Industrial Engineering (I E)

Courses primarily for undergraduates:

I E 101. Industrial Engineering Profession.  
Cr. R. F.S.  
(1-0) Introduces students to the industrial engineering profession, its scope, industrial engineering tools, and future trends.

I E 148. Information Engineering.  
(2-2) Cr. 3. F.S. Prereq: Credit or enrollment in MATH 142  

(3-0) Cr. 3. S. Prereq: I E 248; credit or enrollment in I E 271.  
Study of system improvement methods and strategies. Specific areas of lean system improvements include continuous improvement, setup reduction, workplace organization, inventory and waste minimization. Methods and strategies to analyze and quantify the impact of changes.

(2-2) Cr. 3. F. Prereq: MATH 166 and PHYS 221. Credit or enrollment in I E 101 and MAT E 273.  
Introduction to metrology, engineering drawings and specifications. Engineering methods for designing and improving systems. Theory, applications, and quality issues related to machining processes.

(3-0) Cr. 3. S. Prereq: PHYS 221  
Basic concepts of ergonomics and work design. Their impact on worker and workplace productivity, and cost. Investigations of work physiology, biomechanics, anthropometry, work methods, and their measurement as they relate to the design of human-machine systems.

I E 296. Cooperative Education.  
Cr. R. F.S.S. Prereq: Permission of department and Engineering Career Services  
First professional work period in the cooperative education program. Students must register for this course before commencing work.

I E 305. Engineering Economic Analysis.  
(3-0) Cr. 3. F.S.S.S. Prereq: MATH 166  
Economic analysis of engineering decisions under uncertainty. Financial engineering basics including time value of money, cash flow estimation, and asset evaluation. Make versus buy decisions. Comparison of project alternatives accounting for taxation, depreciation, inflation, and risk. Nonmajor graduate credit.

I E 312. Optimization.  
(3-0) Cr. 3. F. Prereq: Credit or enrollment in MATH 267.  
Concepts, optimization and analysis techniques, and applications of operations research. Formulation of mathematical models for systems, concepts, and methods of improving search, linear programming and sensitivity analysis, network models, and integer programming. Nonmajor graduate credit.

I E 341. Production Systems.  
(3-0) Cr. 3. F. Prereq: STAT 231; credit or enrollment in I E 312  
Introduction of key concepts in the design and analysis of production systems. Topics include inventory control, forecasting, material requirement planning, project planning and scheduling, operations scheduling, and other production systems such as Just-In-Time (JIT) warehousing, and global supply chains. Nonmajor graduate credit.

I E 348. Solidification Processes.  
(2-2) Cr. 3. S. Prereq: I E 248 and Mat E 273.  
Theory and applications related to metal casting, welding, polymer processing, powder metallurgy, and composites manufacturing. Nonmajor graduate credit.

(Cross-listed with STAT). (2-2) Cr. 3. F.S. Prereq: STAT 231, STAT 301, STAT 326 or STAT 401  

I E 396. Summer Internship.  
Cr. R. Repeatable. SS. Prereq: Permission of department and Engineering Career Services  
Summer professional work period.

I E 397. Engineering Internship.  
Cr. R. Repeatable. F.S. Prereq: Permission of department and Engineering Career Services  
Professional work period for a maximum of one semester per academic year. Offered on a satisfactory-fail basis only.

I E 398. Cooperative Education.  
Cr. R. F.S.S.S. Prereq: I E 298, permission of department and Engineering Career Services  
Second professional work period in the cooperative education program. Students must register for this course before commencing work. Offered on a satisfactory-fail basis only.

I E 403. Introduction to Sustainable Production Systems.  
(Dual-listed with I E 503). (3-0) Cr. 3. Alt. S., offered 2013. Prereq: Credit or enrollment in I E 341.  
Quantitative introduction of sustainability concepts in production planning and inventory control. Review of material recovery (recycling) and product/component recovery (remanufacturing) from productivity perspectives. Sustainability rubrics ranging from design and process to systems. Application to multi-echelon supply networks subject to forward/backward flow of material and information. Closed-loop supply chains. Comparative study of sustainable vs. traditional models for local and global production systems.

I E 413. Stochastic Modeling, Analysis and Simulation.  
(4-0) Cr. 4. F. Prereq: MATH 267, STAT 231  
Development and analysis of simulation models using a simulation language. Application to various areas of manufacturing and service systems such as assembly, material handling, and customer queues. Utilizing model output to make important business decisions. Fitting of data to statistical distributions. Introduction to Markov processes and other queueing models. Nonmajor graduate credit.

I E 441. Industrial Engineering Design.  
(1-6) Cr. 3. F.S. Prereq: I E 248, I E 271, I E 361; credit or enrollment in I E 341, I E 413, and I E 448  
A large, open-ended design project related to an enterprise. Application of engineering design principles including problem definition, analysis, synthesis, and evaluation. Nonmajor graduate credit.

I E 446. Geometric Variability in Manufacturing.  
(3-0) Cr. 3. Alt. S., offered 2013. Prereq: I E 348, or MAT E 216, or M E 324  
Assessment, accommodation, and control of geometric variability of manufacturing processes. Use of CMMs, vision and scanning systems, and profilometers. Techniques to successfully accommodate variation through design of product, tooling or process plan including plastic injection molding, metalcasting, welding, machining, powder metallurgy. Methodologies to control geometric variability.

(3-0) Cr. 3. S. Prereq: I E 248, I E 303  
Fixturing and tooling requirements for manufacturing process planning, geometric dimensioning and tolerancing, computer aided inspection, cellular and flexible manufacturing, and facility layout. Lean manufacturing principles and controlled flow production. Nonmajor graduate credit.

(Dual-listed with I E 546). (3-0) Cr. 3. Alt. F., offered 2012. Prereq: Prereq: I E 248 or similar manufacturing engineering course, MATH 265.  
Representation and interpretation of curves, surfaces and solids. Parametric curves and surfaces and solid modeling. Use of CAD software and CAD/CAM integration. Computer numerical control, CNC programming languages, and process planning.

I E 450. Technical Sales for Engineers I.  
(3-0) Cr. 3. F. Prereq: Credit or enrollment in I E 305  
Sales process methodology, techniques for building professional relationships, sales automation software, prospecting and account development, market analysis and segmentation, responding to RFQ’s and RFP’s in written and verbal form. Developing technical value propositions and competitive positioning, evaluating organizational decision processes and people, technical marketing strategies, sales closing strategies. Nonmajor graduate credit.
I E 451. Technical Sales for Engineers II.  
(3-0) Cr. 3. S. Prereq: I E 450  
Case studies and experiential exercises on the development and application of technical sales strategies. Specific topics include developing pricing and distribution strategies, managing a sales staff and channel, developing sales teams and global sales plans, bid and negotiation strategies, time management skills, and implementing sales automation technologies. Nonmajor graduate credit.

I E 466. Multidisciplinary Engineering Design.  
(Cross-listed with A E, AER E, CPR E, E E, ENGR, M E, MAT E). (1-4) Cr. 3. Repeatable. F.S. Prereq: Student must be within two semesters of graduation and receive permission of instructor  
Application of team design concepts to projects of a multidisciplinary nature. Concurrent treatment of design, manufacturing, and life cycle considerations. Application of design tools such as CAD, CAM, and FEM. Design methodologies, project scheduling, cost estimating, quality control, manufacturing processes. Development of a prototype and appropriate documentation in the form of written reports, oral presentations and computer models and engineering drawings.

I E 467. Multidisciplinary Engineering Design II.  
(Cross-listed with A E, AER E, CPR E, E E, ENGR, M E, M E). (1-4) Cr. 3. Repeatable, maximum of 5 times. F.S. Prereq: Student must be within two semesters of graduation or receive permission of instructor  
Build and test of a conceptual design. Detail design, manufacturability, test criteria and procedures. Application of design tools such as CAD and CAM and manufacturing techniques such as rapid prototyping. Development and testing of a full-scale prototype with appropriate documentation in the form of design journals, written reports, oral presentations and computer models and engineering drawings.

I E 481. e-Commerce Systems Engineering.  
(Dual-listed with I E 581). (3-0) Cr. 3. Alt. F., offered 2012. Prereq: I E 148  
Design, analysis, and implementation of e-commerce systems. Information infrastructure, enterprise models, enterprise processes, enterprise views. Data structures and algorithms used in e-commerce systems, SQL, exchange protocols, client/server model, web-based views.

I E 483. Knowledge Discovery and Data Mining.  
(Dual-listed with I E 583). (3-0) Cr. 3. Alt. F., offered 2012. Prereq: I E 148, I E 312, and STAT 231  
Introduction to data warehouses and knowledge discovery techniques. Advanced topics include web-mining and mining of multimedia data. Case studies from both manufacturing and service industries. A computing project is required. Nonmajor graduate credit.

I E 490. Independent Study.  
Cr. 1-5. Repeatable. Prereq: Senior classification, permission of instructor  
Independent study and work in the areas of industrial engineering design, practice, or research.

I E 490A. Independent Study: Manufacturing.  
Cr. 1-5. Repeatable. Prereq: Senior classification, permission of instructor  
Independent study and work in the areas of industrial engineering design, practice, or research.

Cr. 1-5. Repeatable. Prereq: Senior classification, permission of instructor  
Independent study and work in the areas of industrial engineering design, practice, or research.

Cr. 1-5. Repeatable. Prereq: Senior classification, permission of instructor  
Independent study and work in the areas of industrial engineering design, practice, or research.

I E 490D. Independent Study: Enterprise Computing and Information Management.  
Cr. 1-5. Repeatable. Prereq: Senior classification, permission of instructor  
Independent study and work in the areas of industrial engineering design, practice, or research.

Cr. 1-5. Repeatable. Prereq: Senior classification, permission of instructor  
Independent study and work in the areas of industrial engineering design, practice, or research.

I E 490H. Independent Study: Honors.  
Cr. 1-5. Repeatable. Prereq: Senior classification, permission of instructor  
Independent study and work in the areas of industrial engineering design, practice, or research.

I E 498. Cooperative Education.  
Cr. R. Repeatable. F.S.SS. Prereq: I E 298, permission of department and Engineering Career Services  
Third and subsequent professional work periods in the cooperative education program. Students must register for this course before commencing work. Offered on a satisfactory-fail basis only.

Courses primarily for graduate students, open to qualified undergraduates:

Cr. R. Repeatable.  
Principles and practices for research tasks at the M.S. level including proposal writing, presentations, paper preparation, and project management.

I E 503. Introduction to Sustainable Production Systems.  
(Dual-listed with I E 403). (3-0) Cr. 3. Alt. S., offered 2013. Prereq: Credit or enrollment in I E 341  
Quantitative introduction of sustainability concepts in production planning and inventory control. Review of material recovery (recycling) and product/component recovery (remanufacturing) from productivity perspectives. Sustainability rubrics ranging from design and process to systems. Application to multi-echelon networks subject to forward/backward flow of material and information. Closed-loop supply chains. Comparative study of sustainable vs. traditional models for local and global production systems. A course project is required for graduate credit.

(3-0) Cr. 3. Prereq: I E 312 or MATH 307  
Market-based allocation mechanisms from quantitative economic systems perspective. Pricing and costing models designed and analyzed with respect to decentralized decision processes, information requirements, and coordination. Financial Engineering Techniques. Case studies and examples from industries such as regulated utilities, semiconductor manufacturers, and financial engineering services.

I E 510. Network Analysis.  
(3-0) Cr. 3. Prereq: I E 312  
Formulation and solution of deterministic network flow problems including shortest path, minimum cost flow, and maximum flow. Network and graph formulations of combinatorial problems including assignment, matching, and spanning trees. Introduction to deterministic and stochastic dynamic programming.

(3-0) Cr. 3. Prereq: STAT 231  
Introduction to modeling and analysis of manufacturing and service systems subject to uncertainty. Topics include the Poisson process, renewal processes, Markov chains, and Brownian motion. Applications to inventory systems, production system design, production scheduling, reliability, and capacity planning.

I E 514. Production Scheduling.  
(3-0) Cr. 3. Prereq: I E 312, I E 341  
Introduction to the theory of machine shop systems. Complexity results for various systems such as job, flow and open shops. Applications of linear programming, integer programming, network analysis. Enumerative methods for machine sequencing. Introduction to stochastic scheduling.

I E 519. Simulation Modeling and Analysis.  
(3-0) Cr. 3. Prereq: COM S 311, STAT 401  
Event scheduling, process interaction, and continuous modeling techniques. Probability and statistics related to simulation parameters including run length, inference, design of experiments, variance reduction, and stopping rules. Aspects of simulation languages.

I E 531. Quality Control and Engineering Statistics.  
(Cross-listed with STAT). (3-0) Cr. 3. Alt. S., offered 2013. Prereq: STAT 401; STAT 342 or STAT 447  
Wu. Statistical methods and theory applicable to problems of industrial process monitoring and improvement. Statistical issues in industrial measurement; Shewhart, CUSUM, and other control charts; feedback control; process characterization studies; estimation of product and process characteristics; acceptance sampling, continuous sampling and sequential sampling; economic and decision theoretic arguments in industrial statistics.
I E 533. Reliability.  
(Cross-listed with STAT). (3-0) Cr. 3. Alt. S., offered 2014. Prereq: STAT 342 or STAT 432 or STAT 447  
Meeker. Probabilistic modeling and inference in engineering reliability; lifetime models, product limit estimator, probability plotting, maximum likelihood estimation forensored data, Bayesian methods in reliability, system reliability models, competing risk analysis, acceleration models and analysis of accelerated test data; analysis ofrecurrence data; planning studies to obtain reliability data.

I E 534. Linear Programming.  
(3-0) Cr. 3. Prereq: I E 312  

I E 537. Reliability and Safety Engineering.  
(3-0) Cr. 3. Prereq: STAT 231 or STAT 401  

I E 541. Inventory Control and Production Planning.  
(3-0) Cr. 3. Prereq: I E 341  
Economic Order Quantity, dynamic lot sizing, newsboy, base stock, and (Q,r) models. Material Requirements Planning, Just-In-Time (JIT) variability in production systems, push and pull production systems, aggregate and workforce planning, and capacity management. Supply Chain Contracts.

(3-0) Cr. 3. Alt. S., offered 2014. Prereq: Undergraduate engineering degree or permission of instructor.  
Materials, processes and systems required to produce the major components (blades, towers, nacelles) of megawatt scale wind turbines. Transportation, manufacturing siting and procurement decisions as it relates to these large components in an expanding industry.

I E 545. Rapid Prototyping and Manufacturing.  
(3-0) Cr. 3. Prereq: I E 248 or similar manufacturing engineering course, MATH 265. Undergraduates: Permission of instructor.  
Introduction to rapid prototyping processes and other rapid manufacturing methodologies. Operating principles and characteristics of current and developing rapid prototyping processes. Use of rapid prototypes in product design, development, and service. Selection of rapid prototyping systems based on rapid methodologies used in manufacturing processes and rapid tooling approaches.

I E 546. Geometric Variability in Manufacturing.  
(Dual-listed with I E 446). (3-0) Cr. 3. Alt. S., offered 2013. Prereq: I E 348, or MATH 216, or M E 324  
Assessment, accommodation, and control of geometric variability of manufacturing processes. Use of CMMs, vision and scanning systems, and profilometers. Techniques to successfully accommodate variation through design of product, tooling or process plan including plastic injection molding, metalcasting, welding, machining, powder metallurgy. Methodologies to control geometric variability.

(Dual-listed with I E 449). (3-0) Cr. 3. Alt. F., offered 2012. Prereq: Prereq: I E 248 or similar manufacturing engineering course, MATH 265.  
Representation and interpretation of curves, surfaces and solids. Parametric curves and surfaces and solid modeling. Use of CAD software and CAD/CAM integration. Computer numerical control, CNC programming languages, and process planning.

(3-0) Cr. 3. Prereq: I E 361  
Methods for continuous quality improvement in process analysis. The systems analysis for process improvement model based on W. Edwards Deming. Quality function deployment methods. Case studies of applications to manufacturing and other heavy industries. Use of process analysis computerized programs and tools for design analysis.

I E 565. Systems Engineering and Analysis.  
(Cross-listed with AER E, E E). (3-0) Cr. 3. Prereq: Coursework in basic statistics  
Introduction to organized multidisciplinary approach to designing and developing systems. Concepts, principles, and practice of systems engineering as applied to large integrated systems. Life cycle costing, scheduling, risk management, functional analysis, conceptual and detail design, test and evaluation, and systems engineering planning and organization. Not available for degrees in industrial engineering.

(3-0) Cr. 3. Prereq I E 565  
Design for reliability, maintainability, usability, supportability, producibility, disposability, and life cycle costs in the context of the systems engineering process. Students will be required to apply the principles of systems engineering to a project including proposal, program plan, systems engineering management plan, and test and evaluation plan. Not available for degrees in industrial engineering.

I E 570. Systems Engineering and Project Management.  
(3-0) Cr. 3. Prereq: Coursework in basic statistics  
Systems view of projects and the processes by which they are implemented. Focuses on qualitative and quantitative tools and techniques of project management. Specific systems concepts, methodologies, and tools for effective management of both simple and complex projects. Introduction of important performance parameters for planning, cost control, scheduling, and productivity, including discussions of traditional and state of the art tools and systems.

I E 571. Occupational Biomechanics.  
(3-0) Cr. 3. Prereq: E M 274, STAT 231  

(3-0) Cr. 3. Prereq: I E 577  
Human factors methods applied to interface design, prototyping, and evaluation. Concepts related to understanding user characteristics, usability analysis, methods and techniques for design and evaluation of the interface. The evaluation and design of the information presentation characteristics of a wide variety of interfaces: web sites (e-commerce), computer games, information presentation systems (cockpits, instrumentation, etc.), and desktop virtual reality.

(3-0) Cr. 3. Prereq: I E 577  
Investigation of the human interface to consumer and industrial systems and products, providing a basis for their design and evaluation. Discussions of human factors in the product design process: modeling the human during product use; usability; human factors methods in product design evaluation; user-device interface; safety, warnings, and instructions for products; considerations for human factors in the design of products for international use.

I E 577. Human Factors.  
(3-0) Cr. 3. Prereq: I E 271, STAT 231 or STAT 401  
Physical and psychological factors affecting human performance in systems. Signal detection theory, human reliability modeling, information theory, and performance shaping applied to safety, reliability, productivity, stress reduction, training, and human/device interface design. Laboratory assignments related to system design and operation.

I E 581. e-Commerce Systems Engineering.  
(Dual-listed with I E 481). (3-0) Cr. 3. Alt. F., offered 2012. Prereq: I E 148  
Design, analysis, and implementation of e-commerce systems. Information infrastructure, enterprise models, enterprise processes, enterprise views. Data structures and algorithms used in e-commerce systems. SQL exchange protocols, client/server model, web-based views.

I E 582. Enterprise Modeling and Integration.  
(3-0) Cr. 3. Prereq: 3 credits in information technology or information systems  
The design and analysis of enterprise models to support information engineering of enterprise-wide systems. Representation of system behavior and structure including process modeling, information modeling, and conceptual modeling. Applications in enterprise application integration, enterprise resource planning systems, product data management systems, and manufacturing execution systems.

I E 583. Knowledge Discovery and Data Mining.  
(Dual-listed with I E 483). (3-0) Cr. 3. Alt. F., offered 2012. Prereq: I E 148, I E 312, and STAT 231  
Introduction to data warehouses and knowledge discovery. Techniques for data mining, including probabilistic and statistical methods, genetic algorithms and neural networks, visualization techniques, and mathematical programming. Advanced topics include web-mining and mining of multimedia data. Case studies from both manufacturing and service industries. A computing project and an additional project with more theoretical content are required.
I E 585. Requirements Engineering.
(3-0) Cr. 3. Prereq: 3 credits in information technology or information systems
Principles and practices for requirements engineering as part of the product
development process with emphasis on software systems engineering. Problem
definition, problem analysis, requirements analysis, requirements elicitation,
validation, specifications. Case studies using requirements engineering methods
and techniques.

I E 588. Information Systems for Manufacturing.
(3-0) Cr. 3. Prereq: I E 148, I E 448
Design and implementation of systems for the collection, maintenance, and
usage of information needed for manufacturing operations, such as process
control, quality, process definition, production definitions, inventory, and plant
maintenance. Topics include interfacing with multiple data sources, methods
to utilize the information to improve the process, system architectures, and
maintaining adequate and accurate data for entities internal and external to the
enterprise to achieve best manufacturing practices.

I E 590. Special Topics.
Cr. 1-3. Repeatable.
Advanced study of a research topic in the field of industrial engineering.

I E 599. Creative Component.
Cr. arr. Repeatable.

I E 599A. Creative Component: Industrial Engineering.
Cr. arr. Repeatable.

Cr. arr. Repeatable.

Courses for graduate students:
Cr. R. Repeatable.
Principles and practices for conducting research at the Ph.D. level, including
problem definition, proposal writing, presentations, conference proceedings, paper
preparation, and project management.

(3-0) Cr. 3. Prereq: I E 513
Modeling techniques to evaluate performance and address issues in design,
control, and operation of systems. Markov models of single-stage make-to-order
and make-to-stock systems. Approximations for non-Markovian systems. Impact
of variability on flow lines. Open and closed queuing networks.

(3-0) Cr. 3. Prereq: I E 534
Develop nonlinear models, convex sets and functions, optimality conditions,
Lagrangian duality, unconstrained minimization techniques. Constrained
minimization techniques covering penalty and barrier functions, sequential
quadraic programming, the reduced gradient method.

I E 632. Integer Programming.
(3-0) Cr. 3. Prereq: I E 534
Integer programming including cutting planes, branch and bound, and Lagrangian
relaxation. Introduction to complexity issues and search-based heuristics.

I E 634. Computational Optimization.
(3-0) Cr. 3. Alt. S., offered 2014. Prereq: I E 534 or equivalent.
Theory, algorithm, and computer implementation of optimization models. Simplex,
Benders decomposition, computational complexity, mixed integer linear program,
linear program with complementarity constraints, inverse optimization, bilevel
discrete optimization. CPLEX, Matlab, and Tomlab will be used for computer
implementation.

I E 642. Simultaneous Engineering in Manufacturing Systems.
(3-0) Cr. 3. Prereq: I E 549 or M E 415
Current engineering methods for the product life cycle process. Feature-based
design, computer-aided process planning, and data-driven product engineering.

(3-0) Cr. 3. Repeatable. Prereq: I E 571 or I E 577
Ergonomics research topic development, literature evaluation, experimental
design, use of bioinstrumentation, data collection, basic data interpretation,
statistical analysis, manuscript preparation.

I E 690. Advanced Topics.
Cr. 1-3. Repeatable. Prereq: Permission of the instructor
Advanced topics related to Ph.D. research in industrial engineering under the
direction of the instructor.