STATISTICS (STAT)

Courses

STAT 2600 (4) Introduction to Data Science
Introduces students to importing, tidying, exploring, visualizing, summarizing, and modeling data and then communicating the results of these analyses to answer relevant questions and make decisions. Students will learn how to program in R using reproducible workflows. During weekly lab sessions students will collaborate with their teammates to pose and answer questions using real-world datasets.
Requisites: Requires prerequisite or corequisite of APPM 1350 or APPM 1345 or MATH 1300 (minimum grade C-).
Grading Basis: Letter Grade

STAT 3100 (3) Applied Probability
Studies axioms, counting formulas, conditional probability, independence, random variables, continuous and discrete distribution, expectation, joint distributions, moment generating functions, law of large numbers and the central limit theorem.
Equivalent - Duplicate Degree Credit Not Granted: ECEN 3810 or MATH 4510 APPM 3570
Requisites: Requires a prerequisite or corequisite course of APPM 2350 or APPM 2340 or MATH 2400 (prereq minimum grade C-).

STAT 3400 (3) Applied Regression
Introduces methods, theory, and applications of linear statistical models, covering topics such as estimation, residual diagnostics, goodness of fit, transformations, and various strategies for variable selection and model comparison. Examples will be demonstrated using statistical programming language R.
Requisites: Requires prerequisite STAT 2600 and STAT 3100 or MATH 4510 (all minimum grade C-). Requires corequisite APPM 3310.
Grading Basis: Letter Grade

STAT 4000 (3) Statistical Methods and Application I
Introduces exploratory data analysis, probability theory, statistical inference, and data modeling. Topics include discrete and continuous probability distributions, expectation, laws of large numbers, central limit theorem, statistical parameter estimation, hypothesis testing, and regression analysis. Considerable emphasis on applications in the R programming language.
Equivalent - Duplicate Degree Credit Not Granted: STAT 5000
Requisites: Requires prerequisite APPM 1360 or MATH 2300 (both minimum grade C-).
Grading Basis: Letter Grade

STAT 4010 (3) Statistical Methods and Applications II
Expands upon statistical techniques introduced in STAT 4000. Topics include modern regression analysis, analysis of variance (ANOVA), experimental design, nonparametric methods, and an introduction to Bayesian data analysis. Considerable emphasis on application in the R programming language.
Equivalent - Duplicate Degree Credit Not Granted: STAT 5010
Requisites: Requires prerequisite STAT 4000 (minimum grade C-).
Grading Basis: Letter Grade

STAT 4100 (3) Markov Processes, Queues, and Monte Carlo Simulations
Brief review of conditional probability and expectation followed by a study of Markov chains, both discrete and continuous time, including Poisson point processes. Queuing theory, terminology and single queue systems are studied with some introduction to networks of queues. Uses Monte Carlo simulation of random variables throughout the semester to gain insight into the processes under study.
Equivalent - Duplicate Degree Credit Not Granted: APPM 4560 and APPM 5560
Requisites: Requires prerequisite courses of APPM 3570 or STAT 3100 or MATH 4510 (all minimum grade C-).

STAT 4230 (3) Stochastic Analysis for Finance
Studies mathematical theories and techniques for modeling financial markets. Specific topics include the binomial model, risk neutral pricing, stochastic calculus, connection to partial differential equations and stochastic control theory.
Equivalent - Duplicate Degree Credit Not Granted: APPM 4530, APPM 5530 and STAT 5230
Requisites: Requires prerequisite courses of APPM 3310 and APPM 3570, or STAT 3100, or MATH 4510 (all minimum grade C-).

STAT 4250 (3) Data Assimilation in High Dimensional Dynamical Systems
Develops and analyzes approximate methods of solving the Bayesian inverse problem for high-dimensional dynamical systems. After briefly reviewing mathematical foundations in probability and statistics, the course covers the Kalman filter, particle filters, variational methods and ensemble Kalman filters. The emphasis is on mathematical formulation and analysis of methods.
Equivalent - Duplicate Degree Credit Not Granted: APPM 5510, APPM 4510 and STAT 5250
Requisites: Requires prerequisite courses of APPM 3310 and APPM 3570 or STAT 3100 or MATH 4510 (all minimum grade C-).

STAT 4350 (3) Applied Deep Learning 1
Introduces students to state-of-the-art deep learning techniques employed in the industry. This course will focus on training neural networks and computer vision, including image classification and transformation, object detection, and facial recognition. Advanced topics will include domain adaptation and learning techniques. There will be an emphasis on reading current literature.
Equivalent - Duplicate Degree Credit Not Granted: STAT 5350
Requisites: Requires prerequisite courses of APPM 3570 or STAT 3100 and STAT 3400 or STAT 4520 and APPM 4650 or APPM 4600 (all minimum grade C-).
Recommended: Prerequisite knowledge of Python is required, and familiarity with TensorFlow and PyTorch is a plus but is not a requirement.

STAT 4360 (3) Applied Deep Learning 2
Introduces students to state-of-the-art deep learning techniques employed in the industry. This course will focus on natural language processing, multimodal learning, generative and graph neural networks, speech and music recognition, and reinforcement learning. Students will learn software engineering techniques using Python. There will be an emphasis on reading current literature.
Equivalent - Duplicate Degree Credit Not Granted: STAT 5360
Requisites: Requires prerequisite course of STAT 4350 (minimum grade C-).

STAT 4400 (3) Advanced Statistical Modeling
Introduces methods, theory and applications of modern statistical models, from linear to hierarchical linear models, to generalized hierarchical linear models, including hierarchical logistic and hierarchical count regression models. Topics such as estimation, residual diagnostics, goodness of fit, transformations, and various strategies for variable selection and model comparison will be discussed in depth. Examples will be demonstrated using statistical programming language R.
Equivalent - Duplicate Degree Credit Not Granted: STAT 5400
Requisites: Requires prerequisite STAT 3400 and (STAT 4520 or STAT 5010) (all minimum grade C-).
Grading Basis: Letter Grade

STAT 4430 (3) Spatial Statistics
Introduces the theory of spatial statistics with applications. Topics include basic theory for continuous stochastic processes, spatial prediction and kriging, simulation, geostatistical methods, likelihood and Bayesian approaches, spectral methods and an overview of modern topics such as nonstationary models, hierarchical modeling, multivariate processes, methods for large datasets and connections to splines.
Equivalent - Duplicate Degree Credit Not Granted: STAT 5430
Requisites: Requires prerequisite courses of STAT 3400 AND APPM 3310 (all minimum grade C-).
Recommended: Prerequisites STAT 4520 OR STAT 5520 OR MATH 4520 OR MATH 5520.
Additional Information: Arts Sci Gen Ed: Distribution-Natural Sciences

STAT 4520 (3) Introduction to Mathematical Statistics
Examines point and confidence interval estimation. Principles of maximum likelihood, sufficiency, and completeness: tests of simple and composite hypotheses, linear models, and multiple regression analysis if time permits. Analyzes various distribution-free methods.
Equivalent - Duplicate Degree Credit Not Granted: STAT 5520 and MATH 4520 and MATH 5520
Requisites: Requires prerequisites APPM 3570 or STAT 3100 or MATH 4510 (all minimum grade C-).
Additional Information: Arts Sci Gen Ed: Distribution-Natural Sciences

STAT 4540 (3) Introduction to Time Series
Studies basic properties, trend-based models, seasonal models modeling and forecasting with ARIMA models, spectral analysis and frequency filtration.
Equivalent - Duplicate Degree Credit Not Granted: STAT 5540 and MATH 4540 and MATH 5540
Requisites: Requires prerequisite course of APPM 4520 or STAT 4520 or MATH 4520 (minimum grade C-).
Additional Information: Arts Sci Gen Ed: Distribution-Natural Sciences

STAT 4610 (3) Statistical Learning
Consists of applications and methods of statistical learning. Reviews multiple linear regression and then covers classification, regularization, splines, tree-based methods, support vector machines, unsupervised learning and Gaussian process regression.
Equivalent - Duplicate Degree Credit Not Granted: STAT 5610
Requisites: Requires prerequisite course of STAT 3400 (minimum grade C-).
Additional Information: Arts Sci Gen Ed: Distribution-Natural Sciences

STAT 4630 (3) Computational Bayesian Statistics
Introduces Bayesian statistics, normal and non-normal approximation to likelihood and posteriors, the EM algorithm, data augmentation, and Markov Chain Monte Carlo (MCMC) methods. Additionally, introduces more advanced MCMC algorithms and requires significant statistical computing. Examples from a variety of areas, including biostatistics, environmental sciences, and engineering, will be given throughout the course.
Equivalent - Duplicate Degree Credit Not Granted: STAT 5630
Requisites: Requires prerequisite courses of (APPM 4560 or STAT 4100) and STAT 3400 and (STAT 4520 or MATH 4520) (minimum grade C-).
Recommended: Prerequisite prior programming experience.

STAT 4640 (3) Capstone in Statistics and Data Science
Course provides senior-level and graduate students the opportunity to apply the knowledge, skills, and abilities developed throughout the Statistics and Data Science major. Working in teams, students undertake a data-driven problem presented by domain experts from government, industry, or academia. The course provides valuable real-world experience for students intending to pursue graduate education or technical careers. Topics include team building, problem solving, research methods, project management, data ethics, and clear communication (oral, written, and visual).
Equivalent - Duplicate Degree Credit Not Granted: STAT 5640
Requisites: Requires prerequisite course of STAT 4400 or STAT 4610 (minimum grade C-)
Grading Basis: Letter Grade

STAT 4680 (3) Statistics and Data Science Collaboration
Educates and trains students to become effective interdisciplinary collaborators by developing the communication and collaboration skills necessary to apply technical statistics and data science skills to help domain experts answer research or policy questions. Topics include structuring effective meetings and projects; communicating statistics to non-statisticians; using peer feedback, self-reflection and video analysis to improve collaboration skills; creating reproducible statistical workflows; working ethically.
Equivalent - Duplicate Degree Credit Not Granted: STAT 5680
Requisites: Requires a prerequisite course of STAT 4400 or STAT 4010 (minimum grade C-).
Grading Basis: Letter Grade
Additional Information: Arts Sci Gen Ed: Distribution-Natural Sciences

STAT 4690 (2) Advanced Statistical Collaboration
Educates and trains students to become advanced interdisciplinary collaborators by developing and refining the communication, collaboration and technical statistics and data science skills necessary to collaborate with domain experts to answer research questions. Students work on multiple projects. Discussions center on technical skills necessary to solve research problems and video analysis to improve communication and collaboration skills.
Equivalent - Duplicate Degree Credit Not Granted: STAT 5690
Requisites: Requires prerequisite course of STAT 4680 or STAT 5680 (minimum grade C-).
Grading Basis: Letter Grade
Additional Information: Arts Sci Gen Ed: Distribution-Natural Sciences

STAT 4700 (3) Philosophical and Ethical Issues in Statistics
Introduces students to philosophical issues that arise in statistical theory and practice. Topics include interpretations of probability, philosophical paradigms in statistics, inductive inference, causality, reproducible, and ethical issues arising in statistics and data analysis.
Equivalent - Duplicate Degree Credit Not Granted: STAT 5700
Requisites: Requires prerequisites STAT 4520 or STAT 3400 or STAT 4000 (all minimum grade C-).
Grading Basis: Letter Grade

STAT 4720 (1-3) Open Topics in Statistics and Data Science
Provides a vehicle for the development and presentation of new topics that may be incorporated into the core courses in statistics and data science. Department enforced prerequisite: variable, depending on the topic, see instructor.
Equivalent - Duplicate Degree Credit Not Granted: STAT 5720
Repeatable: Repeatable for up to 15.00 total credit hours. Allows multiple enrollment in term.

STAT 4840 (1-3) Reading and Research in Statistics
Introduces undergraduate students to research in statistics and data science. Department enforced prerequisite: variable depending on the topic.
Repeatable: Repeatable for up to 9.00 total credit hours.

STAT 5000 (3) Statistical Methods and Application I
Introduces exploratory data analysis, probability theory, statistical inference, and data modeling. Topics include discrete and continuous probability distributions, expectation, laws of large numbers, central limit theorem, statistical parameter estimation, hypothesis testing, and regression analysis. Considerable emphasis on applications in the R programming language.
Equivalent - Duplicate Degree Credit Not Granted: STAT 4000
Requisites: Restricted to graduate students only.
Recommended: Prerequisites of APPM 1360 or MATH 2300 or equivalent.
Grading Basis: Letter Grade

STAT 5010 (3) Statistical Methods and Applications II
Expands upon statistical techniques introduced in STAT 4000. Topics include modern regression analysis, analysis of variance (ANOVA), experimental design, nonparametric methods, and an introduction to Bayesian data analysis. Considerable emphasis on application in the R programming language.
Equivalent - Duplicate Degree Credit Not Granted: STAT 4010
Requisites: Requires prerequisite STAT 5000 (minimum grade C-)
Grading Basis: Letter Grade

STAT 5100 (3) Markov Processes, Queues, and Monte Carlo Simulations
Brief review of conditional probability and expectation followed by a study of Markov chains, both discrete and continuous time, including Poisson point processes. Queuing theory, terminology and single queue systems are studied with some introduction to networks of queues. Uses Monte Carlo simulation of random variables throughout the semester to gain insight into the processes under study.
Equivalent - Duplicate Degree Credit Not Granted: APPM 4560, STAT 4100 and APPM 5560
Requisites: Restricted to graduate students only.
Recommended: Prerequisite previous coursework equivalent to that of APPM 3570 or STAT 3100 or MATH 4510, with a minimum grade of C-.

STAT 5230 (3) Stochastic Analysis for Finance
Studies mathematical theories and techniques for modeling financial markets. Specific topics include the binomial model, risk neutral pricing, stochastic calculus, connection to partial differential equations and stochastic control theory.
Equivalent - Duplicate Degree Credit Not Granted: APPM 4530, APPM 5530 and STAT 4230
Requisites: Restricted to graduate students only.
Recommended: Prerequisite previous coursework equivalent to that of APPM 3310 and one of APPM 3570, STAT 3100 or MATH 4510; all with minimum grade of C-.

STAT 5250 (3) Data Assimilation in High Dimensional Dynamical Systems
Develops and analyzes approximate methods of solving the Bayesian inverse problem for high-dimensional dynamical systems. After briefly reviewing mathematical foundations in probability and statistics, the course covers the Kalman filter, particle filters, variational methods and ensemble Kalman filters. The emphasis is on mathematical formulation and analysis of methods.
Equivalent - Duplicate Degree Credit Not Granted: APPM 4510 and APPM 5510
Requisites: Restricted to Graduate, Graduate Nondegree and non sponsored students only.

STAT 5310 (3) Statistical Modeling for Data Science
Introduces students to foundational concepts and techniques for statistical modeling in data science, including modern regression analysis, analysis of variance (ANOVA), experimental design, nonparametric methods, and generalized additive models. Considerable emphasis is placed on both theoretical results and applied data analysis.
Requisites: Restricted to graduate students only.
Recommended: Prerequisites coursework equivalent to (STAT 3100 or MATH 4510 or MATH 5510) and (STAT 4000 or STAT 5000 or STAT 4520 or STAT 5520), and previous programming experience in Python or R.

STAT 5350 (3) Applied Deep Learning 1
Introduces students to state-of-the-art deep learning techniques employed in the industry. This course will focus on training neural networks and computer vision, including image classification and transformation, object detection, and facial recognition. Advanced topics will include domain adaptation and learning techniques. There will be an emphasis on reading current literature.
Equivalent - Duplicate Degree Credit Not Granted: STAT 4350
Requisites: Restricted to graduate students only.
Recommended: Prerequisiteprobability (equivalent to APPM 3570), statistics (equivalent to STAT 3400), some familiarity with numerical analysis, solid knowledge of Python, and familiarity with TensorFlow and PyTorch is a plus but is not a requirement.

STAT 5360 (3) Applied Deep Learning 2
Introduces students to state-of-the-art deep learning techniques employed in the industry. This course will focus on natural language processing, multimodal learning, generative and graph neural networks, speech and music recognition, and reinforcement learning. Students will learn software engineering techniques using Python. There will be an emphasis on reading current literature.
Equivalent - Duplicate Degree Credit Not Granted: STAT 4360
Requisites: Requires prerequisite course of STAT 5350 (minimum grade C-). Restricted to graduate students only

STAT 5400 (3) Advanced Statistical Modeling
Introduces methods, theory and applications of modern statistical models, from linear to hierarchical linear models, to generalized hierarchical linear models, including hierarchical logistic and hierarchical count regression models. Topics such as estimation, residual diagnostics, goodness of fit, transformations, and various strategies for variable selection and model comparison will be discussed in depth. Examples will be demonstrated using statistical programming language R.
Equivalent - Duplicate Degree Credit Not Granted: STAT 4400
Requisites: Restricted to graduate students only.
Recommended: Prerequisite previous coursework equivalent to one of STAT 3400 or STAT 4010 or STAT 5010 and one of STAT 4520 or STAT 5520 or STAT 5530; all with a minimum grade of C-.
Grading Basis: Letter Grade

STAT 5430 (3) Spatial Statistics
Introduces the theory of spatial statistics with applications. Topics include basic theory for continuous stochastic processes, spatial prediction and kriging, simulation, geostatistical methods, likelihood and Bayesian approaches, spectral methods and an overview of modern topics such as nonstationary models, hierarchical modeling, multivariate processes, methods for large datasets and connections to splines.
Equivalent - Duplicate Degree Credit Not Granted: STAT 4430
Requisites: Restricted to graduate students only.
Recommended: Prerequisite previous coursework equivalent to one of STAT 3400 or STAT 4010 or STAT 5010 and one of STAT 4520 or STAT 5520 or STAT 5530; all with a minimum grade of C-.

STAT 5520 (3) Introduction to Mathematical Statistics
Examines point and confidence interval estimation. Principles of maximum likelihood, sufficiency, and completeness: tests of simple and composite hypotheses, linear models, and multiple regression analysis if time permits. Analyzes various distribution-free methods. Department enforced prerequisite: one semester calculus-based probability course, such as MATH 4510 or APPM 3570.
Equivalent - Duplicate Degree Credit Not Granted: STAT 4520 and MATH 4520 and MATH 5520
Requisites: Restricted to graduate students only.
Recommended: Prerequisite previous coursework equivalent to APPM 3570 or STAT 3100 or MATH 4510; minimum grade of C- for all.

STAT 5530 (3) Mathematical Statistics
Covers the theory of estimation, confidence intervals, hypothesis testing, and decision theory. In particular, it covers the material of APPM 5520 in greater depth, especially the topics of optimality and asymptotic approximation. Additional topics include M-estimation, minimax tests, the EM algorithm, and an introduction to Bayesian estimation and empirical likelihood techniques. Recommended Prerequisite is a one-semester calculus-based probability course such as MATH 4510 or APPM 3570.
Equivalent - Duplicate Degree Credit Not Granted: STAT 5520 or MATH 5520 or STAT 4520 or MATH 4520
Requisites: Restricted to graduate students only.

STAT 5540 (3) Introduction to Time Series
Studies basic properties, trend-based models, seasonal models modeling and forecasting with ARIMA models, spectral analysis and frequency filtration. Department enforced prerequisite: APPM 5520 or MATH 5520.
Equivalent - Duplicate Degree Credit Not Granted: STAT 4540 and MATH 4540 and MATH 5540
Requisites: Restricted to graduate students only.
Recommended: Prerequisite previous coursework equivalent to STAT 4520 or MATH 4520 or STAT 5520 or MATH 5520; minimum grade of C- for all.

STAT 5600 (3) Methods in Statistical Learning
Provides an introduction to methods in the field of statistical learning. Topics include a review of multiple regression, assessing model accuracy, classification, resampling methods, model selection and regularization, nonlinear regression, tree-based methods, support vector machines and unsupervised learning. Involves hands-on data analysis using the R programming language.
Requisites: Requires prerequisite course of STAT 5010 (minimum grade C-). Restricted to MS-DS students.

STAT 5610 (3) Statistical Learning
Consists of applications and methods of statistical learning. Reviews multiple linear regression and then covers classification, regularization, splines, tree-based methods, support vector machines, unsupervised learning and Gaussian process regression.
Equivalent - Duplicate Degree Credit Not Granted: STAT 4610
Requisites: Restricted to graduate students only.
Recommended: Prerequisite previous coursework equivalent to that of STAT 3400 or STAT 4010 or STAT 5010; minimum C- grade for all.

STAT 5630 (3) Computational Bayesian Statistics
Introduces Bayesian statistics, normal and non-normal approximation to likelihood and posteriors, the EM algorithm, data augmentation, and Markov Chain Monte Carlo (MCMC) methods. Additionally, introduces more advanced MCMC algorithms and requires significant statistical computing. Examples from a variety of areas, including biostatistics, environmental sciences, and engineering, will be given throughout the course.
Equivalent - Duplicate Degree Credit Not Granted: STAT 4630
Requisites: Requires prerequisite courses of (STAT 5520 or MATH 5520 or STAT 5530) and (APPM 5560 or STAT 5100 or APPM 6550 or MATH 6550) (all minimum grade C-).
Recommended: Prerequisite prior programming and basic statistical modeling experience is required.

STAT 5640 (3) Capstone in Statistics and Data Science
Course provides senior-level and graduate students the opportunity to apply the knowledge, skills, and abilities developed throughout the Statistics and Data Science major. Working in teams, students undertake a data-driven problem presented by domain experts from government, industry, or academia. The course provides valuable real-world experience for students intending to pursue graduate education or technical careers. Topics include team building, problem solving, research methods, project management, data ethics, and clear communication (oral, written, and visual).
Equivalent - Duplicate Degree Credit Not Granted: STAT 4640
Requisites: Restricted to graduate students only.
Recommended: Prerequisite STAT 4400 or STAT 4610.
Grading Basis: Letter Grade

STAT 5650 (3) Randomized Algorithms
Investigates modern randomized methods that are used in scientific and numerical computing, in particular randomized matrix approximation methods. Other topics may include stochastic gradient methods and variance reduced versions, compressed sensing, and locality sensitive hashing.
Equivalent - Duplicate Degree Credit Not Granted: APPM 5650
Requisites: Restricted to graduate students only.
Recommended: Prerequisite APPM 4440 or equivalent.

STAT 5680 (3) Statistical Collaboration
Educates and trains students to become effective interdisciplinary collaborators by developing the communication and collaboration skills necessary to apply technical statistics and data science skills to help domain experts answer research questions. Topics include structuring effective meetings and projects; communicating statistics to non-statisticians; using peer feedback, self-reflection and video analysis to improve collaboration skills; creating reproducible statistical workflows; working ethically.
Equivalent - Duplicate Degree Credit Not Granted: STAT 4680
Requisites: Restricted to graduate students only.
Recommended: Prerequisite undergraduate statistics courses equivalent to STAT 4400 (minimum grade C-) or STAT 4010 (minimum grade C-) or Instructor's approval.
Grading Basis: Letter Grade

STAT 5690 (2) Advanced Statistical Collaboration
Educates and trains students to become advanced interdisciplinary collaborators by developing and refining the communication, collaboration and technical statistics and data science skills necessary to collaborate with domain experts to answer research questions. Students work on multiple projects. Discussions center on technical skills necessary to solve research problems and video analysis to improve communication and collaboration skills.
Equivalent - Duplicate Degree Credit Not Granted: STAT 4690
Requisites: Requires prerequisite course of STAT 4680 or STAT 5680 (minimum grade C-). Restricted to graduate students only.
Grading Basis: Letter Grade

STAT 5700 (3) Philosophical and Ethical Issues in Statistics
Introduces students to philosophical issues that arise in statistical theory and practice. Topics include interpretations of probability, philosophical paradigms in statistics, inductive inference, causality, reproducible, and ethical issues arising in statistics and data analysis.
Equivalent - Duplicate Degree Credit Not Granted: STAT 4700
Requisites: Restricted to graduate students only.
Recommended: Prerequisite previous coursework equivalent to STAT 3400 or STAT 4000 or STAT 4520 or STAT 5000 or STAT 5520 or STAT 5530; minimum grade C- for all.
Grading Basis: Letter Grade

STAT 5720 (1-3) Open Topics in Statistics and Data Science
Provides a vehicle for the development and presentation of new topics that may be incorporated into the core courses in applied mathematics. Department enforced prerequisite: variable, depending on the topic, see instructor.
Equivalent - Duplicate Degree Credit Not Granted: STAT 4720
Repeatable: Repeatable for up to 6.00 total credit hours. Allows multiple enrollment in term.