# IE 101 Introduction to Industrial Engineering 3-0-0-3- 3

Basic industrial engineering concepts to include systems optimization, variability in systems, and production systems. Student teams engage in design projects that require the integration of several concepts.

# ISE 292 Bivariate Introduction to Industrial Engineering and Operations Research 2-0-0-2 (3)

Constrained Optimization, Human Factors, Data Analytics, Queues and Chains, and Linear Programming. The course will focus on two-dimensional, i.e., bivariate, examples like dieting, scheduling, and transportation where the problems and methods are based on visualization and geometric intuition

# IE 223 Financial and Managerial Accounting for Engineers 2-2-0-3(4)

Basics of financial accounting. Preparation of balance sheet, income statement and flow of funds statement. Inventory valuation and depreciation methods. Basics of accounting. Definition of costs. Absorption cost techniques, with an emphasis on allocation of overhead in manufacturing organizations. Budgeting. Variance Analysis. Cost-Volume-Profit Analysis. Pricing decisions, special decisions based on incremental analysis.

# IE 215 Operations Research I 3-2-0-4(5)

Modeling and algorithms for optimization of linear constrained optimization problems. The simplex method; theorems of duality; complementary slackness. Applications in production planning and resource allocation. Graph and network problems as linear programs with integer solutions. Algorithms for selected network flow problems. Transportation and logistics problems. Dynamic programming and its role in applications to shortest paths, project management and equipment replacement.

# IE 233 Probability and Risk Analysis for Engineers 2-0-3(4)

Random variables and their applications, intuition about randomness and variability in the real world. Application examples may include reliability, risk analysis, inventory and logistics, computer communications, service systems

# MATH 205  Analytic Geometry and Multivariable Calculus 3-2-0-4(6)

Parametric equations and polar coordinates. Vectors in 2- and 3-dimensional Euclidean spaces. Partial derivatives. Multiple integrals. Vector calculus. Theorems of Green, Gauss, and Stokes.

# IE 212 Logistics Network Design and Supply Chain Management 3-2-0-4(4)

Quantitative and qualitative issues in the integrated design and management of the logistics network. Models and solution techniques for facility location and logistics network design, qualitative issues in distribution network structuring, centralized versus decentralized network control, variability

# IE 226 Operations Research II 3-2-0-4(5)

Introduction to stochastic processes, Discrete-time Markov chains, Mean first passage times, Steady-state analysis, Basics of queueing theory, Types of queues, Deterministic and stochastic dynamic programming.

# MATH 216 Introduction to Mathematical Economics 2-2-0 3(5)

Applications of mathematics to economic theory, Rates of change, tangent, derivative, accumulation, area, integrals in specific contexts, particularly economics. Techniques of differentiation and integration. Application to problem solving. Optimization.

# IE 224 Computer Aided Engineering Graphics 2-0-2-3(4)

Introduction to the study of orthographic projections, technical sketching, engineering drawing, the language of graphics, an introduction to AutoCAD

# IE 326 Discrete Event Simulation 3-0-2-4(6)

Introductory course on design, programming, and statistical analysis of a simulation study. Topics include the types of problems that can be solved by such methods. Programming material includes the theory behind random variable generation for a variety of common variables. Techniques to reduce the variance of the resultant estimator and statistical analysis are considered.

# IE 333  Challenge Lab 0-0-4-2(2)

This course is meant for students who seek a challenging, interactive, team-based, and hands-on learning experience in entrepreneurship and technology. Students work in simulated start-up teams to create products or start-up ideas to address a broadly-defined need of an industry partner or social challenge

# IE 322 Systems Analysis and Design Project 3-0-0-3(5)

Applications of operations research and engineering methods in public or in the private sector, project assignments to detailed analysis and re-designed by student groups.

# IE 407 Production Systems Analysis 3-0-2-4(4)

Quantitative models for operational and tactical decision making in production systems, including production planning, inventory control, forecasting, and scheduling.

# IE 413 Statistical Quality Control 3-2-0-4(6)

Basic statistical techniques such as parameter estimation, hypothesis testing, regression analysis, analysis of variance. Applications in forecasting and quality control.

# IE 422 Industrial Design and Human Factors (Ergonomics) 2-.2-0-3(4)

The design of products and interfaces ranging from alarm clocks, cell phones, medical devices and dashboards to logos, presentations, and web sites. Design of such systems requires familiarity with human factors and ergonomics, including the physics and perception of color, sound, and touch, as well as familiarity with case studies and contemporary practices in interface design and usability testing. Students will solve a series of design problems individually and in teams.

# Departmental Electives (3-0-0-3) (5)

# IE 212 Thermodynamics

The zeroth, first and second laws to basic thermodynamic properties, like energy, temperature, and entropy, and interactions like work and heat, interpret entropy change and entropy production and the related terms isentropic and reversible, solve problems by applying the first and second law of thermodynamics

# IE 214 Reliability Engineering and System Safety

Introduction and Fundamentals of Risk and Reliability Engineering, Risk Management Process Mathematics for risk analysis: Basic probabilities, combined probabilities, Qualitative Reliability Analysis, Failure mode, effects, and criticality analysis, Hazard and operability study, Reliability, Availability, Maintainability and Safety Analysis, Risk Control and Decision Support Systems, Failure Consequences, Introduction to Stochastic Modelling Using at Risk

# IE 216 Project Management for Engineers

Project management principles and methodology with special focus on planning, controlling, and coordinating individual and group efforts, contracts, procurement management, and quality management, as well as hands-on lab instructions of Microsoft Project

# IE 228 Supply Chain Management

The designing and managing complex global supply chains, global supply design design, logistics and sourcing, supply chain inventory models, postponement, supply integration, and contracts. Discusses the interrelation between supply chain management and product design

# IE 229 Decision Analytics

Systematic evaluation of decision-making problems under uncertainty. Emphasis on the formulation, analysis, and use of decision-making techniques in engineering, operations research and systems analysis. Includes formulation of risk problems and probabilistic risk assessments. Graphical methods and computer software using event trees, decision trees, and influence diagrams that focus on model design.

# IE 232 Production and Inventory Systems

Mathematical and computer methods for design, planning, scheduling, and control in manufacturing and distribution systems.

# IE 307 Integer Programming and Combinatorial Optimization

Discrete optimization problems and their complexity. These topics include complexity analysis of algorithms and its drawbacks; solving a system of linear integer equations and inequalities; strongly polynomial algorithms, network flow problems (including matching and branching); polyhedral optimization; branch and bound and lagrangean relaxation

# IE 311 Systems and Control

Introduction to linear systems, transfer functions, and Laplace transforms. It covers stability and feedback, and provides basic design tools for specifications of transient response. It also briefly covers frequency-domain techniques.

# IE 312 Human Resources Management

The designs of systems of rewards, assessment, and manpower development. The interaction of selection, placement, training, personnel evaluation, and career ladders within an on-going organization. Role of the staff manager. Introduction of change. Implications of behavioral research for management problems and policies.

# IE 314 Predictive Analysis

Parametric regression and classification models, modern nonparametric models, simple linear regression and correlation, multiple regression, binomial and multinomial logistic regression and classification, Discriminant analysis, generalized linear models; Poisson regression for count data and Cox regression for censored survival data, fitting models using medium to large data sets, but the underlying theory will also be covered. R will be the primary software but Minitab will also be used.

# IE 316 Decision Making in Health Services

Decision making in health services administration by use of case studies, the study of decisions facing all types of health care organizations

# IE 317 Organizational Behaviour

Human behavior in a variety of organizations. Conceptual frameworks, case discussions, and skill-oriented activities are applied to each topic. Topics include communications, motivation, group dynamics, leadership, power, and organizational design and development. Class sessions and assignments

# IE 318 Applied Occupational Health and Safety

# IE 319 Computer Integrated Manufacturing (CIM)

Computer Modeling, CNC Equipment, CAM Software, Robotics, and Flexible Manufacturing Systems.

# IE 333 Data Science and Analytics

Critical concepts and skills in computer programming and statistical inference, in conjunction with hands-on analysis of real-world datasets, including economic data, document collections, geographical data, and social networks.

# IE 334 Technology Firm Leadership

Entrepreneurship, team building, having a vision, values, ethics, negotiations, communications, power and influence, culture, risk, change, and other related leadership issues

# IE 337 Principles of Programmable Automation

Concepts, principles, and relationships of automated assembly devices, computer aided drafting/design (CADD), computer-aided manufacturing (CAM), industrial robots, numerical control (NC), industrial lasers, programmable logic controllers (PLCs), automated guided vehicles (AGVs), flexible manufacturing systems (FMS), and computer- integrated manufacturing (CIM).

# IE 338 Production and Inventory Systems

Mathematical and computer methods for design, planning, scheduling, and control in manufacturing and distribution systems.

# IE 350 Large Assembly Manufacturing Systems

Integration of production with information and communication technologies. Digitisation, automation, human-machine interaction as well as better networked Industry 4.0 production systems, modern factory planning, the digital supply chain, mobile robots for flexible intralogistics, additive manufacturing (3D printing), assembly robotics, and the ergonomic design of human-machine interaction.

# IE 401 Elements of Dynamic Enterprise Modeling

# IE 402 Portfolio and Risk Analytics

Computational methods such as variants of GARCH, Black-Litterman, conic optimization, Monte Carlo simulation for risk and optimization, factor modeling. Students will undertake computational assignments and a group project.

# IE 408 Reliability in Product Design and Testing

Principles of reliability with emphasis on the problem of quantifying reliability in product design and testing, the reliability point of views: reliability metric, customer perception, and things engineers do, reliability cycle, the functional activities in the design for reliability process.

# IE 410 Nonlinear Dynamical Systems

Stability and bifurcations, chaos; routes to chaos and universality; approximations by maps; strange attractors; fractals. Techniques for analyzing nonlinear systems are introduced with applications to physical, chemical, and biological systems such as forced oscillators, chaotic reactions, and population dynamics.

# IE 411 Introduction to Systems Dynamics

Introduction to systems thinking and system dynamics modeling applied to strategy, organizational change, and policy design, simulation models, management flight simulators, and case studies to develop conceptual and modeling skills for the design and management of high-performance organizations in a dynamic world. Case studies of successful applications of system dynamics in growth strategy, management of technology, operations, supply chains, product development, and others

# IE 412 Game Theory

An introduction to game theory and strategic thinking. Ideas such as dominance, backward induction, Nash equilibrium, evolutionary stability, commitment, credibility, asymmetric information, adverse selection, and signaling are discussed and applied to games played in class and to examples drawn from economics, politics, the movies, and elsewhere

# IE 413 Current Readings in Innovation Engineering

Survey current and classic research on innovation and help formulate their research designs. Readings are drawn from economics, organizations, and other social sciences, and engineering and data science research on analyzing large data sets. Students develop research designs and present each week and formally for their final.

# IE 414 Network Flows and Graphs

Survey of solution techniques and problems that have formulations in terms of flows in networks. Max-flow min-cut theorem. Minimum cost flows. Multiterminal and multicommodity flows. Relationship with linear programming, transportation problems, electrical networks and critical path scheduling.

# IE 421 Robotics

An introduction to the kinematics, dynamics, and control of robot manipulators, robotic vision, and sensing. The course will cover forward and inverse kinematics of serial chain manipulators, the manipulator Jacobian, force relations, dynamics and control-position, and force control. Proximity, tactile, and force sensing. Network modeling, stability, and fidelity in teleoperation and medical applications of robotics.

# IE 424 Design in Industrial Engineering

IE 426 Nonlinear and Discrete Optimization

This course introduces unconstrained and constrained optimization with continuous and discrete domains. Convex sets and convex functions; local optimality; KKT conditions; Lagrangian duality; steepest descent and Newton's method. Modeling with integer variables; branch-and-bound method; cutting planes. Models on production/inventory planning, logistics, portfolio optimization, factor modeling, classification with support vector machines

# IE 443 Special Topics in Industrial Engineering

# IE 445 Advanced Queuing Theory

Networks of queues(reversibility, output theorem, tandem networks, partial balance, product-form distribution, blocking, insensitivity, BCMP networks, mean-value analysis, Norton's theorem,sojourn times), Analytical-numerical techniques (matrix-analytical methods, compensation method, error bound method, approximate decomposition method), Polling systems(cycle times, queue lengths, waiting times, conservation laws, service policies, visit orders)

# IE 446 Production and Inventory Systems

Mathematical and computer methods for design, planning, scheduling, and control in manufacturing and distribution systems.

# IE 447 Dynamic Production Theory and Planning Models

Development of dynamic activity analysis models for production planning and scheduling. Relationship to theory of production, inventory theory and hierarchical organization of production management.