

IND E 513 Linear Optimization Models in Engineering (3) *Ghate, Zabinsky*

Advanced formulation techniques to expand applications of linear programming to large-scale models. Appreciation of role of optimization models in engineering applications through introduction of techniques such as decomposition. Individual engineering projects. Prerequisite: IND E 410 and MATH 308 or permission of instructor.

IND E 515 Fundamentals of Optimization (5)

Maximization and minimization of functions of finitely many variables subject to constraints. Basic problem types and examples of applications; linear, convex, smooth, and non-smooth programming. Optimality conditions. Saddlepoints and dual problems. Penalties, decomposition. Overview of computational approaches. Prerequisite: linear algebra and advanced calculus. Offered: jointly with AMATH 515/MATH 515.

IND E 516 Applications of Optimization in Engineering Design (3) *Zabinsky*

Discussion of issues arising in applications of optimization to engineering design. Emphasis on formulating problems and selecting appropriate solution techniques. Random search methods for problems otherwise computationally intractable. Individual projects in engineering optimal design. Prerequisite: AMATH/MATH/IND E 515 and MATH 328 or permission of instructor. Offered: jointly with AMATH 510.

IND E 518 Seminar on Advances in Manufacturing and Management (1) *Ramulu*

Current topics and advances made in manufacturing and management. Topics presented by invited speakers from academia and industry. Emphasis on the multidisciplinary nature of manufacturing and management. Offered: jointly with ME 518. Offered: AWP.

IND E 521 Quality Control in Manufacturing (3) *Mastrangelo*

Design of quality control systems in manufacturing. Use of advanced statistical process controls, sampling inspection techniques, process capability, and other statistical tools. Also included are vendor sourcing and control tools, methods for establishing specifications and tolerances, quality function deployment, and other quality control techniques. Prerequisite: graduate standing.

IND E 524 Robust Design and Quality Engineering (3) *Kapur*

Introduction to robust design and quality engineering. Applications of design of experiments for product and process design optimization. Experimental design using orthogonal arrays and linear graphs. System models using Chebyshev's orthogonal polynomials. Robustness in design and quality improvement for complex systems including Taguchi methods for quality engineering. Prerequisite: 316 or equivalent.

IND E 526 Reliability in Product Design and Testing (3) *Kapur*

Product assurance including reliability and quality engineering. Reliability design, measurement, and optimization. Advanced topics in probabilistic design. Design of reliability test plans and analysis of test data. Design of reliability programs and their management. Prerequisite: graduate standing.

IND E 531 Computer Integrated Manufacturing (3)

Design and analysis of advanced manufacturing systems from a strategic as well as technological perspective. Focus on information generation, management, and coordination aspects of complex manufacturing organizations. Examination of system integration alternatives and consequences for relationships with customers and suppliers. Joint with ME 505.

IND E 532 Geometric Modeling (3)

Mathematics and computations in geometric modeling of three-dimensional objects. Parametric representation of curves and surfaces. Topology for data structure design. Visibility for line-of-sight computations.

IND E 535 Engineering Simulation (3) *Beamon*

Advanced applications of discrete event, continuous, and combined discrete-continuous simulation modeling, detailed examination of fundamental computer programming concepts underlying the design and development of simulation languages, variance reduction techniques, and output analysis for various engineering, service systems, and manufacturing applications. Prerequisite: 424 or equivalent.

IND E 537 Introduction to Manufacturing Systems (3) Storch

Description of manufacturing systems. Includes discussion of current trends in manufacturing, especially lean principles. Introduces process flow analysis, manufacturing organizations including job-shop, assembly lines, and group technology, manufacturing inventory philosophies (just-in-time, MRP, OPT), work environment, and work simplification. Offered: jointly with ENV H 537; A.

IND E 538 Large Assembly Manufacturing Systems (3) Storch

Presents principles of group technology, zone construction, product-oriented work breakdown structure. Application to shipbuilding, aircraft, rail-car, and truck manufacture. Techniques of production planning, scheduling and control, organization, and plant layout, as well as the role of the computer, are studied in detail. Prerequisite: graduate standing.

IND E 543 Virtual Interface Technology (1/3, max. 3) Furness

Explores advanced concepts and technologies for interfacing humans to complex machines, with focus on virtual interfaces. Interface design principles reviewed from psychological and technological perspectives. Hardware, software, and mindware aspects of virtual interfaces investigated. Applications postulated and designed. Prerequisite: graduate standing in College of Engineering or permission of instructor.

IND E 544 Virtual World Development (3) Furness

Software implementation, physiological and cognitive constraints, and the mathematics and philosophy of inclusion. Development of software tools, editing and interaction techniques, disposition of virtual world entities, nature of space, situated knowledge, divergent models for multiple participants, experiential mathematics, cyberspace. Cultural, legal, moral, ethical issues. Prerequisite: 543 or permission of instructor.

IND E 545 User-centered Design (4) Turns

Students work to design or redesign a product or process in order to enhance the user's experience. Course focuses on how characteristics of an audience (e.g., knowledge, goals, psychological state) impact the effectiveness of communication. Explores various ways that information about users can be infused into the design process. Prerequisite: graduate standing. Offered: jointly with T C 518

IND E 551 Elements of Dynamic Enterprise Modeling (3)

Introduces practical techniques for modeling, analyzing, and implementing real-time enterprise control systems in application areas such as manufacturing, supply chain flow control, and logistics decision schemas. Uses basic mathematical tools supported with a symbolic algebra software tool. Requires basic computer skills. Offered: A.

IND E 552 Introduction to Real-Time Enterprise Control (3)

Provides students with principles, designs, techniques and algorithms for synthesizing real-time control of enterprise processes, using hybrid systems theory. Application areas include supply chain flow control, logistics decision schemas, transportation systems, dynamic reconciliation procedures, minimum cost production, and maximum profit price/ordering strategies. Prerequisite: IND E 551, or permission of instructor. Offered: W.

IND E 553 Modeling and Automation of Enterprise Processes (3)

Third course in a three-course sequence. Provides architecture, algorithms and procedures for designing and implementing enterprise control policies for automating and enhancing enterprise functionality. Emphasis on hybrid system theories. Prerequisite: IND E 552, or permission of instructor. Offered: Sp.

IND E 564 Recognition of Health and Safety Problems in Industry (4)

Develops skills in occupational health and safety hazard recognition in a variety of important northwest industries. Focuses on process understanding and hazard recognition skills during walk-through inspections of several local facilities, stressing a multidisciplinary approach. Offered: jointly with ENV H 564.

IND E 566 Introduction to Ergonomics (3)

Basic principles of ergonomics in work environment applied to problems of worker and management. Topics include measurement of physical work capacity, problems of fatigue and heat stress, applied biomechanics, worker-machine interactions and communication, design of displays and controls. Prerequisite: basic human physiology or permission of instructor. Offered: jointly with ENV H 566 & NSG 508; odd years. Offered: Sp.

IND E 567 Applied Occupational Health & Safety (3)

Application of occupational safety and health ergonomic principles through a field project and classroom discussions. Student teams perform evaluations, assess production methods/processes and exposures, health and safety procedures and

programs, and develop engineering and administrative controls. Students simulate consulting with a local company including budgeting, project reporting, and presentation. Prerequisite: ENV H 453, ENV H 562, ENV H 566, or equivalent, or permission of instructor. Offered: jointly with ENV H 559 and NSG 505. Offered: Sp.

IND E 569 Occupational Biomechanics (4)

Lectures and laboratories address human occupational biomechanical and physiological limits and measurement, analysis, and modeling techniques that are used by ergonomists for design of safe, healthful, and productive physical work.

Prerequisite: IND E 566 or permission of instructor. Offered: jointly with ENV H 569, even years. Offered: Sp.

IND E 570 Supply Chain Systems (3) *Beamon*

Develops concepts related to the design, evaluation, and performance of supply chain systems through an exploration of contemporary practice and research, focusing on current issues, analytical frameworks, and case studies. Prerequisite: IND E 315 or equivalent.

IND E 591, 592, 593 Seminar (1,1,1) Credit/no credit only.

Prerequisite: graduate standing in Industrial Engineering or permission of instructor.

IND E 599 Special Topics in Industrial Engineering (1-5, max. 9)

IND E 600 Independent Study or Research (1-10) Credit/no credit only.

IND E 700 Master's Thesis (1-10) Credit/no credit only.

IND E 800 Doctoral Dissertation (1-10) Credit/no credit only.

Revised 08/06/07