intended for College of Engineering students who have completed their lower-division requirements in mathematics, engineering, technology, and basic science. Same as I E 561 with differential assignments. Prerequisite: Junior standing

I E 412. Design for Manufacturing and Assembly
3 Credits (3)
Engineering methodology focusing on reducing time-to-market and total production costs by prioritizing both the ease of manufacture for the product's parts and the simplified assembly of those parts into the final product.
Prerequisite: (ENGR 217 or I E 217) and I E 316.

Learning Outcomes

1. The ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. The 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.
3. The 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.
4. The ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.

I E 413. Engineering Operations Research I
3 Credits (3)
Deterministic operations research modeling including linear and integer programming.
Prerequisite: MATH 1521G or MATH 1521H or ENGR 190.
Corequisite: MATH 480 or MATH 2415.

Learning Outcomes

1. Ability to model optimization problems that can be solved by linear optimization.
2. Ability to solve linear optimization problems
3. Ability to interpret solutions of linear optimization problems in the context of the larger problem.

I E 423. Engineering Operations Research II
3 Credits (3)
Probabilistic operations research modeling, including queuing systems and their optimization; Markov chains. May be repeated up to 3 credits.
Prerequisite(s): I E 311.
Corequisite(s): MATH 392.

I E 424. Manufacturing Systems
3 Credits (3)
Organization and functions of manufacturing planning and control systems including forecasting, MRP, capacity planning, JIT systems, scheduling, and inventory control.
Prerequisite: I E 311.

I E 425. Supply Chain Modeling and Analysis
3 Credits (3)
This course introduces supply chain and logistics concepts integrating theory and its application. The course emphasis is on understanding the role of supply chains for competitive advantage, when and how these concepts are applied to improve the distribution of goods and services, as well as in using mathematical programming and optimization methods for their adequate implementation.
Prerequisite: MATH 1521G or MATH 1521H or ENGR 190.
Corequisite: MATH 2415.

Learning Outcomes

1. Define and understand different structures and the importance of the supply chain.
2. Identify the main drivers of supply chain performance and measure them using precise metrics.
3. Integrate production operations management topics in the context of the supply chain.
4. Develop the ability to formulate quantitative decision models for supply chain and logistics management.
5. Study inventory planning decisions, Economic Order Quantity (EOQ), and its variants.

I E 451. Engineering Economy
3 Credits (3)
Discounted cash flows, economics of project, contract and specifications as related to engineering design.

I E 456. Large Scale Systems Engineering
3 Credits (3)
Systems engineering approaches to large-scale complex technological and societal problems. Concepts of interaction and structural graphs, matrices, delta, and Gantt charts. The hall matrix approach, structural concepts, reachability matrices, and cross impact-analysis, modeling and decision making. May be repeated up to 3 credits.
Learning Outcomes

1. Ability to describe the systems engineering standards and best practices
2. Ability to characterize the limitations of the way that current systems engineering is practiced in terms of dealing with lifecycle uncertainty.

I E 459. Systems Thinking and Decision Making
3 Credits (3)
A general introduction to systems engineering. Topics include General Systems Theory, Systems Thinking and emerging concepts, Systems Dynamics approaches for modelling and analyzing non-linear feedback mechanisms in complex systems, and Complexity science and complex adaptive systems. May be repeated up to 3 credits.
Learning Outcomes

1. Ability to understand the complexities of engineering systems, and the implications of change on system behavior
2. Ability to understand the nature of complex systems in respect to people, processes, the environment and development organization
3. Ability to understand Systems Thinking's' role and value within organizations
4. Ability to recognize the advantages, as well as the flaws of our present predominant way of thinking (Cartesian), while looking at the changes that would enable us to deal with complex issues in daily practice (Systems Thinking)
5. Ability to recognize the value and limitations of modeling and simulation as well as how to construct and interpret various models to support decision making.

I E 460. Evaluation of Engineering Data
3 Credits (3)
Analysis of engineering systems possessing variability, employing regression, analysis of variance, distribution theory, and experimental design methods.
Prerequisite: I E 311 or equivalent.

I E 466. Reliability
3 Credits (3)
Application of statistical theory to engineering reliability estimation, reliability improvement, and the analysis of reliability test data.
Prerequisite: I E 311 or equivalent.

I E 467. Discrete-Event Simulation Modeling
3 Credits (3)
Basic modeling concepts, organizations of simulations, input data analysis, random variate generation, simulation design and analysis, model validation, output analysis, and management of simulations. Differentiated graduate assignments. May be repeated up to 3 credits.
Prerequisite(s): I E 311 or equivalent.

I E 468. Advanced Discrete-Event Simulation Applications
3 Credits (3)
Semester long project involving development and application of advanced simulation skills. May be repeated up to 3 credits.
Prerequisite: I E 467.
Learning Outcomes

1. Ability to understand the techniques of computer simulation modeling in the context of hierarchy of knowledge about a system and develop the capability to apply the same to study systems through available computer simulation software

I E 478. Facilities Planning and Design
3 Credits (3)
Plant location methods, total process analysis, process integration, materials handling analysis, and traditional and computerized plant layout methodologies.
Prerequisite(s): I E 316.
Prerequisite(s)/Corequisite(s): I E 424.

I E 490. Selected Topics
1-3 Credits
May be repeated for a maximum of 9 credits.
Prerequisite: consent of the head of the department.

I E 505. Directed Readings
1-3 Credits
May be repeated for a maximum total of 6 credits.
Prerequisite: consent of the head of the department.

I E 511. Survey of Industrial Engineering
3 Credits (3)
A project-based course covering methods of engineering, plant layout, production and inventory control, economic analysis, etc. May be repeated up to 3 credits.
Learning Outcomes

1. Ability to apply the various techniques of Industrial Engineering to solve real-life problems

I E 515. Stochastic Processes Modeling
3 Credits (3)
Introduction to the use of stochastic processes in the modeling of physical and natural systems. Use of generating functions, conditional probability and expectation, Poisson processes, random walk models, Markov chains, branching processes, Markov processes, and queuing processes in an applied setting.
Prerequisites: I E 311 or equivalent; and MATH 392 or equivalent.

I E 522. Queuing Systems
3 Credits (3)
Elements and classification of queuing systems, single server models, multi-server models, cost analysis and applications.
Learning Outcomes

1. Ability to model, analyze, and apply solutions to problems involving queueing systems

2. Ability to read and understand literature in the queueing system analysis field.

I E 523. Advanced Engineering Economy
3 Credits (3)
Theoretical basis for engineering economy methods, problems of cost estimation, replacement, nonmonetary factors, and feasibility studies. Same as C E 523.

I E 524. Advanced Production and Inventory Control
3 Credits (3)
Organization and functions of manufacturing planning and control systems including forecasting, MRP, capacity planning, JIT systems, scheduling and inventory control. Same as I E 424 with differentiated assignments.

I E 525. Systems Synthesis and Design
3 Credits (3)
Examination of the production management complex in terms of its components and the synthesis of these components into an effective operating unit. Development of input-output models representing the basis structure of all production activities.

I E 530. Environmental Management Seminar
1 Credit (1)
Survey of practical and new developments in hazardous and radioactive waste management provided through a series of guest lectures and reports of ongoing research. Same as C E 530, E E 530, CHME 530.

I E 533. Linear Programming
3 Credits (3)
Linear programming problem formulation, simplex algorithm, theory of linear programming, duality, revised simplex algorithm, and sensitivity analysis.

I E 534. Nonlinear Programming
3 Credits (3)
Theoretical and computational methods to solve optimization problems in engineering, statistics, economics, and operations research. Topics include convexity, optimality conditions, Newton's method, Lagrange multipliers, search algorithms for unconstrained and constrained problems, as well as barrier and penalty methods.
Learning Outcomes
1. Ability to model situations which may be solved by nonlinear optimization and to interpret the results in the context of the larger problem
2. Ability to employ several computer tools to correctly solve nonlinear optimization problems.
3. Ability to read and understand literature in the field of nonlinear optimization
4. Ability to select appropriate methods and algorithms from a core representative set of methods and tools to solve nonlinear optimization problems

I E 535. Discrete Optimization
3 Credits (3)
Combinatorial Optimization problems using both integer programming and graph theoretic approaches. Emphasis on modeling and computational algorithms.

I E 537. Large Scale Systems Engineering
3 Credits (3)
Systems engineering approaches to large-scale complex technological and societal problems. Concepts of interaction and structural graphs, matrices, delta, and Gantt charts. The hall matrix approach, structural concepts, reachability matrices, and cross impact-analysis, modeling and decision making.

I E 545. Characterizing Time-Dependent Engineering Data
3 Credits (3)
Theory and techniques employed in the characterization of stochastic processes commonly found in engineering applications. Distribution models include exponential, gamma, Weibull, and extreme value. Design and analysis of experiments involving complete and censored data and elevated stress. Analytical techniques include parametric, nonparametric, and graphical approaches with emphasis on modern computer tools. Exact and approximate maximum-likelihood techniques are stressed.
Learning Outcomes
1. Ability to characterize a process, based on data that is time-dependent or sequential in nature.

I E 561. Advanced Safety Engineering
3 Credits (3)
Regulation as well as qualitative, and quantitative methods to achieve and maintain safety in the workplace. Includes liability, worker's compensation, OSHA, hazard control, safety assessment, cost justification, and system analysis.
Prerequisite: graduate status in engineering.

I E 563. Topics in Engineering Administration
3 Credits (3)
Study of qualitative and quantitative aspects. Consideration given to philosophical, psychological, political and social implications of engineering administrative decisions.

I E 567. Design and Implementation of Discrete-Event Simulation
3 Credits (3)
Basic modeling concepts, organizations of simulations, input data analysis, random variate generation, simulation design and analysis, model validation, output analysis, and management of simulations. Taught with I E 467 with differentiated assignments for graduate students.

I E 571. Advanced Quality Control
3 Credits (3)
Advanced topics in quality control and design of experiments for improvement of quality.
Prerequisite: I E 311 or equivalent.

I E 575. Advanced Manufacturing Processes
3 Credits (3)
Covers major process parameters in casting, forming, machining, and joining. Process economics and selection of processes design and interactions.
Prerequisite: graduate standing.

I E 590. Selected Topics
1-3 Credits
May be repeated for a maximum of 9 credits.
Prerequisite: consent of the head of the department.

I E 598. Special Research Programs
1-3 Credits
Individual analytical or experimental investigations. May be repeated for a maximum total of 6 credits.
Prerequisite: consent of instructor.

I E 599. Master's Thesis
1-15 Credits
Thesis.

I E 610. Topics in Operations Research
3 Credits (3)

Selected topics of current interest, to be designated by subtitle. May be repeated for a maximum of 6 credits.

I E 620. Topics in Computer Modeling
3 Credits (3)
Selected topics of current interest, to be designated by subtitle. May be repeated for a maximum of 6 credits.

I E 630. Topics in Engineering Management
3 Credits (3)
Selected topics of current interest, to be designated by subtitle. May be repeated for a maximum of 6 credits.

I E 690. Selected Topics
1-15 Credits
May be repeated.
Prerequisite: consent of department head.

I E 700. Doctoral Dissertation
15 Credits
Dissertation.

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