STATISTICS (STAT)

STAT 201. Basic Statistics for Social and Life Sciences. 3 Units.
Designed for undergraduates in the social sciences and life sciences who need to use statistical techniques in their fields. Descriptive statistics, probability models, sampling distributions. Point and confidence interval estimation, hypothesis testing. Elementary regression and analysis of variance. Not for credit toward major or minor in Statistics. A student may receive credit for only one of the following: ANTH 319, PSCL 282, SOCI 307, or STAT 201. Counts as a CAS Quantitative Reasoning course. Counts as a Quantitative Reasoning course.

STAT 243. Statistical Theory with Application I. 3 Units.
Probability theory and distributions are introduced to provide foundation for inferential statistics. Randomness and probability laws. Univariate random variables and common discrete and continuous probability distributions. Expectations and moment generating functions. Multiple random variables and joint, marginal and conditional probability distributions. Expected values of functions, including linear functions, of random variables. Conditional Expectations. Prereq: MATH 122 or MATH 126.

STAT 244. Statistical Theory with Application II. 3 Units.
Inferential statistics theory and applications are introduced. Distributions of functions of random variables. Sampling distributions and Central Limit Theorem. Point estimation and its evaluation, including unbiasedness, consistency, and sufficiency. Weak law of large numbers. Method of moments and maximum likelihood estimation. Interval estimation and pivotal quantity. Common large and small sample applications. Hypothesis testing elements and common large and small sample cases. Neyman-Pearson Lemma and Likelihood Ratio Tests. Prereq: STAT 243.

STAT 312. Basic Statistics for Engineering and Science. 3 Units.
For advanced undergraduate students in engineering, physical sciences, life sciences. Comprehensive introduction to probability models and statistical methods of analyzing data with the object of formulating statistical models and choosing appropriate methods for inference from experimental and observational data and for testing the model's validity. Balanced approach with equal emphasis on probability, fundamental concepts of statistics, point and interval estimation, hypothesis testing, analysis of variance, design of experiments, and regression modeling. Note: Credit given for only one (1) of STAT 312, STAT 312R, STAT 313; SYBB 312R. Prereq: MATH 122 or equivalent.

STAT 312R. Basic Statistics for Engineering and Science Using R Programming. 3 Units.
For advanced undergraduate students in engineering, physical sciences, life sciences. Comprehensive introduction to probability models and statistical methods of analyzing data with the object of formulating statistical models and choosing appropriate methods for inference from experimental and observational data and for testing the model's validity. Balanced approach with equal emphasis on probability, fundamental concepts of statistics, point and interval estimation, hypothesis testing, analysis of variance, design of experiments, and regression modeling. Note: Credit given for only one (1) of STAT 312, STAT 312R, STAT 313 or SYBB 312R. Offered as STAT 312R and SYBB 312R. Prereq: MATH 122 or equivalent.

STAT 313. Statistics for Experimenters. 3 Units.
For advanced undergraduates in engineering, physical sciences, life sciences. Comprehensive introduction to modeling data and statistical methods of analyzing data. General objective is to train students in formulating statistical models, in choosing appropriate methods for inference from experimental and observational data and to test the validity of these models. Focus on practicalities of inference from experimental data. Inference for curve and surface fitting to real data sets. Designs for experiments and simulations. Student generation of experimental data and application of statistical methods for analysis. Critique of model; use of regression diagnostics to analyze errors. Note: Credit given for only one (1) of STAT 312, STAT 312R, STAT 313; SYBB 312R. Prereq: MATH 122 or equivalent.

STAT 317. Actuarial Science I. 3 Units.
Practical knowledge of the theory of interest in both finite and continuous time. That knowledge should include how these concepts are used in the various annuity functions, and apply the concepts of present and accumulated value for various streams of cash flows as a basis for future use in: reserving, valuation, pricing, duration, asset/liability management, investment income, capital budgeting, and contingencies. Valuation of discrete and continuous streams of payments, including the case in which the interest conversion period differs from the payment period will be considered. Application of interest theory to amortization of lump sums, fixed income securities, depreciation, mortgages, etc., as well as annuity functions in a broad finance context will be covered. Topics covered include areas examined in the American Society of Actuaries Exam 2. Offered as STAT 317 and STAT 417. Prereq: MATH 122 or MATH 126 or requisites not met permission.

STAT 318. Actuarial Science II. 3 Units.
Theory of life contingencies. Life table analysis for simple and multiple decrement functions. Life and special annuities. Life insurance and reserves for life insurance. Statistical issues for prediction from actuarial models. Topics covered include areas examined in the American Society of Actuaries Exam 3. Offered as STAT 318 and STAT 418. Prereq: STAT 312 or STAT 312R or STAT 317 or STAT 345 or Requisites Not Met permission.

STAT 325. Data Analysis and Linear Models. 3 Units.
Basic exploratory data analysis for univariate response with single or multiple covariates. Graphical methods and data summarization, model-fitting using S-plus computing language. Linear and multiple regression. Emphasis on model selection criteria, on diagnostics to assess goodness of fit and interpretation. Techniques include transformation, smoothing, median polish, robust/resistant methods. Case studies and analysis of individual data sets. Notes of caution and some methods for handling bad data. Knowledge of regression is helpful. Offered as STAT 325 and STAT 425. Prereq: STAT 243 or STAT 312 or STAT 312R or PQHS 431 or PQHS 458.

STAT 326. Multivariate Analysis and Data Mining. 3 Units.
Extensions of exploratory data analysis and modeling to multivariate response observations and to non-Gaussian data. Singular value decomposition and projection, principal components, factor analysis and latent structure analysis, discriminant analysis and clustering techniques, cross-validation, E-M algorithm, CART. Introduction to generalized linear modeling. Case studies of complex data sets with multiple objectives for analysis. Recommended preparation: STAT 325 or STAT 425. Offered as STAT 326 and STAT 426.

STAT 332. Statistics for Signal Processing. 3 Units.
For advanced undergraduate students or beginning graduate students in engineering, physical sciences, life sciences. Introduction to probability models and statistical methods. Emphasis on probability as relative frequencies. Derivation of conditional probabilities and memoryless channels. Joint distribution of random variables, transformations, autocorrelation, series of irregular observations, stationarity. Random harmonic signals with noise, random phase and/or random amplitude. Gaussian and Poisson signals. Modulation and averaging properties. Transmission through linear filters. Power spectra, bandwidth, white and colored noise. ARMA processes and forecasting. Optimal linear systems, signal-to-noise ratio, Wiener filter. Completion of additional assignments required from graduate students registered in this course. Offered as STAT 332 and STAT 432. Prereq: MATH 122.

STAT 333. Uncertainty in Engineering and Science. 3 Units.
Phenomena of uncertainty appear in engineering and science for various reasons and can be modeled in different ways. The course integrates the mainstream ideas in statistical data analysis with models of uncertain phenomena stemming from three distinct viewpoints: algorithmic/computational complexity; classical probability theory; and chaotic behavior of nonlinear systems. Descriptive statistics, estimation procedures and hypothesis testing (including design of experiments). Random number generators and their testing. Monte Carlo Methods. Mathematica notebooks and simulations will be used. Graduate students are required to do an extra project. Offered as STAT 333 and STAT 433. Prereq: MATH 122 or MATH 223.

STAT 345. Theoretical Statistics I. 3 Units.
Topics provide the background for statistical inference. Random variables; distribution and density functions; transformations, expectation. Common univariate distributions. Multiple random variables; joint, marginal and conditional distributions; hierarchical models, covariance. Distributions of sample quantities, distributions of sums of random variables, distributions of order statistics. Methods of statistical inference. Offered as STAT 345, STAT 445, and PQHS 481. Prereq: MATH 122 or MATH 223 or Coreq: PQHS 431.

STAT 346. Theoretical Statistics II. 3 Units.
Point estimation: maximum likelihood, moment estimators. Methods of evaluating estimators including mean squared error, consistency, "best" unbiased and sufficiency. Hypothesis testing; likelihood ratio and union-intersection tests. Properties of tests including power function, bias. Interval estimation by inversion of test statistics, use of pivotal quantities. Application to regression. Graduate students are responsible for mathematical derivations, and full proofs of principal theorems. Offered as STAT 346, STAT 446 and PQHS 482. Prereq: STAT 345 or STAT 445 or PQHS 481.

STAT 382. High Dimensional Probability. 3 Units.
Behavior of random vectors, random matrices, and random projections in high dimensional spaces, with a view toward applications to data sciences. Topics include tail inequalities for sums of independent random variables, norms of random matrices, concentration of measure, and bounds for random processes. Applications may include structure of random graphs, community detection, covariance estimation and clustering, randomized dimension reduction, empirical processes, statistical learning, and sparse recovery problems. Additional work is required for graduate students. Offered as MATH 382, MATH 482, STAT 382 and STAT 482. Prereq: MATH 307 and (MATH 380 or STAT 345 or STAT 445).

STAT 395. Senior Project in Statistics. 3 Units.
An individual project done under faculty supervision involving the investigation and statistical analysis of a real problem encountered in university research or an industrial setting. A student must obtain consent of a capstone advisor to register for the course. This course unifies what students have learned in their statistics, data science, and written, oral, and multimodal communication coursework. The course begins with the outlining of goals, necessary background required, and methods and analysis needed. The course concludes with a substantial written product which includes a clear description of the project, the importance of the project, methods, results, and conclusions along with a public presentation of the project. Counts as a Capstone Project course. Counts as a SAGES Senior Capstone course.

STAT 417. Actuarial Science I. 3 Units.
Practical knowledge of the theory of interest in both finite and continuous time. That knowledge should include how these concepts are used in the various annuity functions, and apply the concepts of present and accumulated value for various streams of cash flows as a basis for future use in: reserving, valuation, pricing, duration, asset/liability management, investment income, capital budgeting, and contingencies. Valuation of discrete and continuous streams of payments, including the case in which the interest conversion period differs from the payment period will be considered. Application of interest theory to amortization of lump sums, fixed income securities, depreciation, mortgages, etc., as well as annuity functions in a broad finance context will be covered. Topics covered include areas examined in the American Society of Actuaries Exam 2. Offered as STAT 317 and STAT 417. Prereq: MATH 122 or MATH 126 or requisites not met permission.

STAT 418. Actuarial Science II. 3 Units.
Theory of life contingencies. Life table analysis for simple and multiple decrement functions. Life and special annuities. Life insurance and reserves for life insurance. Statistical issues for prediction from actuarial models. Topics covered include areas examined in the American Society of Actuaries Exam 3. Offered as STAT 318 and STAT 418. Prereq: STAT 312 or STAT 312R or STAT 317 or STAT 345 or Requisites Not Met permission.

STAT 425. Data Analysis and Linear Models. 3 Units.
Basic exploratory data analysis for univariate response with single or multiple covariates. Graphical methods and data summarization, model-fitting using S-plus computing language. Linear and multiple regression. Emphasis on model selection criteria, on diagnostics to assess goodness of fit and interpretation. Techniques include transformation, smoothing, median polish, robust/resistant methods. Case studies and analysis of individual data sets. Notes of caution and some methods for handling bad data. Knowledge of regression is helpful. Offered as STAT 325 and STAT 425.

STAT 426. Multivariate Analysis and Data Mining. 3 Units.
Extensions of exploratory data analysis and modeling to multivariate response observations and to non-Gaussian data. Singular value decomposition and projection, principal components, factor analysis and latent structure analysis, discriminant analysis and clustering techniques, cross-validation, E-M algorithm, CART. Introduction to generalized linear modeling. Case studies of complex data sets with multiple objectives for analysis. Recommended preparation: STAT 325 or STAT 425. Offered as STAT 326 and STAT 426.

STAT 432. Statistics for Signal Processing. 3 Units.
For advanced undergraduate students or beginning graduate students in engineering, physical sciences, life sciences. Introduction to probability models and statistical methods. Emphasis on probability as relative frequencies. Derivation of conditional probabilities and memoryless channels. Joint distribution of random variables, transformations, autocorrelation, series of irregular observations, stationarity. Random harmonic signals with noise, random phase and/or random amplitude. Gaussian and Poisson signals. Modulation and averaging properties. Transmission through linear filters. Power spectra, bandwidth, white and colored noise. ARMA processes and forecasting. Optimal linear systems, signal-to-noise ratio, Wiener filter. Completion of additional assignments required from graduate students registered in this course. Offered as STAT 332 and STAT 432. Prereq: MATH 122.

STAT 433. Uncertainty in Engineering and Science. 3 Units.
Phenomena of uncertainty appear in engineering and science for various reasons and can be modeled in different ways. The course integrates the mainstream ideas in statistical data analysis with models of uncertain phenomena stemming from three distinct viewpoints: algorithmic/computational complexity; classical probability theory; and chaotic behavior of nonlinear systems. Descriptive statistics, estimation procedures and hypothesis testing (including design of experiments). Random number generators and their testing. Monte Carlo Methods. Mathematica notebooks and simulations will be used. Graduate students are required to do an extra project. Offered as STAT 333 and STAT 433. Prereq: MATH 122 or MATH 223.

STAT 437. Stochastic Models: Time Series and Markov Chains. 3 Units.
Introduction to stochastic modeling of data. Emphasis on models and statistical analysis of data with a significant temporal and/or spatial structure. This course will analyze time and space dependent random phenomena from two perspectives: Stationary Time Series: Spectral representation of deterministic signals, autocorrelation. Power spectra. Transmission of stationary signals through linear filters. Optimal filter design, signal-to-noise ratio. Gaussian signals and correlation matrices. Spectral representation and computer simulation of stationary signals. Discrete Markov Chains: Transition matrices, recurrences and the first step analysis. Steady rate. Recurrence and ergodicity, empirical averages. Long run behavior, convergence to steady state. Time to absorption. Eigenvalues and nonhomogeneous Markov chains. Introduction to Gibbs fields and Markov Chain Monte Carlo (MCMC). This course is related to STAT 538 but can be taken independently of it. Offered as: MATH 497 and STAT 437. Prereq: STAT 312 or STAT 313 or STAT 332 or STAT 333 or STAT 345 or MATH 380 or MATH 491 or (STAT 243 and 244) or Requisites Not Met permission.

STAT 439. Bayesian Scientific Computing. 3 Units.
This course will embed numerical methods into a Bayesian framework. The statistical framework will make it possible to integrate a prori information about the unknowns and the error in the data directly into the most efficient numerical methods. A lot of emphasis will be put on understanding the role of the priors, their encoding into fast numerical solvers, and how to translate qualitative or sample-based information--or lack thereof--into a numerical scheme. Confidence on computed results will also be discussed from a Bayesian perspective, at the light of the given data and a priori information. The course should be of interest to anyone working on signal and image processing statistics, numerical analysis and modeling. Recommended Preparation: MATH 431. Offered as MATH 439 and STAT 439.

STAT 445. Theoretical Statistics I. 3 Units.
Topics provide the background for statistical inference. Random variables; distribution and density functions; transformations, expectation. Common univariate distributions. Multiple random variables; joint, marginal and conditional distributions; hierarchical models, covariance. Distributions of sample quantities, distributions of sums of random variables, distributions of order statistics. Methods of statistical inference. Offered as STAT 345, STAT 445, and PQHS 481. Prereq: MATH 122 or MATH 223 or Coreq: PQHS 431.

STAT 446. Theoretical Statistics II. 3 Units.
Point estimation: maximum likelihood, moment estimators. Methods of evaluating estimators including mean squared error, consistency, "best" unbiased and sufficiency. Hypothesis testing; likelihood ratio and union-intersection tests. Properties of tests including power function, bias. Interval estimation by inversion of test statistics, use of pivotal quantities. Application to regression. Graduate students are responsible for mathematical derivations, and full proofs of principal theorems. Offered as STAT 346, STAT 446 and PQHS 482. Prereq: STAT 345 or STAT 445 or PQHS 481.

STAT 448. Bayesian Theory with Applications. 3 Units.
Principles of Bayesian theory, methodology and applications. Methods for forming prior distributions using conjugate families, reference priors and empirically-based priors. Derivation of posterior and predictive distributions and their moments. Properties when common distributions such as binomial, normal or other exponential family distributions are used. Hierarchical models. Computational techniques including Markov chain, Monte Carlo and importance sampling. Extensive use of applications to illustrate concepts and methodology. Recommended preparation: STAT 445.

STAT 455. Linear Models. 3 Units.
Theory of least squares estimation, interval estimation and tests for models with normally distributed errors. Regression on dummy variables, analysis of variance and covariance. Variance components models. Model diagnostics. Robust regression. Analysis of longitudinal data. Prereq: MATH 201 and STAT 346 or STAT 446

STAT 482. High Dimensional Probability. 3 Units.
Behavior of random vectors, random matrices, and random projections in high dimensional spaces, with a view toward applications to data sciences. Topics include tail inequalities for sums of independent random variables, norms of random matrices, concentration of measure, and bounds for random processes. Applications may include structure of random graphs, community detection, covariance estimation and clustering, randomized dimension reduction, empirical processes, statistical learning, and sparse recovery problems. Additional work is required for graduate students. Offered as MATH 382, MATH 482, STAT 382 and STAT 482. Prereq: Graduate student standing.

STAT 495. Statistical Consulting and Collaboration. 3 Units.
This course unifies what students have learned in their statistics, data science, and related course work to apply their knowledge in consulting and collaboration. It recognizes the fact that the essence of a statistician's and/or data scientist's profession is continuing interaction and collaboration with practitioners in the sciences, engineering, medicine, economics, etc. The course presents the views of prominent experts in the field as obtained from the literature and other sources. The responsibilities of the consultant and the client are discussed. Sample consulting and collaboration problems are presented and strategies for solving them are provided. Prereq: STAT 325 or STAT 425.

STAT 538. Stochastic Models: Diffusive Phenomena and Stochastic Differential Equations. 3 Units.
Introduction to stochastic modeling of data. Emphasis on models and statistical analysis of data with significant temporal and/or spatial structure. This course will analyze time and space dependent random phenomena from two perspectives: Brownian motion and diffusive processes: Classification of stochastic processes, finite dimensional distributions, random walks and their scaling limits, Brownian motion and its paths properties, general diffusive processes, Fokker-Planck-Kolmogorov equations, Poisson and point processes, heavy tail diffusions, Levy processes, tempered stable diffusions. Stochastic calculus and stochastic differential equations: Wiener random integrals, mean-square theory, Brownian stochastic integrals and Ito formula, stochastic integrals for Levy processes, martingale property, basic theory and applications of stochastic differential equations. This course is related to STAT 437 but can be taken independently of it. Offered as MATH 598 and STAT 538. Prereq: STAT 312 or equivalent.

STAT 545. Advanced Theory of Statistics I. 3 Units.
A systematic development of advanced statistical theory. Background concepts. Limits, order comparisons, convergence. Sample moments, quantiles and other statistics. Transformations. Characterization of distribution functions and characteristic functions. Normal and other approximations to distributions. Quadratic forms and other functions of asymptotically normal statistics. Asymptotic properties of statistics including asymptotic efficiency, consistency. Admissibility, sufficiency and ancillarity. Nuisance parameters, parameter orthogonality. Distribution theory in nuisance parameters. Prereq: STAT 446.

STAT 601. Reading and Research. 1 - 9 Units.
Individual study and/or project work.

STAT 621. M.S. Research Project. 1 - 9 Units.
Completion of statistical design and/or analysis of a research project in a substantive field which requires substantial and/or nonstandard statistical techniques and which leads to results suitable for publication. Written project report must present the context of the research, justify the statistical methodology used, draw appropriate inferences and interpret these inferences in both statistical and substantive scientific terms. Oral presentation of research project may be given in either graduate student seminar or consulting forum.

STAT 651. Thesis M.S.. 1 - 18 Units.
(Credit as arranged.) May be used as alternative to STAT 621 (M.S. Research Project) in fulfillment of requirements for M.S. degree in Statistics.

STAT 701. Dissertation Ph.D.. 1 - 9 Units.
(Credit as arranged.) Prereq: Predoctoral research consent or advanced to Ph.D. candidacy milestone.