IME - Industrial and Manufacturing Engineering

Please note that for all graduate programs in ISME, some IME courses may require programming skills as a prerequisite, and some IME courses may require Linear Algebra or Calculus III as a prerequisite.

Courses numbered 500 to 799 = *undergraduate/graduate*. (Individual courses may be limited to undergraduate students only.) Courses numbered 800 to 999 = *graduate*.

IME 524. Descriptive Analytics (3).
A study of confidence interval, regression analysis, analysis of variance, correlation analysis and design of experiments emphasizing applications to engineering. For undergraduate students only. Prerequisite(s): IME 254.

IME 549. Industrial Ergonomics (3).
A systematic approach to the optimization of the human-task-environment system. Includes work space design, manual materials handling, work related musculoskeletal disorders and environmental factors. Emphasizes applications in industry. Prerequisite(s): IME 254 or departmental consent.

IME 550. Operations Research I (3).
Covers deterministic models and methods in operations research including linear programming, integer programming, and network optimization to aid in the analysis and solution of complex, large-scale decision problems. Prerequisite(s): MATH 511.

IME 553. Production Systems (3).
Quantitative techniques used in the analysis and control of production systems. Includes forecasting, inventory models, operation planning and scheduling. Prerequisite(s): IME 254. Pre- or corequisite(s): IME 255.

IME 554. Statistical Quality Control (3).
A study of the measurement and control of product quality using statistical methods. Includes acceptance sampling, statistical process control and total quality management. Pre- or corequisite(s): IME 254.

IME 556. Information Systems (3).
Provides a basic understanding of information systems in a modern enterprise, including database design, information technology and ethics using hands-on activities and directed classroom discussion. For ISME undergraduates students only. Prerequisite(s): CS 211 or MIS 310 or MATH 451.

IME 557. Safety Engineering (3).
Environmental aspects of accident prevention, industrial compensation and safety legislation. Fundamental concepts of occupational health and hygiene. Prerequisite(s): IME 254.

IME 558. Manufacturing Methods and Materials II (4).
Covers theoretical and practical aspects of manufacturing processes, including material properties and behavior as influenced by the manufacturing process. In-depth study of such manufacturing processes as casting heat treatment, bulk forming, sheet metal forming, metal cutting, nontraditional machining and process monitoring through measurement of manufacturing process variables. Also includes laboratory experience and plant tours. Prerequisite(s): IME 258, ME 250. Corequisite(s): IME 558L.

IME 561. Applied Control Systems (3).
Covers the fundamentals of control systems and their applications. Topics include theory of control systems, Laplace transforms, Z transforms, stability analysis, state space methods, PID control, tuning, relay logic controllers, programmable logic controllers, supervisory control and data acquisition, and case studies. Prerequisite(s): MATH 555 with a C or better grade or instructor’s consent.

IME 563. Facilities Planning and Design (3).
Quantitative and qualitative approaches to problems in facilities planning and design, emphasizing activity relationships, space requirements, materials handling and storage, and plant layout. Quantitative and qualitative approaches to selection of material handling devices and design of storage systems, and introduction to concepts of supply chain. Prerequisite(s): IME 452, 550, 553.

IME 565. Systems Simulation (3).
The design of simulation models and techniques for use in designing and evaluating discrete systems, including manufacturing systems too complex to be solved analytically. Emphasizes general purpose computer simulation languages. Prerequisite(s): computer programming competency. For ISME undergraduate students only. Pre- or corequisite(s): IME 553, 524.

IME 590. Industrial Engineering Design I (3).
An industry-based team design project using industrial engineering and manufacturing engineering methods and principles; performed under faculty guidance. For undergraduate credit only. Prerequisite(s): IME 553; must be within two semesters of graduation or departmental consent. Pre- or corequisite(s): PHIL 385.

IME 625. Product Performance Evaluation using CAE (3).
Covers the application of analysis and simulation methods and tools to evaluate product designs for strength, life and robustness. Includes a lab experience and a design project aimed at developing proficiency in virtual product evaluation. Prerequisite(s): AE 333 and IME 425.

IME 650. Operations Research II (3).
The second of a two-course sequence on models and solution approaches commonly used in the analysis of decision-making problems. Familiarizes students with nonlinear deterministic as well as probabilistic models in operations research and their applications. In particular, upon completion of this course, students develop an understanding of how to model and analyze systems that show nonlinear and probabilistic behavior. Moreover, students learn how to use state-of-the-art optimization solvers. Topics include nonlinear programming, decision making under uncertainty, game theory, Markov chains, queuing theory and dynamic programming. Prerequisite(s): IME 550 or instructor's consent.

IME 664. Engineering Management (3).
Introduction to the design and control of technologically-based projects. Considers both the theoretical and practical aspects of systems models, organizational development, project planning and control, resource allocation, team development and personal skill assessment. Prerequisite(s): IME 255, (IME 254 or APEN 354), all with a C or better.

IME 676. Aircraft Manufacturing and Assembly (3).
Covers key aspects of assembly design for aircraft structures. First module covers design of jigs and fixtures to locate parts and machine features to tolerance, and the effect of part and tool stiffness on the tolerances. Second module covers gage design and gage studies, and geometric dimensioning and tolerancing. Third module covers assembly planning and best practices for aircraft assembly. Laboratory experiments and case studies are used to understand issues related to aircraft assembly. For ISME undergraduate students only. Prerequisite(s): IME 258.

IME 690. Industrial Engineering Design II (3).
Continuation of the design project initiated in IME 590 or the performance of a second industrial engineering design project; an industry-based team design project using industrial and manufacturing

engineering methods and principles; performed under faculty guidance. For undergraduate credit only. Prerequisite(s): IME 590 and departmental consent. Pre- or corequisite(s): CHEM 211.

IME 724. Statistical Methods for Engineers (3).
For graduate students majoring in engineering. Students study and model real-life engineering problems and draw reliable conclusions through applications of probability theory and statistical techniques. Not available for undergraduate credit. Prerequisite(s): MATH 243.

IME 734. Introduction to Data Mining and Analytics (3).
Introduces the theory and basic analysis methods for analyzing existing datasets. Topics include: data preprocessing, linear regression, logistic regression, classification (using linear regression, logistic regression, decision trees, rule-based classifiers, instance-based classifiers, Bayesian classifiers, support vector machine), association analysis and cluster analysis. Focuses on the data mining tasks that each method addresses, the assumptions of each method, the inputs needed, the outputs, interpretation of results, and evaluation of the quality of the analysis. Includes a term project based on the research/application interests of the students. The software package R is used to illustrate the implementation of the analysis. Prerequisite(s): IME 254 and MATH 511 or instructor's consent.

IME 749. Ergonomic Assessment Methods (3).
Covers current and commonly used risk and exposure assessment methods used for musculoskeletal disorders in the workplace. Students develop an understanding and working knowledge of how to evaluate and control the risk of work-related musculoskeletal disorders in the design of workplaces. Critical assessments and discussions of risk and exposure assessment techniques are performed relative to the strengths and weaknesses of each technique as well as the evidence for risk control and validity of the various methods. Prerequisite(s): IME 549 or instructor's consent.

IME 754. Reliability and Maintainability Engineering (3).
Studies problems of quantifying, assessing and verifying reliability. Presents various factors that determine the capabilities of components emphasizing practical applications. Examples and problems cover a broad range of engineering fields. Prerequisite(s): IME 524 or 724.

IME 755. Design of Experiments (3).
Application of analysis of variance and experimental design for engineering studies. Includes general design methodology, single-factor designs, randomized blocks, factorial designs, fractional replication and confounding. Prerequisite(s): IME 524 or 724.

IME 758. Analysis of Manufacturing Processes (3).
Introduces students to plasticity and builds upon their knowledge of mechanics and heat transfer in order to analyze various manufacturing processes. Numerical techniques (mainly finite element analysis) as well as theoretical methods are introduced and applied to analysis of processes such as open and closed die forging, superplastic forming, machining, grinding, laser welding, etc. The effect of friction, material properties and process parameters on the mechanics of the processes and process outputs is the main focus of study. Prerequisite(s): AE 333.

IME 759. Ergonomic Interventions (3).
Provides an understanding and working knowledge of how to evaluate and control the risk of musculoskeletal disorders in the design of workplaces and processes. Scientific aspects of intervention design and effectiveness assessment are discussed, including an assessment of the strengths and weaknesses of the intervention research literature. Prerequisite(s): IME 549 or instructor's consent.

IME 761. Robot Programming and Applications (3).
Covers broad interdisciplinary topics in industrial robotics. Topics include path planning and programming of robot manipulators, collaborative robots and mobile robots, as well as robot applications in conjunction with the industrial internet of things (IIoT), industrial automation, and smart manufacturing. Both theoretical and practical approaches are considered for smooth transitions from theories to applications. Practical applications are facilitated by lab activities that use robot simulation software. Prerequisite(s): IME 561 with a C or better grade or instructor's consent.

IME 762. Smart Manufacturing (3).
Introduces smart manufacturing that employs adaptive interoperable systems, sensor fusion, digital information technology and skilled technical workforce. The topics cover artificial intelligence, statistical optimization, digital transformation, smart manufacturing enablers and case studies. Prerequisite(s): MATH 555 with a "C" or better grade (2.000 on a 4.000 scale) and basic programming skills or instructor's consent.

IME 764. Systems Engineering and Analysis (3).
Presentation of system design process from the identification of a need through conceptual design, preliminary design, detail design and development, and system test and evaluation. Studies operational feasibility, reliability, maintainability, supportability and economic feasibility. Prerequisite(s): IME 254, 255.

IME 765. Modeling and Analysis of Manufacturing Systems (3).
Introduces students to the basic concepts underlying modeling and analysis of manufacturing systems to support operations and performance evaluation. Students learn to select the appropriate analytical methods (e.g., optimization, stochastic modeling) to solve specific problems by illustrating models and algorithms frequently used in analyzing common manufacturing configurations. Prerequisite(s): basic knowledge of deterministic operations research, probability theory and stochastic modeling expected (IME 550 and IME 650).

IME 767. Lean Manufacturing (3).
Introduces lean concepts as applied to the manufacturing environment. Deals with the concepts of value, value stream, flow, pull and perfection. Includes waste identification, value stream mapping, visual controls and lean metrics. Prerequisite(s): IME 553.

IME 770. Badge: Industrial Engineering Topics (0.5).
An umbrella course created to explore a variety of subtopics differentiated by letter (e.g., 770BA, 770BB). Not all subtopics are offered each semester – see the course schedule for availability. Students enroll in the lettered courses with specific topics in the titles rather than in this root course.

IME 770BA. Badge: Discrete Event Simulation (0.5).
Simulation is a key technology to understand factory operations. This course is designed to enable engineers to learn and use Simio, a standard discrete event simulation (DES) software. DES is a means for designing and evaluating systems with random elements that are too complex to be solved analytically. This course covers simulation theory, methodology and its application. The general-purpose simulation software Simio is used for hands-on application. Prerequisite(s): preferred IME 254 and CS 211.

IME 775. Computer Integrated Manufacturing (3).
A study of the concepts, components and technologies of CIM systems; enterprise modeling for CIM, local area networks, CAD/CAM interfaces, information flow for CIM, shop floor control and justification of CIM systems. Prerequisite(s): knowledge of a programming language, IME 558.

IME 777. IME Colloquium (0).
Presentations and discussions of industrial engineering problems, research methods and case analyses for graduate students. Repeatable.

IME 780. Topics in Industrial Engineering (3).
An umbrella course created to explore a variety of subtopics differentiated by letter (e.g., 780A, 780B). Not all subtopics are offered each semester – see the course schedule for availability. Students enroll in the lettered courses with specific topics in the titles rather than in this root course.

IME 780AG. Nonlinear Programming (3).
Discusses analytical and numerical methods used to solve problems that involve nonlinear objectives and/or nonlinear constraints. It starts with fundamentals of mathematical programming including problem formulation, convex analysis, duality theory and optimality conditions. It then focuses on numerical methods used to solve unconstrained and constrained nonlinear programming (NLP) problems. Additionally, students discuss global-optimization techniques for non-convex problems. Throughout the course, special classes of NLP problems including quadratic programming, semi-definite programming, separable programming, bi-level programming, fractional programming and geometric programming are discussed. Students learn how to use MATLAB and related libraries to solve NLP problems. Prerequisite(s): IME 550 or equivalent.

IME 780AL. Energy Analytics & Management (3).
Covers topics on energy auditing, rate structures, economic evaluation techniques, analysis of opportunities in energy systems including but not limited to lighting, compressed air, process heating, steam, and other process-based energy systems. Also covers multiple software programs used by energy auditing professionals. Prerequisite(s): ECE 282 or instructor’s approval.

IME 780AM. Advanced Cyber-Physical Systems (3).
A cyber-physical system is a set of interconnected digital computing devices that interact with physical world through sensors and actuators in a feedback control loop. The course outlines the basic principles of design, modeling, and analysis of cyber-physical systems with the use of mathematical abstractions, control theories, data communication, and distributed algorithms. The course also explains some of the Industry-4.0 technologies, such as cognitive robotics and Industrial Internet of Things (IIoT), with some hands-on lab activities.

IME 780AN. Big Data Analytics in Engineering (3).
Provides a graduate-level introduction to methods in data science and big data analytics with engineering applications. Specifically, examines some widely used statistical methods and machine learning tools for big data (data with high volume, velocity and variety). A variety of up-to-date industrial engineering topics are covered as application examples. Prerequisite(s): basic engineering statistics and programming skills.

IME 780AP. Neural Networks and Machine Learning (3).
Introduces the theory and practical applications of artificial neural networks and machine learning. Covers several network paradigms, emphasizing the use of neural networks as a solution tool for industrial problems which require pattern recognition, predictive and interpretive models, pattern classification, optimization and clustering. Covers machine learning. Presents examples and discusses them from a variety of areas including quality detection, process monitoring, robotics, simulation metamodeling, diagnostic models, combinatorial optimization and machine vision. For students from a variety of disciplines.

IME 780AQ. Simulation Modeling and Applications (3).
Familiarizes students with fundamental methodologies of simulation modeling and applications to engineering and management sciences. Upon completion of this course, students develop an in-depth knowledge of two main methodologies used to build dynamic simulation models: discrete-event modeling and agent-based modeling. Students also learn about the key steps involved in simulation modeling, namely, data collection and cleaning, statistical analysis of input data, model design, model verification and validation, and statistical analysis of model output. Students gain hands-on experience through a term project that involves the development and implementation of a simulation model for an engineering application using a commercial software application. Prerequisite(s): IME 254 and IME 524, or instructor’s consent.

IME 781. Cooperative Education (0.5-8).
Academic program that expands a student's learning experiences through paid employment in a supervised educational work setting related to the student's major field of study or career focus. Repeatable for credit. May not be used to satisfy degree requirements. Prerequisite(s): departmental consent, graduate GPA of 3.000 or above.

IME 781P. Cooperative Education (1).
Academic program that expands a student's learning experiences through paid employment in a supervised educational work setting related to the student's major field of study or career focus. Students must enroll concurrently in a minimum of 6 credit hours of coursework including this course in addition to a minimum of 20 hours per week at their co-op assignment. Graded Cr/NCr unless student has received permission before enrolling for course to be used as an elective. For graduate credit only. Repeatable for credit.

IME 783. Supply Chain Management (3).
Quantitative and qualitative techniques used in the design and management of the supply chain. Includes distribution management, multi-plant coordination, optimal design of the logistics network, adequate safety stock levels and the risk pooling concept, and integrating decision support systems (DDS) in the management of the supply chain. Prerequisite(s): IME 553 or DS 350 or DS 850 or instructor's consent.

IME 788. Rapid Prototyping and 3D Printing (3).
Provides engineering students with knowledge about all available rapid prototyping and rapid tooling techniques. Topics include fundamentals of rapid prototyping and additive manufacturing, reverse engineering, CAD modeling, and current 3D printing technologies. Additional concepts important to product development in aviation industry and medical applications are addressed and exercised during term projects. Prerequisite(s): IME 775 or instructor's consent.

IME 794. Applied Quantum Computation (3).
Introduces the principles of quantum information science and computation. Reviews fundamental quantum algorithms with applications to machine learning and optimization along with hands-on training in gate-based quantum computing paradigm using the IBM Q platform. This course is ideal for upper-level undergraduate and graduate students majoring in engineering and applied sciences with interests in data analytics, machine learning and computer programming. Prerequisite(s): CS 560 or MATH 511 or IME 734 or instructor’s consent.

IME 851. Stochastic Modeling and Analysis (3).
Discusses stochastic processes and their application to modeling and analysis of systems that involve uncertainty in engineering and management sciences. Topics include review of probability concepts and random variables, discrete-time Markov chains, Poisson processes, continuous-time Markov processes, renewal theory, and basic queueing models. Prerequisite(s): IME 550 or instructor's consent.

IME 854. Quality Engineering (3).
A broad view of quality tools and their integration into a comprehensive quality management and improvement system. Covers the theory and approaches of the major quality leaders such as Deming, Juran and Crosby. Explores off-line and online quality engineering techniques, including cost of quality, the seven old and seven new tools, Quality

Function Deployment, and statistical process control methods. Explores design of engineering experiments, including Taguchi's methods. Prerequisite(s): IME 554 or instructor's consent.

IME 869. Bayesian Statistics and Uncertainty Quantification (3).
Studies Bayesian probability theory, model-based design of engineering systems, different uncertainty sources and their quantification, sensitivity analysis, dynamic systems, real-time control, diagnostics and prognostics. Designed for graduate students majoring in engineering. Prerequisite(s): IME 754 or instructor's consent.

IME 872. Applied Learning Project in Industrial, Systems, and Manufacturing Engineering (1).
Incorporates an industry-based project conducted under the supervision of departmental graduate faculty. Satisfies the applied learning requirement for MS-level students in the department. Requires a written report and an oral presentation on the project. Prerequisite(s): instructor's consent.

IME 874. MSIE Graduate Seminar (1).
Seminar course performed under faculty supervision, related to a topic of research interest to both the faculty and the student. Repeatable for credit. Prerequisite(s): faculty consent.

IME 876. Thesis (1-6).
Student-driven research experience to address a specific research question. Potential topics should be formulated by the student and discussed with their advisor. Repeatable for credit. Prerequisite(s): thesis advisor's consent.

IME 878. Master's Directed Project (1-3).
A project conducted under the supervision of an academic advisor for the directed project option. Requires a written report and an oral presentation on the project. Prerequisite(s): consent of academic advisor.

IME 880. Topics in Industrial Engineering (3).
An umbrella course created to explore a variety of subtopics differentiated by letter (e.g., 880A, 880B). Not all subtopics are offered each semester – see the course schedule for availability. Students enroll in the lettered courses with specific topics in the titles rather than in this root course.

IME 880AA. Digital Twinning of Manufacturing Operations (3).
Deals with the development and use of digital twins in manufacturing systems and its application to real-time decision making. Topics for study include – types and use of sensors in manufacturing applications (literature review), identification of data parsing and data formats for unified structure, development of digital twins, and real-time algorithms for decision-making (scheduling, alternate routing, quality control decisions, etc.). It is a project-oriented class and involves reading and presentation of papers and a project. Prerequisite(s): IME 553 and IME 783, or instructor's consent.

IME 880K. Advanced Facilities Planning and Material Handling (3).
Deals with the latest research issues in facilities planning and material handling. Topics for study include – advanced techniques, heuristics for static layout design, dynamic facility layout planning, selection of material handling equipment and control systems for material handling in a dynamic environment, and design of manufacturing facilities for life-cycle management. Prerequisite(s): IME 563 or instructor's consent.

IME 880R. Advanced Industrial Robotics (3).
Covers advanced topics on industrial robotics, robotic process identification, digital/continuous control of robot tool paths, optimal control, and applications. Prerequisite(s): IME 761 or instructor's consent.

IME 880Y. Forecasting and Analytics (3).
Covers topics on time series regression models, forecasting and smoothing, exploratory data analytics, predictive analytics and modeling, and ARIMA models. Students will use R program to model predictive analytics problems. Prerequisite(s): IME 524 and IME 724 or instructor's approval.

IME 883. Supply Chain Analytics (3).
Uses operations research and analytics to provide state-of-the-art mathematical models, concepts and solution methods important in the design, control, operation and management of global supply chains by emphasizing a quantitative analytical approach. Prerequisite(s): IME 550 and IME 553; or instructor's consent.

IME 890. Independent Study in Industrial Engineering (1-3).
Arranged individual independent study in specialized content areas under the supervision of a faculty member. Repeatable for credit. Prerequisite(s): instructor's consent.

IME 960. Advanced Selected Topics (3).
An umbrella course created to explore a variety of subtopics differentiated by letter (e.g., 960A, 960B). Not all subtopics are offered each semester – see the course schedule for availability. Students enroll in the lettered courses with specific topics in the titles rather than in this root course. Prerequisite(s): instructor's consent.

IME 960F. Statistical Process Control (3).
Studies the measurement and control of product quality using statistical methods. Includes total quality management, statistical process control and acceptance sampling. Prerequisite(s): IME 254 or IME 724.

IME 960G. Exoskeletons and Ergonomics (3).
Exoskeletons are mechanical devices worn by people to enhance their capabilities and are used for military personnel, rehabilitation and in the manufacturing sector. This course explores current use of exoskeletons in industry, exposing students to the multiple uses, the current research on exoskeletons, as well as develop laboratory studies to assess enhancement of human capabilities with the use of exoskeletons. Prerequisite(s): IME 549 or instructor's consent.

IME 960I. Rubber Processing for 3D Printing (3).
A study of rubber and rubber processing. Includes industrial applications of rubber, vulcanization and devocalization of rubber, environmental and economic impact of recycling rubber, and potentials for using rubber in 3D printing. Prerequisite(s): IME 788 and ME 665, or instructor's consent.

IME 960J. Industry 4.0 and Leading Challenges in Construction (3).
Provides engineering students with knowledge about all available rapid prototyping and rapid tooling techniques. Topics covered include fundamentals of rapid prototyping and additive manufacturing, reverse engineering, CAD modeling, and current 3D printing technologies. Additional concepts important to product development in aviation industry and medical applications are addressed and exercised during term projects. Prerequisite(s): IME 788 or instructor's consent.

IME 960K. Advanced Topics in Industry 4.0 (3).
The fourth industrial revolution, which is also known as Industry 4.0, is making manufacturing enterprises increasingly reliant on cyber-physical systems that facilitate automation and flexibility in production lines. This course focuses on theories and tools that are instrumental in data acquisition and information processing involved in interconnected cyber-physical systems. The topics include cyber-physical systems, digital logic, synchronous/asynchronous system principles and programming, and machine learning tools. The topics also cover data acquisition with sensors, signal conditioning, noise

filtering and data collection fundamentals. Prerequisite(s): IME 561 or IME 761 or instructor's consent.

IME 960M. Computer Integrated Manufacturing (3).
Reviews advanced aspects of computer numerical control of manufacturing systems, and provides hands-on involvement with automated manufacturing processes. Students are required to design control algorithms for tool interpolation in multi-axis fabrication or multi-axis inspection processes. Prerequisite(s): graduate standing or instructor's consent.

IME 960N. Planning and Scheduling in Manufacturing and Services (3).
Introduces the area of planning and scheduling in manufacturing and services scheduling from the theoretical and practical point of view. Both classical (e.g., exact methods including dynamic programming) and new methods (metaheuristics, approximation methods, machine learning and artificial intelligence) for solving planning and scheduling problems are presented. Description of general-purpose scheduling procedures gives the basic overview of solution methods. Various models for planning and scheduling in manufacturing and services are described and algorithms for their solution are presented. The models include real-life problems like project planning, scheduling assembly systems, timetabling, workforce scheduling or telecommunication planning. Each student learns how to use state of the art optimization software CPLEX and GAMS. Prerequisite(s): IME 550, knowledge of modeling, and experience in programming; or instructor’s consent.

IME 976. PhD Dissertation (1-12).
Student-driven research experience to address a specific research question. Potential topics should be formulated by the student and discussed with their advisor. Repeatable for credit. Prerequisite(s): admission to doctoral aspirant status.

IME 990. Advanced Independent Study (1-3).
Arranged individual, independent study in specialized content areas. Repeatable for credit toward the PhD degree. Prerequisite(s): advanced standing and departmental consent.