

# Industrial and Manufacturing Engineering (IME)

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## **IME 111. Introduction to Industrial and Manufacturing Engineering. 3 Credits.**

Overview of industrial engineering and manufacturing engineering professional careers and work environments. Basic skill acquisition using computer software tools to solve engineering problems, prepare reports, plan projects, deliver professional presentations, and manage data.

## **IME 194. Individual Study. 1-5 Credits.**

## **IME 196. Field Experience. 1-15 Credits.**

## **IME 199. Special Topics. 1-5 Credits.**

## **IME 291. Seminar. 1-3 Credits.**

## **IME 292. Global Practicum: Study Abroad. 1-15 Credits.**

Pre-Arranged study at accredited foreign institutions (study abroad), domestic institutions (National Student Exchange) or on approved study abroad programs. Pre-requisite: Sophomore standing and prior approval by International Student and Study Abroad Services and major department. Graded 'P' or 'F' (Undergraduate), or 'S' or 'U' (Graduate).

## **IME 294. Individual Study. 1-5 Credits.**

## **IME 299. Special Topics. 1-5 Credits.**

## **IME 311. Work/Station Design and Measurement. 3 Credits.**

Analytical methods for measuring human performance in industrial, commercial and manufacturing settings. Development of work procedures and design of workstations. Considerations of ergonomics, safety, performance effectiveness and efficiency, interactions between workstations, information and data requirements, production throughput, training and skill requirements, and resources. Weekly laboratory. Prereq: IME 111.

## **IME 330. Manufacturing Processes. 3 Credits.**

Traditional manufacturing processing methods as employed in contemporary practice. Includes properties of materials, machining, casting, forming, and fabrication techniques. Several experiments will be conducted on various manufacturing processes in the laboratory. Coreq: ME 212.

## **IME 335. Welding Technology. 3 Credits.**

Study of arc and gas welding technology together with related metallurgy. Laboratory instruction in welding techniques and skills. 2 recitations, 1 two-hour laboratory.

## **IME 379. Global Seminar. 1-6 Credits.**

NDSU instructed experience or field study in a foreign country. Conducted in English for residence credit. Pre-requisite: Prior approval by International Student and Study Abroad Services and major department. May be repeated. Standard Grading.

## **IME 380. CAD/CAM for Manufacturing. 3 Credits.**

Coverage of CAD, numerical control, and CAM software. Use of manufacturing standards for geometric dimensioning and tolerancing. Prereq: ME 212.

## **IME 391. Seminar. 1-3 Credits.**

## **IME 392. Global Practicum: Study Abroad. 1-15 Credits.**

Pre-Arranged study at accredited foreign institutions (study abroad), domestic institutions (National Student Exchange) or on approved study abroad programs. Pre-requisite: Sophomore standing and prior approval by International Student and Study Abroad Services and major department. Graded 'P' or 'F' (Undergraduate), or 'S' or 'U' (Graduate).

## **IME 394. Individual Study. 1-5 Credits.**

## **IME 397. Fe/Coop Ed/Internship. 1-4 Credits.**

## **IME 399. Special Topics. 1-5 Credits.**

## **IME 411. Human Factors Engineering. 3 Credits.**

A survey of human factors engineering topics with an emphasis on optimizing person-machine and person-system interactions. Human physical and cognitive capabilities will be investigated to improve work design, interface design, and usability. Prereq: IME 311, IME 460. {Also offered for graduate credit - see IME 611.}.

## **IME 427. Packaging for Electronics. 3 Credits.**

Processes and materials for packaging of electronic components and devices, including integrated circuit chips, chip packages, and board level packaged systems; boards and substrates technology; quality and reliability of electronic packages. Open to all engineering majors. Prereq: Junior standing. Cross-listed with ECE 427. {Also offered for graduate credit - see IME 627.}.

## **IME 429. Introduction to IC Fabrication. 3 Credits.**

This course examines issues about fabrication methods and procedures. Topics will include implantation, pattern transfer and process integration. Cross-listed with ECE 429.

**IME 430. Process Engineering. 3 Credits.**

Comprehensive analysis of selected manufacturing processes; mathematical modeling of process dynamics, and evaluation of processing alternatives. Design of effective and efficient processes for selected industrial products. Prereq: IME 330 and MATH 266. {Also offered for graduate credit - see IME 630.}.

**IME 431. Production Engineering. 3 Credits.**

Design of a production system for selected manufactured products, development of production system flow maps and linked process dynamic models, evaluation of throughput and identification of constraints. Evaluation of alternative solutions for production constraints. Recommended: IME 430/630. Prereq: IME 330. {Also offered for graduate credit - see IME 631.}.

**IME 432. Composite Materials Manufacturing. 3 Credits.**

Processes for manufacturing products from fiber-reinforced composite materials. Analysis of tooling, process variables and quality management during processing. Design of processes for manufacture of selected composite parts. Weekly laboratory. Prereq: IME 330, ME 331.

**IME 433. Additive Manufacturing. 3 Credits.**

A synchronized approach considering functional design, analysis and manufacturing that support seamless integration of geometry with performance. The course will address additive manufacturing principles; scope of additive manufacturing; bio-manufacturing. Prereq: IME 330. {Also offered for graduate credit - see IME 633.}.

**IME 435. Plastics and Polymer Processing in Manufacturing. 3 Credits.**

Product and process engineering for manufacturers of plastic products; material evaluation and selection, mold design, process design, quality evaluation of manufactured plastic parts. Prereq: MATH 266. {Also offered for graduate credit - see IME 635.}.

**IME 437. Methods for Precision Manufacturing. 3 Credits.**

Fundamental principles and applications of methods of precision micro- and nano-scale manufacturing of discrete parts and assembled products made of metallic and non-metallic engineering materials. Prereq: IME 430 and ME 331. {Also offered for graduate credit - see IME 637.}.

**IME 440. Engineering Economy. 2-3 Credits.**

Capital investment decision foundation within the rules of general and project accounting. Analysis of benefits and returns against cost for engineering installation, operation, life cycle, and buy-rent-lease decisions. Prereq: Junior standing or IME major. {Also offered for graduate credit - see IME 640.}.

**IME 450. Systems Engineering and Management. 3 Credits.**

Integration of technical disciplines through the stages of systems life cycle: needs and requirements determination, operating and support concepts, design and prototyping, test and evaluation, facilitation, manuals, training, and supportability. Prereq: Junior standing. {Also offered for graduate credit - see IME 650.}.

**IME 451. Logistics Engineering and Management. 3 Credits.**

This course emphasizes integrated logistics management methods to improve the effectiveness and efficiency of material flow, information flow and cash flow for the entire supply chains. Prereq: IME 470. Coreq: IME 450. {Also offered for graduate credit - see IME 651.}.

**IME 453. Hospital Management Engineering. 3 Credits.**

Survey of management engineering roles in the delivery of health care. Review of functional relationships present in health care delivery systems. Application of industrial engineering tools to solve health care delivery problems focused on cost reduction, process redesign, facility design, quality improvement, and systems integration. Prereq: Core IME courses. {Also offered for graduate credit - see IME 653.}.

**IME 456. Program and Project Management. 3 Credits.**

Integrated approaches to managing engineering, technology and business projects, addressing the project management lifecycle including initiating, planning, executing, controlling and closing. Additional topics include program management, portfolio management, and applying principles in a business environment. Prereq: Junior standing. {Also offered for graduate credit - see IME 656.}.

**IME 460. Evaluation of Engineering Data. 3 Credits.**

Design of engineering experiments and evaluations, curve fitting, regression, hypothesis testing, ANOVA, Taguchi methods in engineering design. Coreq: MATH 166. {Also offered for graduate credit - see IME 660.}.

**IME 461. Quality Assurance and Control. 3-4 Credits.**

Proactive and reactive quality assurance and control techniques; emphasis on quality planning, statistical process control, acceptance sampling, and total quality management. Issues in reliability and maintainability engineering. Prereq: IME 460. {Also offered for graduate credit - see IME 661.}.

**IME 462. Total Quality In Industrial Management. 3 Credits.**

The meaning and means for achieving 'total quality' in all dimensions of industrial activities and organizations. Topics include continuous improvement, statistical process control, leadership, and training. {Also offered for graduate credit - see IME 662.}.

**IME 463. Reliability Engineering. 3 Credits.**

Study and application of statistical models and methods for defining, measuring and evaluating reliability of products, processes and services: life distributions, reliability functions, reliability configurations, reliability estimation, parametric reliability models, accelerate life testing, reliability improvement. Prereq: IME 460. {Also offered for graduate credit - see IME 663.}.

**IME 464. Reliability Analysis. 3 Credits.**

System modeling and analysis, designing for reliability, reliability testing, reliability in manufacturing, and reliability management, fault tree analysis, RBD, and cut sets are covered along with sneak circuits, time-on-test plots and acceptance testing. Prereq: IME 460 and IME 463. {Also available for graduate credit - See IME 664.}

**IME 465. Introduction to Machine Learning. 3 Credits.**

Machine learning uses interdisciplinary techniques such as statistics, linear algebra, and optimization to create automated systems that can sift through large volumes of data at high speeds to make predictions or decisions. This class will cover topics in linear regression (multivariate, subset selection, RIDGE & LASSO, and model selection), basic classification methods (kNN, Naïve Bayes, logistic regression, LDA, and SVM), and the concept of unsupervised learning (k-means cluster and PCA). Prereq: IME 460.

**IME 470. Operations Research I. 3 Credits.**

Techniques to optimize and analyze industrial operations. Use of linear programming, transportation models, networks, integer programming, goal programming, dynamic programming, and non-linear programming. Prereq: MATH 129. Co-req: IME 460. {Also offered for graduate credit - see IME 670.}

**IME 472. Simulation of Business and Industrial Systems. 3 Credits.**

Development of the fundamentals and techniques of simulating business and industrial systems. Monte-Carlo techniques and computer usage. Prereq: IME 460, high-level computer language. {Also offered for graduate credit - see IME 672.}

**IME 480. Production and Inventory Control. 3 Credits.**

Planning and controlling of industrial production and inventory: demand forecasting, master scheduling, materials requirements planning, job scheduling, assembly line balancing, and just-in-time production. Prereq: IME 460. {Also offered for graduate credit - see IME 680.}

**IME 482. Automated Manufacturing Systems. 3 Credits.**

Design of integrated production systems including flexible, programmed automatic control for fabrication, assembly, packaging, movement, and storage. Numerical control, flexible manufacturing systems, and computer integrated manufacturing. 2 recitations, 1 two-hour laboratory. Prereq: IME 311, IME 330, PHYS 252. {Also offered for graduate credit - see IME 682.}

**IME 485. Industrial and Manufacturing Facility Design. 3 Credits.**

Capstone integration of analysis and design tools to convert product design into production plans and plants. Prereq: Senior standing. {Also offered for graduate credit - see IME 685.}

**IME 489. Industrial and Manufacturing Engineering Capstone. 3 Credits.**

Capstone experience. Student projects in design, analysis, and experimental investigation related to industrial and manufacturing engineering. Prereq: IME 482 and senior standing with less than 36 hours of required class work to graduate.

**IME 491. Seminar. 1-5 Credits.****IME 492. Global Practicum: Study Abroad. 1-15 Credits.**

Pre-Arranged study at accredited foreign institutions (study abroad), domestic institutions (National Student Exchange) or on approved study abroad programs. Pre-requisite: Sophomore standing and prior approval by International Student and Study Abroad Services and major department. Graded 'P' or 'F' (Undergraduate), or 'S' or 'U' (Graduate).

**IME 493. Undergraduate Research. 1-5 Credits.**

Student research, scholarly project or creative investigation completed under the guidance of a faculty mentor. Directed independent project, collaborative work or ongoing participation in faculty research should culminate in a presentation, article or scholarly project.

**IME 494. Individual Study. 1-5 Credits.****IME 496. Field Experience. 1-15 Credits.****IME 499. Special Topics. 1-5 Credits.****IME 611. Human Factors Engineering. 3 Credits.**

A survey of human factors engineering topics with an emphasis on optimizing person-machine and person-system interactions. Human physical and cognitive capabilities will be investigated to improve work design, interface design, and usability. {Also offered for undergraduate credit - see IME 411.}

**IME 627. Packaging for Electronics. 3 Credits.**

Processes and materials for packaging of electronic components and devices, including integrated circuit chips, chip packages, and board level packaged systems; boards and substrates technology; quality and reliability of electronic packages. Open to all engineering majors. Cross-listed with ECE 627. {Also offered for undergraduate credit - see IME 427.}

**IME 630. Process Engineering. 3 Credits.**

Comprehensive analysis of selected manufacturing processes; development of process flow maps, schematic and mathematical modeling of process dynamics, and evaluation of processing alternatives. Design of effective and efficient processes for selected industrial products. Seminar/case study format. {Also offered for undergraduate credit - see IME 430.}

**IME 631. Production Engineering. 3 Credits.**

Design of a production system for selected manufactured products, development of production system flow maps and linked process dynamic models, evaluation of throughput and identification of constraints. Evaluation of alternative solutions for production constraints. Undergraduate: design of fixtures, dies and tooling for economical production. Graduate: In-depth analysis of contemporary production systems for selected manufactured products; development of production systems issues. Seminar/case study format. Recommended: IME 630. {Also offered for undergraduate credit - see IME 431.}.

**IME 633. Additive Manufacturing. 3 Credits.**

A synchronized approach considering functional design, analysis and manufacturing that support seamless integration of geometry with performance. The course will address additive manufacturing principles; scope of additive manufacturing; bio-manufacturing. {Also offered for undergraduate credit - see IME 433.}.

**IME 635. Plastics and Injection Molding Manufacturing. 3 Credits.**

Product and process engineering for manufacturers of plastic products; material evaluation and selection, mold design, process design, quality evaluation of manufactured plastic parts. Cross-listed with ME 635. {Also offered for undergraduate credit - see IME 435.}.

**IME 637. Methods for Precision Manufacturing. 3 Credits.**

Fundamental principles and applications of methods of precision micro- and nano-scale manufacturing of discrete parts and assembled products made of metallic and non-metallic engineering materials. {Also offered for undergraduate credit - see IME 437.}.

**IME 640. Engineering Economy. 2-4 Credits.**

Capital investment decision foundation within the rules of general and project accounting. Analysis of benefits and returns against cost for engineering installation, operation, life cycle, and buy-rent-lease decisions. Prereq: Junior standing or IME major. {Also offered for undergraduate credit - see IME 440.}.

**IME 650. Systems Engineering and Management. 3 Credits.**

Integration of technical disciplines through the stages of systems life cycle: needs and requirements determination, operating and support concepts, design and prototyping, test and evaluation, facilitation, manuals, training, and supportability. {Also offered for undergraduate credit - see IME 450.}.

**IME 651. Logistics Engineering and Management. 3 Credits.**

This course emphasizes integrated logistics management methods to improve the effectiveness and efficiency of material flow, information flow and cash flow for the entire supply chains. {Also offered for undergraduate credit - see IME 451.}.

**IME 653. Hospital Management Engineering. 3 Credits.**

Survey of management engineering roles in the delivery of health care. Review of functional relationships present in health care delivery systems. Application of industrial engineering tools to solve health care delivery problems focused on cost reduction, process redesign, facility design, quality improvement, and systems integration. Prereq: Core IME courses. {Also offered for undergraduate credit - see IME 453.}.

**IME 656. Program and Project Management. 3 Credits.**

Integrated approaches to managing engineering, technology and business projects, addressing the project management lifecycle including initiating, planning, executing, controlling and closing. Additional topics include program management, portfolio management, and applying principles in a business environment. {Also offered for undergraduate credit - see IME 456.}.

**IME 660. Evaluation of Engineering Data. 3 Credits.**

Design of engineering experiments and evaluations, curve fitting, regression, hypothesis testing, ANOVA, Taguchi methods in engineering design. {Also offered for undergraduate credit - see IME 460.}.

**IME 661. Quality Assurance and Control. 3-4 Credits.**

Proactive and reactive quality assurance and control techniques; emphasis on quality planning, statistical process control, acceptance sampling, and total quality management. Issues in reliability and maintainability engineering. Prereq: IME 660. {Also offered for undergraduate credit - see IME 461.}.

**IME 662. Total Quality In Industrial Management. 3 Credits.**

The meaning and means for achieving 'total quality' in all dimensions of industrial activities and organizations. Topics include continuous improvement, statistical process control, leadership, and training. {Also offered for undergraduate credit - see IME 462.}.

**IME 663. Reliability Engineering. 3 Credits.**

Study and application of statistical models and methods for defining, measuring and evaluating reliability of products, processes and services: life distributions, reliability functions, reliability configurations, reliability estimation, parametric reliability models, accelerated life testing, reliability improvement. Prereq: IME 660. {Also offered for undergraduate credit - see IME 463.}.

**IME 664. Reliability Analysis. 3 Credits.**

System modeling and analysis, designing for reliability, reliability testing, reliability in manufacturing, and reliability management, fault tree analysis, RBD, and cut sets are covered along with sneak circuits, time-on-test plots and acceptance testing. Prereq: IME 660 and IME 663. {Also available for undergraduate credit - See IME 464.}.

**IME 670. Operations Research I. 3 Credits.**

Techniques to optimize and analyze industrial operations. Use of linear programming, transportation models, networks, integer programming, goal programming, dynamic programming, and non-linear programming. {Also offered for undergraduate credit - see IME 470.}.

**IME 672. Simulation of Business and Industrial Systems. 3 Credits.**

Development of the fundamentals and techniques of simulating business and industrial systems. Monte-Carlo techniques and computer usage. Prereq: IME 660, high-level computer language. {Also offered for undergraduate credit - see IME 472.}.

**IME 680. Production and Inventory Control. 3 Credits.**

Planning and controlling of industrial production and inventory: demand forecasting, master scheduling, materials requirements planning, job scheduling, assembly line balancing, and just-in-time production. Prereq: IME 660. {Also offered for undergraduate credit - see IME 480.}.

**IME 682. Automated Manufacturing Systems. 3 Credits.**

Design of integrated production systems including flexible, programmed automatic control for fabrication, assembly, packaging, movement, and storage. Numerical control, flexible manufacturing systems, and computer integrated manufacturing. 2 recitations, 1 two-hour laboratory. {Also offered for undergraduate credit - see IME 482.}.

**IME 685. Industrial and Manufacturing Facility Design. 3 Credits.**

Capstone integration of analysis and design tools to convert product design into production plans and plants. Prereq: Senior standing. {Also offered for undergraduate credit - see IME 485.}.

**IME 690. Graduate Seminar. 1-3 Credits.****IME 696. Special Topics. 1-5 Credits.****IME 765. Data Analysis. 3 Credits.**

Applications oriented. Topics include: statistical estimation, hypothesis testing, non-parametric methods, design of experiments, factorial experiments, response surface methodology, regression analysis, time series analysis and forecasting, multivariate methods, statistical control charts. Prereq: IME 660.

**IME 770. Quantitative Modeling. 3 Credits.**

Applications modeling and optimization methods. Domains: transportation, logistics, manufacturing, service systems scheduling, and supply-chain management. Decision models: linear programming and sensitivity analysis, transportation and assignment, network models and algorithms, and integer, dynamic and nonlinear programming. Cross-listed with ENGR 770.

**IME 771. Probabilistic and Deterministic Methods. 3 Credits.**

Applications modeling. Domains include transportation, logistics, manufacturing, service systems scheduling, and supply-chain management. Quantitative models and tools include Markov chains, stochastic processes, queuing, deterministic and stochastic decision analysis, time series, forecasting, and regression modeling. Prereq: IME 660. Cross-listed with ENGR 771.

**IME 774. Neural Networks. 3 Credits.**

Introduction to the parallel processing paradigms that have been developed recently including neuronetworks and genetic algorithms. Students will work on projects using these tools. Prereq: CSCI 724. Cross-listed with PSYC 774 and CSCI 735.

**IME 775. Data Driven and Sensor Based Modeling. 3 Credits.**

This course introduces the foundations and advancements in a series of topics related to sensor-based and data-driven methods for modeling, predicting and controlling complex systems. The investigated complex systems are considered as nonlinear, dynamic, multi-scale in space and time, high-dimensional, with the underlying patterns that could be characterized and modeled for sensing, prediction, estimation, and control. The topics include dimensionality reduction and transforms, data representation and analysis, and system dynamics.

**IME 780. Advanced Production and Inventory Control. 3 Credits.**

Study of the theory and applications of production scheduling, inventory management, production planning, just-in-time production, and materials requirement planning. Prereq: IME 680. F (even years).

**IME 790. Graduate Seminar. 1-3 Credits.****IME 791. Temporary/Trial Topics. 1-5 Credits.****IME 793. Individual Study/Tutorial. 1-5 Credits.****IME 795. Field Experience. 1-15 Credits.****IME 796. Special Topics. 1-5 Credits.****IME 797. Master's Paper. 1-3 Credits.****IME 798. Master's Thesis. 1-10 Credits.****IME 899. Doctoral Dissertation. 1-15 Credits.**