STATISTICS AND OPERATIONS RESEARCH (STOR)

Additional Resources

- Catalog Course Search (https://catalog.unc.edu/course-search/)
- Course Numbering Guide (https://catalog.unc.edu/courses/course-numbering/)
- Scheduled Classes (https://reports.unc.edu/class-search/)
- Historical Course Record (https://reports.unc.edu/historical_course_record/)

Courses

STOR 52. First-Year Seminar: Decisions, Decisions, Decisions. 3 Credits.
In this course, we will investigate the structure of these decision problems, show how they can be solved (at least in principle), and solve some simple problems.

Rules & Requirements

IDEAs in Action Gen Ed: FY-SEMINAR.
Making Connections Gen Ed: QI.
Grading Status: Letter grade.

STOR 53. FYS: Networks: Degrees of Separation and Other Phenomena Relating to Connected Systems. 3 Credits.
Networks, mathematical structures that are composed of nodes and a set of lines joining the nodes, are used to model a wide variety of familiar systems.

Rules & Requirements

IDEAs in Action Gen Ed: FY-SEMINAR.
Making Connections Gen Ed: QI.
Grading Status: Letter grade.

STOR 54. First-Year Seminar: Adventures in Statistics. 3 Credits.
This seminar aims to show that contrary to common belief, statistics can be exciting and fun. The seminar will consist of three modules: statistics in our lives, randomness, and principles of statistical reasoning.

Rules & Requirements

IDEAs in Action Gen Ed: FY-SEMINAR.
Making Connections Gen Ed: QI.
Grading Status: Letter grade.

STOR 55. First-Year Seminar: Risk and Uncertainty in the Real World. 3 Credits.
The aim of this class is to study the role of uncertainty in our daily lives, to explore the cognitive biases that impair us, and to understand how one uses quantitative models to make decisions under uncertainty in a wide array of fields including medicine, law, finance, and the sciences.

Rules & Requirements

IDEAs in Action Gen Ed: FY-SEMINAR.
Making Connections Gen Ed: QI.
Grading Status: Letter grade.

STOR 56. First-Year Seminar: The Art and Science of Decision Making in War and Peace. 3 Credits.
This seminar will use recently assembled historical material to tell the exciting story of the origins and development of operations research during and after World War II.

Rules & Requirements

IDEAs in Action Gen Ed: FY-SEMINAR.
Making Connections Gen Ed: QI.
Grading Status: Letter grade.

STOR 60. First-Year Seminar: Statistical Decision-Making Concepts. 3 Credits.
We will study some basic statistical decision-making procedures and the errors and losses they lead to. We will analyze the effects of randomness on decision making using computer experimentation and physical experiments with real random mechanisms like dice, cards, and so on.

Rules & Requirements

IDEAs in Action Gen Ed: FY-SEMINAR.
Making Connections Gen Ed: QI.
Grading Status: Letter grade.

STOR 61. First-Year Seminar: Statistics for Environmental Change. 3 Credits.
Studies the Environmental Protection Agency's Criteria Document, mandated by the Clean Air Act; this document reviews current scientific evidence concerning airborne particulate matter. Students learn some of the statistical methods used to assess the connections between air pollution and mortality, and prepare reports on studies covered in the Criteria Document.

Rules & Requirements

IDEAs in Action Gen Ed: FY-SEMINAR.
Making Connections Gen Ed: QI.
Grading Status: Letter grade.

STOR 62. First-Year Seminar: Probability and Paradoxes. 3 Credits.
The theory of probability, which can be used to model the uncertainty and chance that exist in the real world, often leads to surprising conclusions and seeming paradoxes. We survey and study these, along with other paradoxes and puzzling situations arising in logic, mathematics, and human behavior.

Rules & Requirements

IDEAs in Action Gen Ed: FY-SEMINAR.
Making Connections Gen Ed: QI.
Grading Status: Letter grade.

STOR 63. FYS: Statistics, Biostatistics, and Bioinformatics: An Introduction to the Ongoing Evolution. 3 Credits.
This course is designed to emphasize the motivation, philosophy, and cultivation of statistical reasoning in the interdisciplinary areas of statistical science and bioinformatics.

Rules & Requirements

IDEAs in Action Gen Ed: FY-SEMINAR.
Making Connections Gen Ed: QI.
Grading Status: Letter grade.

STOR 64. First-Year Seminar: A Random Walk down Wall Street. 3 Credits.
Introduces basic concepts in finance and economics, useful tools for collecting and summarizing financial data, and simple probability models for quantification of market uncertainty.

Rules & Requirements

IDEAs in Action Gen Ed: FY-SEMINAR.
Making Connections Gen Ed: QI.
Grading Status: Letter grade.

STOR 66. First-Year Seminar: Visualizing Data. 3 Credits.
This seminar looks at a variety of ways in which modern computational tools allow easy and informative viewing of data. Students will also study the kinds of choices that have to be made in data presentation and viewing.

Rules & Requirements

IDEAs in Action Gen Ed: FY-SEMINAR.
Making Connections Gen Ed: QI.
Grading Status: Letter grade.

STOR 72. First-Year Seminar: Unlocking the Genetic Code. 3 Credits.
Introduces students to the world of genetics and DNA and to the use of computers to organize and understand the complex systems associated with the structure and dynamics of DNA and heredity.

Rules & Requirements

IDEAs in Action Gen Ed: FY-SEMINAR.
Making Connections Gen Ed: QI.
Grading Status: Letter grade.

STOR 89. First-Year Seminar: Special Topics. 3 Credits.
Special Topics Course. Contents will vary each semester.

Rules & Requirements

IDEAs in Action Gen Ed: FY-SEMINAR.
Grading Status: Letter grade.

STOR 113. Decision Models for Business and Economics. 3 Credits.
An introduction to multivariable quantitative models in economics. Mathematical techniques for formulating and solving optimization and equilibrium problems will be developed, including elementary models under uncertainty.

Rules & Requirements

IDEAs in Action Gen Ed: FC-QUANT.
Making Connections Gen Ed: QR.
Requisites: Prerequisite, MATH 110.
Grading Status: Letter grade.

STOR 115. Reasoning with Data: Navigating a Quantitative World. 3 Credits.
Students will use mathematical and statistical methods to address societal problems, make personal decisions, and reason critically about the world. Authentic contexts may include voting, health and risk, digital humanities, finance, and human behavior. This course does not count as credit towards the psychology or neuroscience majors.

Rules & Requirements

IDEAs in Action Gen Ed: FC-QUANT.
Making Connections Gen Ed: QR.
Grading Status: Letter grade.
Same as: MATH 115, BIOL 115, PSYC 115.

STOR 120. Foundations of Statistics and Data Science. 4 Credits.
The course teaches 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. It delves into social issues surrounding data analysis such as privacy and design.

Rules & Requirements

IDEAs in Action Gen Ed: FY-LAUNCH (only designated sections), FC-QUANT.
Making Connections Gen Ed: QR.
Grading Status: Letter grade.

STOR 151. Introduction to Data Analysis. 3 Credits.
Elementary introduction to statistical reasoning, including sampling, elementary probability, statistical inference, and data analysis. STOR 151 may not be taken for credit by students who have credit for ECON 400 or PSYC 210.

Rules & Requirements

IDEAs in Action Gen Ed: FC-QUANT.
Making Connections Gen Ed: QR.
Requisites: Prerequisite, MATH 110.
Grading Status: Letter grade.

STOR 155. Introduction to Data Models and Inference. 3 Credits.
Data analysis; correlation and regression; sampling and experimental design; basic probability (random variables, expected values, normal and binomial distributions); hypothesis testing and confidence intervals for means, proportions, and regression parameters; use of spreadsheet software.

Rules & Requirements

IDEAs in Action Gen Ed: FY-LAUNCH (only designated sections), FC-QUANT.
Making Connections Gen Ed: QR.
Requisites: Prerequisite, MATH 110.
Grading Status: Letter grade.

STOR 190. Special Topics. 3 Credits.
Examines selected topics from statistics and operations research. Course description is available from the department office.

Rules & Requirements
Repeat Rules: May be repeated for credit. 12 total credits. 4 total completions.
Grading Status: Letter grade.

STOR 215. Foundations of Decision Sciences. 3 Credits.
Introduction to basic concepts and techniques of discrete mathematics with applications to business and social and physical sciences. Topics include logic, sets, functions, combinatorics, discrete probability, graphs, and networks.

Rules & Requirements

IDEAs in Action Gen Ed: FC-QUANT.
Making Connections Gen Ed: QR.
Requisites: Prerequisite, MATH 110.
Grading Status: Letter grade.

STOR 235. Mathematics for Data Science. 4 Credits.
This course introduces students to some of the key mathematical tools underlying algorithmic data science. The primary focus of the course is matrix algebra and multivariable calculus. The mathematical topics covered in the course will be motivated and connected by concrete applications in data science, with an emphasis on machine learning and optimization.

Rules & Requirements

IDEAs in Action Gen Ed: FC-QUANT.
Requisites: Prerequisites, MATH 231 and MATH 232.
Grading Status: Letter grade.
Same as: MATH 235.

STOR 290. Special Topics. 3 Credits.
Examines selected topics from statistics and operations research. Course description is available from the department office.

Rules & Requirements
Repeat Rules: May be repeated for credit. 12 total credits. 4 total completions.
Grading Status: Letter grade.

STOR 291. Undergraduate Learning Assistantship. 1 Credits.
Experience includes preparations, demonstrations, assistance, and attendance at weekly meetings and lab sections. This course will enable you to deepen your understanding of topics in statistics and data science by learning the material with an eye toward explaining it to other less-experienced students, and; develop pedagogical skills, such as developing a rapport with learners, engaging in clear oral and written communication, and taking the perspective of less experienced students.

Rules & Requirements

IDEAs in Action Gen Ed: HI-LEARNTA.
Making Connections Gen Ed: EE - Undergraduate Learning Assistant, ULA.
Requisites: Prerequisite, STOR 120 grade of A- or higher.
Repeat Rules: May be repeated for credit. 7 total credits. 7 total completions.
Grading Status: Pass/Fail.

STOR 305. Introduction to Decision Analytics. 3 Credits.
The use of mathematics to describe and analyze large-scale decision problems. Situations involving the allocation of resources, making decisions in a competitive environment, and dealing with uncertainty are modeled and solved using suitable software packages. Students cannot enroll in STOR 305 if they have already taken STOR 415.

Rules & Requirements

IDEAs in Action Gen Ed: FC-QUANT.
Making Connections Gen Ed: QI.
Requisites: Prerequisite, STOR 120, 155, or MATH 152.
Grading Status: Letter grade.

STOR 315. Discrete Mathematics for Data Science. 4 Credits.
The course gives a solid introduction to rigorous mathematical thinking and problem solving, all of which are fundamental in data science. It covers proofs, mathematical induction, counting, and the basics of graph theory.

Rules & Requirements

IDEAs in Action Gen Ed: FC-QUANT.
Requisites: Prerequisite, MATH 232.
Grading Status: Letter grade.

STOR 320. Introduction to Data Science. 4 Credits.
Development of basic skill set for data analysis from obtaining data to data carpentry, exploration, modeling, and communication. Topics covered include regression, clustering, classification, algorithmic thinking, and non-standard data objects (networks and text data). Students may not receive credit for both STOR 320 and STOR 520.

Rules & Requirements

IDEAs in Action Gen Ed: FC-QUANT, FC-LAB.
Making Connections Gen Ed: QI.
Requisites: Prerequisite, STOR 120 or 155.
Grading Status: Letter grade.

STOR 358. Sample Survey Methodology. 4 Credits.
Fundamental principles and methods of sampling populations, with emphasis on simple, random, stratified, and cluster sampling. Sample weights, nonsampling error, and analysis of data from complex designs are covered. Practical experience through participation in the design, execution, and analysis of a sampling project.

Rules & Requirements
Making Connections Gen Ed: EE- Field Work.
Requisites: Prerequisite, BIOS 650; permission of the instructor for students lacking the prerequisite.
Grading Status: Letter grade.
Same as: BIOS 664.

STOR 390. Special Topics in Statistics and Operations Research. 3 Credits.
Examines selected topics from statistics and operations research. Course description is available from the department office.

Rules & Requirements
Repeat Rules: May be repeated for credit; may be repeated in the same term for different topics; 12 total credits. 4 total completions.
Grading Status: Letter grade.

STOR 415. Introduction to Optimization. 3 Credits.
Linear, integer, nonlinear, and dynamic programming, classical optimization problems, network theory.

Rules & Requirements
Requisites: Prerequisites, MATH 347 and STOR 315, 215 or MATH 381.
Grading Status: Letter grade.

STOR 435. Introduction to Probability. 3 Credits.
Introduction to mathematical theory of probability covering random variables; moments; binomial, Poisson, normal and related distributions; generating functions; sums and sequences of random variables; and statistical applications. Students may not receive credit for both STOR 435 and STOR 535.

Rules & Requirements
Making Connections Gen Ed: QI.
Requisites: Prerequisites, MATH/STOR 235 or MATH 233; and STOR 215 or MATH 381 or COMP 283.
Grading Status: Letter grade.
Same as: MATH 535.

STOR 445. Stochastic Modeling. 3 Credits.
Introduction to Markov chains, Poisson process, continuous-time Markov chains, renewal theory. Applications to queueing systems, inventory, and reliability, with emphasis on systems modeling, design, and control.

Rules & Requirements
Requisites: Prerequisite, BIOS 660, STOR 435 or 535.
Grading Status: Letter grade.

STOR 455. Methods of Data Analysis. 3 Credits.
Review of basic inference; two-sample comparisons; correlation; introduction to matrices; simple and multiple regression (including significance tests, diagnostics, variable selection); analysis of variance; use of statistical software.

Rules & Requirements
Requisites: Prerequisite, STOR 120, or 155.
Grading Status: Letter grade.

STOR 471. Long-Term Actuarial Models. 3 Credits.
Probability models for long-term insurance and pension systems that involve future contingent payments and failure-time random variables. Introduction to survival distributions and measures of interest and annuities-certain.

Rules & Requirements
Making Connections Gen Ed: QI.
Requisites: Prerequisite, STOR 435, or 535.
Grading Status: Letter grade.

STOR 472. Short Term Actuarial Models. 3 Credits.
Short term probability models for potential losses and their applications to both traditional insurance systems and conventional business decisions. Introduction to stochastic process models of solvency requirements.

Rules & Requirements
Requisites: Prerequisite, STOR 435, or 535.
Grading Status: Letter grade.

STOR 475. Healthcare Risk Analytics. 3 Credits.
This course will introduce students to the healthcare industry and provide hands-on experience with key actuarial and analytical concepts that apply across the actuarial field. Using real world situations, the course will focus on how mathematics and the principles of risk management are used to help insurance companies and employers make better decisions regarding employee benefit insurance products and programs.

Rules & Requirements
Requisites: Prerequisite, STOR 435, or 535.
Grading Status: Letter grade.

STOR 490. Special Topics. 3 Credits.
Examines selected topics from statistics and operations research. Course description is available from the department office.

Rules & Requirements
Repeat Rules: May be repeated for credit. 12 total credits. 4 total completions.
Grading Status: Letter grade.

STOR 493. Internship in Statistics and Operations Research. 3 Credits.
Requires permission of the department. Statistics and analytics majors only. An opportunity to obtain credit for an internship related to statistics, operations research, or actuarial science. Pass/Fail only. Does not count toward the statistics and analytics major or minor.

Rules & Requirements
IDEAs in Action Gen Ed: HI-INTERN.
Making Connections Gen Ed: EE- Academic Internship.
Repeat Rules: May be repeated for credit. 6 total credits. 2 total completions.
Grading Status: Pass/Fail.

STOR 496. Undergraduate Reading and Research in Statistics and Operations Research. 1-3 Credits.
Permission of the director of undergraduate studies. This course is intended mainly for students working on honors projects. May be repeated for credit.

Rules & Requirements
IDEAs in Action Gen Ed: RESEARCH.
Making Connections Gen Ed: EE- Mentored Research.
Repeat Rules: May be repeated for credit; may be repeated in the same term for different topics; 6 total credits. 6 total completions.
Grading Status: Letter grade.

STOR 512. Optimization for Machine Learning and Neural Networks. 3 Credits.
This is an upper-level course focusing on optimization aspects of common and practical problems and topics in statistical learning, machine learning, neural networks, and modern AI. It covers several topics such as optimization perspective of linear regression, nonlinear regression, matrix factorization, stochastic gradient descent, regularization techniques, neural networks, deep learning techniques, and minimax models.

Rules & Requirements
Requisites: Prerequisites, STOR 415 or STOR 612; or MATH 233 and MATH 347, or MATH 235, and COMP 110 or COMP 116; or permission of instructor.
Grading Status: Letter grade.

STOR 515. Dynamic Decision Analytics. 3 Credits.
An introduction to algorithms and modeling techniques that use knowledge gained from prior experience to make intelligent decisions in real time. Topics include Markov decision processes, dynamic programming, multiplicative weights update, exploration vs. exploitation, multi-armed bandits, and two player games.

Rules & Requirements
Requisites: Prerequisites, STOR 435 or 535, and MATH 347.
Grading Status: Letter grade.

STOR 520. Statistical Computing for Data Science. 4 Credits.
This course provides hands-on experience working with data sets provided in class and downloaded from certain public websites. Lectures cover basic topics such as R programming, visualization, data wrangling and cleaning, exploratory data analysis, web scraping, data merging, predictive modeling, and elements of machine learning. Programming analyses in more advanced areas of data science. Students may not receive credit for both STOR 320 and STOR 520.

Rules & Requirements
Requisites: Prerequisites, STOR 435 or 535, and STOR 455.
Grading Status: Letter grade.

STOR 535. Probability for Data Science. 3 Credits.
This course is an advanced undergraduate course in probability with the aim to give students the technical and computational tools for advanced courses in data analysis and machine learning. It covers random variables, moments, binomial, Poisson, normal and related distributions, generating functions, sums and sequences of random variables, statistical applications, Markov chains, multivariate normal and prediction analytics. Students may not receive credit for both STOR 435 and STOR 535.

Rules & Requirements
Requisites: Prerequisites, MATH/STOR 235 or MATH 233; and STOR 215 or STOR 315 or MATH 381 or COMP 283.
Grading Status: Letter grade.

STOR 538. Sports Analytics. 3 Credits.
This course will survey the history of sports analytics across multiple areas and challenge students in team-based projects to practice sports analytics. Students will learn how applied statistics and mathematics help decision makers gain competitive advantages for on-field performance and off-field business decisions.

Rules & Requirements
Requisites: Prerequisite, STOR 320 or STOR 455.
Grading Status: Letter grade.

STOR 555. Mathematical Statistics. 3 Credits.
Functions of random samples and their probability distributions, introductory theory of point and interval estimation and hypothesis testing, elementary decision theory.

Rules & Requirements
Requisites: Prerequisite, STOR 435, or 535.
Grading Status: Letter grade.

STOR 556. Time Series Data Analysis. 3 Credits.
This course covers the fundamental theory and methods for time series data, as well as related statistical software and real-world data applications. Topics include the autocorrelation function, estimation and elimination of trend and seasonality, estimation and forecasting procedures in ARMA models and nonstationary time series models.

Rules & Requirements
Requisites: Prerequisites, STOR 435 or 535, and STOR 455.
Grading Status: Letter grade.

STOR 557. Advanced Methods of Data Analysis. 3 Credits.
The course covers advanced data analysis methods beyond those in STOR 455 and how to apply them in a modern computer package, specifically R or R-Studio which are the primary statistical packages for this kind of analysis. Specific topics include (a) Generalized Linear Models; (b) Random Effects; (c) Bayesian Statistics; (d) Nonparametric Methods (kernels, splines and related techniques).

Rules & Requirements
Requisites: Prerequisites, STOR 435 or 535, and STOR 455.
Grading Status: Letter grade.

STOR 565. Machine Learning. 3 Credits.
Introduction to theory and methods of machine learning including classification; Bayes risk/rule, linear discriminant analysis, logistic regression, nearest neighbors, and support vector machines; clustering algorithms; overfitting, estimation error, cross validation.

Rules & Requirements
Requisites: Prerequisites, STOR 215 or MATH 381, and STOR 435 or 535.
Grading Status: Letter grade.

STOR 566. Introduction to Deep Learning. 3 Credits.
Deep neural networks (DNNs) have been widely used for tackling numerous machine learning problems that were once believed to be challenging. With their remarkable ability of fitting training data, DNNs have achieved revolutionary successes in many fields such as computer vision, natural language progressing, and robotics. This is an introduction course to deep learning.

Rules & Requirements
Requisites: Prerequisites, STOR 435 or 535; and COMP 110 or 116.
Grading Status: Letter grade.

STOR 572. Simulation for Analytics. 3 Credits.
This upper-level-undergraduate and beginning-graduate-level course introduces the concepts of modeling, programming, and statistical analysis as they arise in stochastic computer simulations. Topics include modeling static and discrete-event simulations of stochastic systems, random number generation, random variate generation, simulation programming, and statistical analysis of simulation input and output.

Rules & Requirements
Requisites: Prerequisites, STOR 120 or 155, and STOR 435 or 535.
Grading Status: Letter grade.

STOR 590. Special Topics in Statistics and Operations Research. 3 Credits.
Examines selected topics from statistics and operations research. Course description is available from the department office.

Rules & Requirements
Repeat Rules: May be repeated for credit; may be repeated in the same term for different topics; 12 total credits. 4 total completions.
Grading Status: Letter grade.

STOR 612. Foundations of Optimization. 3 Credits.
STOR 612 consists of three major parts: linear programming, quadratic programming, and unconstrained optimization. Topics: Modeling, theory and algorithms for linear programming; modeling, theory and algorithms for quadratic programming; convex sets and functions; first-order and second-order methods such as stochastic gradient methods, accelerated gradient methods and quasi-Newton methods for unconstrained optimization.

Rules & Requirements
Requisites: Prerequisites, MATH 347 and 521 or permission of the instructor.
Grading Status: Letter grade.

STOR 614. Advanced Optimization. 3 Credits.
STOR 614 consists of three major parts: Integer programming, conic programming, and nonlinear optimization. Topics: modeling, theory and algorithms for integer programming; second-order cone and semidefinite programming; theory and algorithms for constrained optimization; dynamic programming; networks.

Rules & Requirements
Requisites: Prerequisite, STOR 612 or equivalent (or permission of instructor).
Grading Status: Letter grade.

STOR 634. Probability I. 3 Credits.
Required preparation, advanced calculus. Lebesgue and abstract measure and integration, convergence theorems, differentiation. Radon-Nikodym theorem, product measures. Fubini theorems. Lp spaces.

Rules & Requirements
Grading Status: Letter grade.

STOR 635. Probability II. 3 Credits.
Foundations of probability. Basic classical theorems. Modes of probabilistic convergence. Central limit problem. Generating functions, characteristic functions. Conditional probability and expectation.

Rules & Requirements
Requisites: Prerequisite, STOR 634; permission of the instructor for students lacking the prerequisite.
Grading Status: Letter grade.
Same as: MATH 635.

STOR 641. Stochastic Modeling I. 3 Credits.
The aim of this 3-credit graduate course is to introduce stochastic modeling that is commonly used in various fields such as operations research, data science, engineering, business, and life sciences. Although it is the first course in a sequence of three courses, it can also serve as a standalone introductory course in stochastic modeling and analysis. The course covers the following topics: discrete-time Markov chains, Poisson processes, and continuous-time Markov chains.

Rules & Requirements
Requisites: Prerequisite, Probability background at the level of STOR 435 or STOR 535.
Grading Status: Letter grade.

STOR 642. Stochastic Modeling II. 3 Credits.
This 3-credit course is the second graduate-level course on stochastic modeling that expands upon the material taught in STOR 641. The course covers the following topics: renewal and regenerative processes, queueing models, and Markov decision processes.

Rules & Requirements
Requisites: Prerequisite, STOR 641.
Grading Status: Letter grade.

STOR 654. Statistical Theory I. 3 Credits.
Required preparation, two semesters of advanced calculus. Probability spaces. Random variables, distributions, expectation. Conditioning. Generating functions. Limit theorems: LLN, CLT, Slutsky, delta-method, big-O in probability. Inequalities. Distribution theory: normal, chi-squared, beta, gamma, Cauchy, other multivariate distributions. Distribution theory for linear models.

Rules & Requirements
Grading Status: Letter grade.

STOR 655. Statistical Theory II. 3 Credits.
Point estimation. Hypothesis testing and confidence sets. Contingency tables, nonparametric goodness-of-fit. Linear model optimality theory: BLUE, MVU, MLE. Multivariate tests. Introduction to decision theory and Bayesian inference.

Rules & Requirements
Requisites: Prerequisite, STOR 654.
Grading Status: Letter grade.

STOR 664. Applied Statistics I. 3 Credits.
Permission of the instructor. Basics of linear models: matrix formulation, least squares, tests. Computing environments: SAS, MATLAB, S +. Visualization: histograms, scatterplots, smoothing, QQ plots. Transformations: log, Box-Cox, etc. Diagnostics and model selection.

Rules & Requirements
Grading Status: Letter grade.

STOR 665. Applied Statistics II. 3 Credits.
ANOVA (including nested and crossed models, multiple comparisons). GLM basics: exponential families, link functions, likelihood, quasi-likelihood, conditional likelihood. Numerical analysis: numerical linear algebra, optimization; GLM diagnostics. Simulation: transformation, rejection, Gibbs sampler.

Rules & Requirements
Requisites: Prerequisite, STOR 664; permission of the instructor for students lacking the prerequisite.
Grading Status: Letter grade.

STOR 672. Simulation Modeling and Analysis. 3 Credits.
Introduces students to modeling, programming, and statistical analysis applicable to computer simulations. Emphasizes statistical analysis of simulation output for decision-making. Focuses on discrete-event simulations and discusses other simulation methodologies such as Monte Carlo and agent-based simulations. Students model, program, and run simulations using specialized software. Familiarity with computer programming recommended.

Rules & Requirements
Requisites: Prerequisites, STOR 555 and 641.
Grading Status: Letter grade.
Same as: COMP 672.

STOR 674. Statistical and Computational Tools for Reproducible Data Science. 3 Credits.
The purpose of this course is to provide a strong foundation in computational skills needed for reproducible research in data science and statistics. Topics will include computational tools and programming skills to facilitate reproducibility, as well as procedures and methods for reproducible conclusions.

Rules & Requirements
Requisites: Prerequisite, STOR 320 or 664.
Grading Status: Letter grade.

STOR 690. Special Topics. 3 Credits.
Examines selected topics from statistics and operations research. Course description is available from the department office.

Rules & Requirements
Repeat Rules: May be repeated for credit. 12 total credits. 4 total completions.
Grading Status: Letter grade.

STOR 691H. Honors in Statistics and Analytics. 3 Credits.
Permission of the department. Majors only. Individual reading, study, or project supervised by a faculty member.

Rules & Requirements
IDEAs in Action Gen Ed: RESEARCH.
Making Connections Gen Ed: EE- Mentored Research.
Grading Status: Letter grade.

STOR 692H. Honors in Statistics and Analytics. 3 Credits.
Permission of the department. Majors only. Individual reading, study, or project supervised by a faculty member.

Rules & Requirements
IDEAs in Action Gen Ed: RESEARCH.
Making Connections Gen Ed: EE- Mentored Research.
Grading Status: Letter grade.

STOR 697. Capstone. 3 Credits.
This course is designed to give Statistics & Analytics (STAN) majors an opportunity to integrate and apply the knowledge and skills acquired throughout the STAN degree. At the beginning of the semester, the instructor will present to the class a broad description of several problems originating from external industry partners, and covering a wide range of statistics, modeling, optimization, and data science topics. Students will work on these problems throughout the remainder of the semester.

Rules & Requirements
IDEAs in Action Gen Ed: COMMBEYOND.
Requisites: Prerequisite, Students are expected to have completed at least 75% of the core requirements for the STAN major.
Grading Status: Letter grade.

STOR 701. Statistics and Operations Research Colloquium. 1 Credits.
This seminar course is intended to give Ph.D. students exposure to cutting edge research topics in statistics and operations research and assist them in their choice of a dissertation topic. The course also provides a forum for students to meet and learn from major researchers in the field.

Rules & Requirements
Repeat Rules: May be repeated for credit. 10 total credits. 10 total completions.
Grading Status: Letter grade.

STOR 702. Seminar in Teaching. 1 Credits.
This seminar course is intended to give Ph.D. students exposure to various issues and pedagogy in teaching statistics and operations research. The course also provides a forum for students to observe and learn from current teaching faculty. Students should register for one credit only. STOR Ph.D. students only.

Rules & Requirements
Repeat Rules: May be repeated for credit. 3 total credits. 3 total completions.
Grading Status: Letter grade.

STOR 712. Optimization for Machine Learning and Data Science. 3 Credits.
This course will provide a detailed and deep treatment for commonly used methods in continuous optimization, with applications in machine learning, statistics, data science, operations research, among others.

Rules & Requirements
Requisites: Prerequisite, STOR 612 or equivalent.
Grading Status: Letter grade.

STOR 713. Mathematical Programming II. 3 Credits.
Advanced theory for nonlinear optimization. Algorithms for unconstrained and constrained problems.

Rules & Requirements
Requisites: Prerequisite, STOR 712; permission of the instructor for students lacking the prerequisite.
Grading Status: Letter grade.

STOR 722. Integer Programming. 3 Credits.
Techniques for formulating and solving discrete valued and combinatorial optimization problems. Topics include enumerative and cutting plane methods, Lagrangian relaxation, Benders' decomposition, knapsack problems, and matching and covering problems.

Rules & Requirements
Requisites: Prerequisite, STOR 614; permission of the instructor for students lacking the prerequisite.
Grading Status: Letter grade.

STOR 734. Stochastic Processes. 3 Credits.
Discrete and continuous parameter Markov chains, Brownian motion, stationary processes.

Rules & Requirements
Requisites: Prerequisite, STOR 435.
Grading Status: Letter grade.

STOR 743. Reinforcement Learning and Markov Decision Processes. 3 Credits.
Markov decision processes (stochastic dynamic programming): finite horizon, infinite horizon, discounted and average-cost criteria; reinforcement learning(RL): design and analysis of model-free, model-based, value-based, and policy-based RL algorithms, RL algorithms in continuous and discrete state and action space, and RL with functional approximation. These algorithms include but are not limited to (deep) Q-learning, asynchronous advantage actor-critic, soft actor-critic, and proximal policy optimization.

Rules & Requirements
Requisites: Prerequisite, STOR 641 or permission of instructor.
Grading Status: Letter grade.

STOR 754. Time Series and Multivariate Analysis. 3 Credits.
Introduction to time series: exploratory analysis, time-domain analysis and ARMA models, Fourier analysis, state space analysis. Introduction to multivariate analysis: principal components, canonical correlation, classification and clustering, dimension reduction.

Rules & Requirements
Requisites: Prerequisites, STOR 435 and 555.
Grading Status: Letter grade.

STOR 755. Estimation, Hypothesis Testing, and Statistical Decision. 3 Credits.
Bayes procedures for estimation and testing. Minimax procedures. Unbiased estimators. Unbiased tests and similar tests. Invariant procedures. Sufficient statistics. Confidence sets. Large sample theory. Statistical decision theory.

Rules & Requirements
Requisites: Prerequisites, STOR 635 and 655.
Grading Status: Letter grade.

STOR 757. Bayesian Statistics and Generalized Linear Models. 3 Credits.
Bayes factors, empirical Bayes theory, applications of generalized linear models.

Rules & Requirements
Requisites: Prerequisite, STOR 555.
Grading Status: Letter grade.

STOR 765. Statistical Consulting. 1.5 Credits.
Application of statistics to real problems presented by researchers from the University and local companies and institutes. (Taught over two semesters for a total of 3 credits.)

Rules & Requirements
Repeat Rules: May be repeated for credit. 3 total credits. 2 total completions.
Grading Status: Letter grade.

STOR 767. Advanced Statistical Machine Learning. 3 Credits.
This is a graduate course on statistical machine learning.

Rules & Requirements
Requisites: Prerequisites, STOR 654, 655, 664, 665 and permission of the instructor.
Grading Status: Letter grade.

STOR 790. Operations Research and Systems Analysis Student Seminar. 1 Credits.
Survey of literature in operations research and systems analysis.

Rules & Requirements
Grading Status: Letter grade.

STOR 822. Topics in Discrete Optimization. 3 Credits.
Topics may include polynomial algorithms, computational complexity, matching and matroid problems, and the traveling salesman problem.

Rules & Requirements
Requisites: Prerequisite, STOR 712; Permission of the instructor for students lacking the prerequisite.
Grading Status: Letter grade.
Same as: COMP 822.

STOR 824. Computational Methods in Mathematical Programming. 3 Credits.
Advanced topics such as interior point methods, parallel algorithms, branch and cut methods, and subgradient optimization.

Rules & Requirements
Requisites: Prerequisite, STOR 712; Permission of the instructor for students lacking the prerequisite.
Grading Status: Letter grade.

STOR 831. Advanced Probability. 3 Credits.
Advanced theoretic course, covering topics selected from weak convergence theory, central limit theorems, laws of large numbers, stable laws, infinitely divisible laws, random walks, martingales.

Rules & Requirements
Requisites: Prerequisites, STOR 634 and 635.
Repeat Rules: May be repeated for credit. 9 total credits. 3 total completions.
Grading Status: Letter grade.

STOR 832. Stochastic Processes. 3 Credits.
Advanced theoretic course including topics selected from foundations of stochastic processes, renewal processes, Markov processes, martingales, point processes.

Rules & Requirements
Requisites: Prerequisites, STOR 634 and 635.
Grading Status: Letter grade.

STOR 834. Extreme Value Theory. 3 Credits.
This course covers both mathematical theory and statistical methodology concerned with extreme values in sequences of random variables. IID theory: the three types of extreme value distributions, statistical methods by block maxima and threshold exceedances. Extensions to dependent stochastic sequences: the extremal index and related concepts. Multivariate and spatial extremes, max-stable process. Applications in: engineering and strength of materials; finance and insurance; environment and climate.

Rules & Requirements
Requisites: Prerequisites, STOR 635 and 654.
Grading Status: Letter grade.

STOR 835. Point Processes. 3 Credits.
Random measures and point processes on general spaces, Poisson and related processes, regularity, compounding. Point processes on the real line stationarity, Palm distributions, Palm-Khintchine formulae. Convergence and related topics.

Rules & Requirements
Requisites: Prerequisite, STOR 635.
Grading Status: Letter grade.

STOR 836. Stochastic Analysis. 3 Credits.
Brownian motion, semimartingale theory, stochastic integrals, stochastic differential equations, diffusions, Girsanov's theorem, connections with elliptic PDE, Feynman-Kac formula. Applications: mathematical finance, stochastic networks, biological modeling.

Rules & Requirements
Requisites: Prerequisites, STOR 634 and 635.
Grading Status: Letter grade.

STOR 854. Statistical Large Sample Theory. 3 Credits.
Asymptotically efficient estimators; maximum likelihood estimators. Asymptotically optimal tests; likelihood ratio tests.

Rules & Requirements
Requisites: Prerequisites, STOR 635 and 655.
Grading Status: Letter grade.

STOR 871. Convex Analysis and Optimization Theory. 3 Credits.
Convex analysis and optimization including sets, functions, basic concepts, minimax theory, duality, and optimality conditions.

Rules & Requirements
Grading Status: Letter grade.

STOR 881. Object Oriented Data Analysis. 1-3 Credits.
Object Oriented Data Analysis (OODA) is the statistical analysis of populations of complex objects. Examples include data sets where the data points could be curves, images, shapes, movies, or tree structured objects.

Rules & Requirements
Grading Status: Letter grade.

STOR 890. Special Problems. 1-3 Credits.
Permission of the instructor.

Rules & Requirements
Repeat Rules: May be repeated for credit.
Grading Status: Letter grade.

STOR 891. Special Problems. 1-3 Credits.
Permission of the instructor.

Rules & Requirements
Repeat Rules: May be repeated for credit; may be repeated in the same term for different topics.
Grading Status: Letter grade.

STOR 892. Special Topics in Operations Research and Systems Analysis. 1-3 Credits.
Permission of the instructor.

Rules & Requirements
Repeat Rules: May be repeated for credit.
Grading Status: Letter grade.

STOR 893. Special Topics. 1-3 Credits.
Advance topics in current research in statistics and operations research.

Rules & Requirements
Repeat Rules: May be repeated for credit; may be repeated in the same term for different topics.
Grading Status: Letter grade.

STOR 894. Special Topics at SAMSI. 3 Credits.
Advanced topics in current research in statistics and operations research. This course is held at SAMSI.

Rules & Requirements
Repeat Rules: May be repeated for credit. 6 total credits. 2 total completions.
Grading Status: Letter grade.

STOR 910. Directed Reading in Statistics and Operations Research. 1-3 Credits.
Students will read selected works under supervision of instructor, and attend discussion meetings. Permission of the instructor.

Rules & Requirements
Repeat Rules: May be repeated for credit. 12 total credits. 12 total completions.
Grading Status: Letter grade.

STOR 930. Advanced Research. 1-3 Credits.
Permission of the instructor.

Rules & Requirements
Grading Status: Letter grade.

STOR 940. Seminar in Theoretical Statistics. 1-3 Credits.
Rules & Requirements
Requisites: Prerequisite, STOR 655.
Repeat Rules: May be repeated for credit.
Grading Status: Letter grade.

STOR 950. Advanced Research. 0.5-21 Credits.
Permission of the instructor.

Rules & Requirements
Grading Status: Letter grade.

STOR 960. Seminar in Theoretical Statistics. 0.5-21 Credits.
Rules & Requirements
Requisites: Prerequisite, STOR 655.
Grading Status: Letter grade.

STOR 970. Practicum. 1-3 Credits.
Students work with other organizations (Industrial/Governmental) to gain practical experience in Statistics and Operations Research.

Rules & Requirements
Repeat Rules: May be repeated for credit.
Grading Status: Letter grade.

STOR 992. Master's (Non-Thesis). 3 Credits.
Permission of instructor.

Rules & Requirements
Repeat Rules: May be repeated for credit.

STOR 994. Doctoral Research and Dissertation. 3 Credits.
Permission of instructor.

Rules & Requirements
Repeat Rules: May be repeated for credit.