

Operations Research and Industrial Engineering (ORI)

ORI 119S, 219S, 319S, 419S, 519S, 619S, 719S, 819S, 919S Topics in Operations Research and Industrial Engineering 1-9 Hours
This course is used to record credit the student earns while enrolled at another institution in a program administered by the University's Study Abroad Office. Credit is recorded as assigned by the study abroad adviser in the Department of Mechanical Engineering. University credit is awarded for work in an exchange program; it may be counted as coursework taken in residence. Transfer credit is awarded for work in an affiliated studies program.

ORI 129S, 229S, 329S, 429S, 529S, 629S, 729S, 829S, 929S Topics in Operations Research and Industrial Engineering 1-9 Hours
This course is used to record credit the student earns while enrolled at another institution in a program administered by the University's Study Abroad Office. Credit is recorded as assigned by the study abroad adviser in the Department of Mechanical Engineering. University credit is awarded for work in an exchange program; it may be counted as coursework taken in residence. Transfer credit is awarded for work in an affiliated studies program.

ORI 365 Data Science for Engineers 3 Hours
Learn data analysis and programming skills. Explore essential data science techniques, including regression, decision trees, classification, and neural networks.

ORI 366 Operations Research Models 3 Hours
Formulation and solution-interpretation for operations research models requiring, for example, optimization, simulation, or analysis of Markov chains or queues. Applications include manufacturing design and control, routing and scheduling, plant location, inventory analysis, and management of queueing systems.

ORI 367 Simulation Modeling 3 Hours
Basic concepts of discrete-event simulation. Statistical input and output analysis. Application of simulation software. Modeling of systems under uncertainty.

ORI 369 Decision Analysis 3 Hours
Principles and application of techniques for the logical illumination of complex decision problems within any context. Subjects may include utility theory, probability as a statement of belief, risk preference, value of information and control, probability assessment, influence diagrams, risk sharing and scaling, and life-and-death decision making.

ORI 370 Statistical Methods in Manufacturing 3 Hours
Contemporary concepts and methods for statistical quality design and control will be presented. These include: descriptive statistics, behavior of process over time, design and interpretation of control charts, process capability studies, measurement system analysis, correlation and regression analysis, design and analysis of two level factorial experiments, design and analysis of two level fractional factorial experiments, response surface methodology, and Taguchi approach to robust design.

ORI 373 Facility Planning and Logistics 3 Hours
Design and analysis of production systems, including plant layout and location, material flow, and flexible manufacturing.

ORI 374 Production and Inventory Management 3 Hours
Introduction to production and inventory models; basic factory dynamics; analysis of variability; push-and-pull production control; sequencing and dispatching.

ORI 177K, 277K, 377K Projects in Operations Research and Industrial Engineering 1-3 Hours
Independent project carried out under the supervision of a faculty member in operations research & industrial engineering. Student prepares a project proposal and a final report, each of which is evaluated by the faculty committee on individual projects.

ORI 180M, 280M, 380M, 680M, 980M Research 1,2,3,6,9 Hours

ORI 383 Healthcare Delivery Models 3 Hours
Study the operations research literature on the use of models and techniques related to healthcare delivery. Discuss decomposition techniques for integer programs, simulation, Markov chains, and stochastic programming.

ORI 384 Emerging Trends in Operations Research and Industrial Engineering 3 Hours
Explore the development and use of operations research and industrial engineering techniques via weekly presentations and speakers, including faculty and visiting experts.

ORI 390D Topics in Analytics and Decision Making 3 Hours
Discuss the tools and concepts to enable quantitative analysis and to support decisions under uncertainty.

ORI 390D.1 Analytics and Data Science 3 Hours
Examine theory and methods to draw inferences from data and apply these insights to support decision making in uncertain environments.

ORI 390D.2 Decision Analysis 3 Hours
Examine the theory and principles required to make good decisions in the face of uncertainty. Discuss expected utility theory, families of utility functions, Bayesian inference, value of information, probability elicitation, scoring rules, and the verification of probabilistic forecasts. Explore how these apply to areas including engineering, business, public policy, healthcare, and sports.

ORI 390D.3 Decision Engineering 3 Hours
Examine the tools, methods, and processes required to apply decision analysis to applied problems. Explore creativity, framing, ideation, modeling, approximations, and decision biases that can degrade decision making.

ORI 390D.4 Decision Theory 3 Hours
Explore the fundamental axioms supporting decision analysis and challenges to this approach. Examine behavioral decision making, subjective probability, alternative approaches to decision making, and advanced decision analytic tools.

ORI 390D.5 Markov Decision Processes 3 Hours
Discuss the theory and application of Markov decision processes. Examine finite horizon models, average-cost and discounted-cost infinite horizon problems, discrete-time and continuous-time frameworks. Explore approximate dynamic programming, reinforcement learning, and stochastic bandit problems.

ORI 390D.6 Systems Modeling and Decision Making 3 Hours
Explore the application of operations research, decision analysis, economics, and management science tools and concepts to the modeling of human-designed and natural systems with the goal of improving decisions that involve these systems. Examine models that integrate engineering, economics, natural science, and policy.

ORI 390Q Topics in Industrial Engineering 3 Hours
Industrial engineering techniques for quantitative solution of contemporary systems and management problems.

ORI 390Q.1 Project Management 3 Hours

Methods for organizing, coordinating, and controlling resources to minimize risk and conflict and to maintain budgets and schedules. Topics include evaluation of competing alternatives, organization of a project, scheduling of tasks and resources, and the role of management over time.

ORI 390Q.10 Logistics Analytics 3 Hours

Discuss strategic, tactical, and operational logistics decision making; exact and heuristic methods for logistics problems; optimization models; deterministic and stochastic logistics modeling; network design and routing; manufacturing, service, and transportation logistics; applications. Explore freight logistics, humanitarian logistics and disaster management.

ORI 390Q.2 Production and Inventory Control 3 Hours

Issues in inventory control with known and unknown demand, materials requirement planning, just-in-time, pull control systems, operations scheduling, dispatching and aggregate planning, and the basic dynamics of production and inventory control.

ORI 390Q.4 Modeling and Analysis of Manufacturing Systems 3 Hours

Applications of analysis to manufacturing processes, using mathematical models, optimization, and stochastic analysis. Economic evaluation, identification of bottlenecks, estimation of resources requirements, and system design.

ORI 390Q.5 Scheduling Theory and Applications 3 Hours

Modeling, analysis, and solution techniques for production and service scheduling problems, machine scheduling in deterministic and stochastic settings, exact and heuristic algorithms, and industrial applications, including semiconductor manufacturing and airlines applications.

ORI 390Q.7 Statistical Methods in Manufacturing 3 Hours

Statistical monitoring of manufacturing processes; methods and applications of various control charts; formal design of experiments (DOE), including the statistical evaluation of main and interaction effects, as well as intelligent experimentation through reduced factorial experimental design; Taguchi's design philosophy as applied to response surface methods and gradient-based search techniques; and advanced issues in quality control and design of manufacturing systems.

ORI 390Q.9 Analytics and Control in Semiconductor Manufacturing 3 Hours

Learn key data analytics and process control methods for turning metrology and sensing data into useful information and decisions in semiconductor manufacturing. Explore applications of statistical models for statistical process control, as well as applications of dynamic models for virtual metrology and run-to-run control in semiconductor manufacturing systems.

ORI 390R Topics in Statistics and Probability 3 Hours

Concepts of probability and mathematical statistics; application of these analytical methods to planning and evaluation of research and industrial experimentation.

ORI 390R.1 Applied Probability 3 Hours

Basic probability theory, combinatorial analysis of random phenomena, conditional probability and independence, parametric families of distributions, expectation, distribution of functions of random variables, limit theorems.

ORI 390R.14 Special Topics in Probability, Stochastic Processes, and Statistics 3 Hours

Study of specialized topics, such as advanced stochastic processes, Bayesian statistics, simulation, and stochastic optimization, intended to introduce and stimulate further research.

ORI 390R.2 Mathematical Statistics 3 Hours

Sampling distributions, properties of estimators, point and interval estimation, hypothesis testing, introduction to multivariate and nonparametric statistics.

ORI 390R.3 Time-Series Modeling, Analysis, and Control 3 Hours

Methods for analytical modeling, analysis, prediction, and control of linear, stationary time series. Includes examples of advanced research in nonstationary time-series modeling and applications in manufacturing, financial engineering, geosciences, and other areas. Students complete a project on a topic of their choice.

ORI 390R.4 Reliability Theory and Modeling 3 Hours

Theory of probabilistic and statistical models of aging elements, reliability, replacement, and repair maintenance, and their integration in surveillance, quality control, and manufacturing problems.

ORI 390R.5 Applied Stochastic Processes 3 Hours

Poisson process, renewal theory, discrete and continuous-time Markov chains, queueing and reliability applications.

ORI 390R.6 Regression and Analysis of Variance 3 Hours

Fitting equations to data; joint confidence regions; partial correlation analysis; general linear hypotheses; dummy variables; diagnostics and remedial measures; design of experiments; fixed, random, and mixed models; factorial and nested designs.

ORI 390R.8 Queueing Theory 3 Hours

Introduction to the classical and modern theories of queueing systems. Simple Markovian queues; the M/G/1 and G/G/1 queues; Jackson and Kelly networks; multiclass networks; stability, scheduling, and routing in queueing networks; fluid and diffusion approximations.

ORI 390R.9 Systems Simulation 3 Hours

Random number generation, simulation experiments, statistical verification, clock routines, simulation language applications, industrial problems.

ORI 391Q Topics in Optimization 3 Hours

Mathematical optimization techniques with applications to engineering and industrial problems.

ORI 391Q.1 Nonlinear Programming 3 Hours

Theory and solution techniques for nonlinear, continuous optimization problems. Topological properties of functions, general convexity, optimality conditions, line search methods, unconstrained techniques, and algorithms for constrained formulations. Lagrangian duality theory and bundle methods for nondifferentiable optimization.

ORI 391Q.10 Stochastic Optimization 3 Hours

Optimization of mathematical programming models under uncertainty; model formulations; exact, bounding-and-approximation, and Monte Carlo sampling-based solution techniques that exploit special structures; applications; use of algebraic modeling language.

ORI 391Q.11 Advanced Mathematical Programming 3 Hours

Advanced topics in modeling and algorithms for linear, integer, nonlinear, and network programming. Model formulation considerations, decomposition algorithms, interior point and active set methods, duality, modern optimization software.

ORI 391Q.12 Metaheuristics 3 Hours

Reactive and adaptive tabu search methods, simulated annealing, genetic algorithms, and greedy randomized adaptive search methods. Emphasis on theoretical context of methods and on similarities and distinguishing characteristics.

ORI 391Q.14 Computational Optimization 3 Hours

Computer programming methods and tools for implementing advanced optimization algorithms, working with data, and visualizing results. Code organization techniques, debugging, and building complex software.

ORI 391Q.15 Convex Optimization 3 Hours

The fundamentals of convex optimization with a focus on modeling, computation and scale: convex sets and functions, unconstrained optimization via first and second-order methods, duality, constrained optimization, SDPs, stochastic and sub-gradient descent methods, ADMMs, and applications.

ORI 391Q.16 Optimization in Engineering Systems 3 Hours

Formulation and solution of continuous optimization problems in engineering design and operations.

ORI 391Q.17 Optimization Under Uncertainty 3 Hours

Introduction to optimization models and methodologies for addressing uncertainty-affected decision problems. Examine fundamental techniques from stochastic programming, robust optimization, and distributionally robust optimization. Explore theory through concrete examples from production planning, supply chain management, project management, portfolio selection, machine learning.

ORI 391Q.18 Computational and Variational Methods for Inverse Problems 3 Hours

Introduction to the numerical solution of inverse problems that are governed by systems of partial differential equations (PDEs). Explore variational formulations, ill-posedness, regularization, adjoint methods for gradients and Hessians, variational discretization, and efficient large-scale optimization algorithms for inverse problems. Examine the Bayesian framework and draw connections between the classical and the Bayesian interpretations of inverse problems.

ORI 391Q.2 Dynamic Programming 3 Hours

Systems that require sequential decisions. Problem modeling and solution algorithms for deterministic and stochastic systems.

ORI 391Q.3 Network Flow Programming 3 Hours

Optimization problems related to network flows, shortest path, maximum flow, minimum cost flow, generalized networks, nonlinear costs. Modeling, theory, and computational methods.

ORI 391Q.4 Integer Programming 3 Hours

Models, theory, and computational methods for problems with discrete decision alternatives. Greedy algorithms, branch and bound, cutting plane methods, Lagrangian relaxation, and heuristics.

ORI 391Q.5 Linear Programming 3 Hours

Models, algorithms, and theory of linear programming. Linear programming geometry, primal, dual and revised simplex algorithms, duality theory, optimality conditions, sensitivity analyses, interior point methods, and computer implementations.

ORI 391Q.6 Algorithms for Mixed Integer Programming 3 Hours

Methods and software for solving large-scale mixed integer programming problems: intelligent heuristics, decomposition, lower bounding schemes, limited enumeration, and simple methods for quickly finding good feasible solutions. Numerous examples taken from industry.

ORI 391Q.8 Combinatorial Optimization 3 Hours

Optimization of combinatorial structures; computational complexity; stable marriages, shortest paths, maximum flows, minimum-cost flows, matching problems; approximation algorithms for NP-hard problems.

ORI 391Q.9 Large-Scale Systems Optimization 3 Hours

Mathematical programs with special structure, Dantzig-Wolfe decomposition, partitioning and relaxation procedures, duality and decomposition, compact inverse methods, applications in engineering and management.

ORI 397 Current Topics in Operations Research and Industrial Engineering 3 Hours

ORI 197K, 297K, 397K Graduate Seminar 1-3 Hours

ORI 397M Graduate Research Internship 3 Hours

Students conduct research in an industrial setting to gain practical experience in their area of interest.

ORI 197P, 297P, 397P Projects in Operations Research and Industrial Engineering 1-3 Hours

Independent project carried out under the supervision of a faculty member in operations research and industrial engineering.

ORI 698 Thesis 6 Hours

ORI 398R Master's Report 3 Hours

Preparation of a report to fulfill the requirement for the master's degree under the report option.

ORI 399W, 699W, 999W Dissertation 3,6,9 Hours