

# STATISTICS AND PROBABILITY

## STT

### Department of Statistics and Probability College of Natural Science

- 200 Statistical Methods**  
Fall, Spring, Summer. 3(4-0) P: (MTH 103 or MTH 110 or MTH 116 or MTH 124 or MTH 132 or LB 118) or designated score on Mathematics Placement test Not open to students with credit in STT 201 or STT 421.  
Data analysis, probability models, random variables, estimation, tests of hypotheses, confidence intervals, and simple linear regression.
- 201 Statistical Methods**  
Fall, Spring, Summer. 4(3-2) P: (MTH 103 or MTH 110 or MTH 116 or MTH 124 or MTH 132 or LB 118) or designated score on Mathematics Placement test Not open to students with credit in STT 200 or STT 421.  
Probability and statistics with computer applications. Data analysis, probability models, random variables, tests of hypotheses, confidence intervals, simple linear regression. Weekly lab using statistical software.
- 224 Introduction to Probability and Statistics for Ecologists**  
Spring. 3(2-2) Interdepartmental with Fisheries and Wildlife. Administered by Statistics and Probability. P: MTH 103 or MTH 116 or (MTH 124 or concurrently) or (MTH 132 or concurrently) or (MTH 152H or concurrently) or (LB 118 or concurrently) RB: BS 162 or BS 182H or LB 144 SA: FW 324 Not open to students with credit in STT 231.  
Probability and statistics with computer applications for the analysis, interpretation and presentation of ecological data. Data analysis, probability models, random variables, estimation, confidence intervals, test of hypotheses, and simple linear regression with applications to ecology.
- 231 Statistics for Scientists**  
Fall, Spring, Summer. 3(3-0) P: MTH 124 or MTH 132 or MTH 152H or LB 118 R: Open to students in the College of Natural Science and open to students in the Lyman Briggs College. SA: STT 331  
Calculus-based course in probability and statistics. Probability models, and random variables. Estimation, confidence intervals, tests of hypotheses, and simple linear regression with applications in sciences.
- 250 Statistics and Probability for K-8 Teachers**  
Spring. 4(4-0) P: MTH 103 R: Open to undergraduate students in the College of Education or approval of department.  
Data collection and analysis. Statistics, probability models. Decision-making in the presence of variability. Computer software relevant for teaching practice.
- 290 Topics in Statistics and Probability**  
Fall, Spring, Summer. 1 to 3 credits. RB: MTH 103 R: Approval of department.  
Individualized study of selected topics.
- 315 Introduction to Probability and Statistics for Business**  
Fall, Spring, Summer. 3(4-0) P: MTH 124 or MTH 132 or MTH 152H or LB 118  
A first course in probability and statistics primarily for business majors. Data analysis, probability models, random variables, confidence intervals, and tests of hypotheses with business applications.
- 317 Quantitative Business Research Methods**  
Fall, Spring, Summer. 3(3-0) Interdepartmental with Marketing. Administered by Marketing. P: STT 315 R: Open to juniors or seniors in the Eli Broad College of Business and The Eli Broad Graduate School of Management and not open to undergraduate students in the School of Hospitality Business and open to juniors or seniors in the Applied Engineering Sciences major. SA: MSC 317  
Application of statistical techniques, including forecasting, to business decision making. Includes applications of linear regression and correlation, analysis of variance, selected non-parametric tests, time series, and index numbers.
- 351 Probability and Statistics for Engineering**  
Fall, Spring, Summer. 3(3-0) P: MTH 234 or MTH 254H or LB 220 Not open to students with credit in STT 430.  
Probability models and random variables. Estimation, confidence intervals, tests of hypotheses, simple linear regression. Applications to engineering.
- 371 Statistical Biology**  
Spring. 3(3-0) Interdepartmental with Mathematics. Administered by Statistics and Probability. P: (MTH 132 or LB 118 or approval of department) and (STT 231 or STT 351 or STT 421 or STT 441 or STT 464 or approval of department) and (BS 161 or BS 162 or BS 181H or BS 182H or LB 144 or LB 145)  
Probability models in biological systems. Design and analysis of biological experiments including ANOVA models. Multiple testing. Classification and clustering for genomic and proteomic data. Computational software packages. Internet-based query systems.
- 421 Statistics I**  
Fall, Spring, Summer. 3(3-0) P: MTH 103 or MTH 110 or MTH 116 Not open to students with credit in STT 200 or STT 201.  
Basic probability, random variables, and common distributions. Estimation and tests for one-, two-, and paired sample problems. Introduction to simple linear regression and correlation, one-way ANOVA.
- 422 Statistics II**  
Fall, Spring, Summer. 3(3-0) RB: STT 421 Not open to students with credit in STT 464.  
Goodness of fit and other non-parametric methods. Linear models including multiple regression and ANOVA for simple experimental designs.
- 430 Introduction to Probability and Statistics**  
Fall, Spring, Summer. 3(3-0) RB: MTH 234 or concurrently Not open to students with credit in STT 351.  
Calculus-based probability and statistics with applications. Discrete and continuous random variables and their expectations. Point and interval estimation, tests of hypotheses, and simple linear regression.
- 441 Probability and Statistics I: Probability**  
Fall, Spring, Summer. 3(3-0) RB: MTH 234 or MTH 254H or LB 220  
Probability models and basic statistics at an intermediate mathematical level. Discrete, continuous, univariate, and multivariate distributions. Random variables. Normal approximation. Sampling distributions, parameter estimation, and elementary tests of hypotheses.
- 442 Probability and Statistics II: Statistics**  
Spring. 3(3-0) RB: STT 441 and (MTH 309 or MTH 314 or MTH 415)  
Estimation, testing hypotheses and simple and multiple regression analysis. Time series: ARMA (Auto Regressive Moving Average) and ARIMA (Auto Regressive Integrated Moving Average) models, data analysis and forecasting.
- 455 Actuarial Models I**  
Fall. 3(3-0) Interdepartmental with Mathematics. Administered by Statistics and Probability. RB: STT 441 and MTH 360  
Stochastic models used in insurance. Survival distributions, life insurance, life annuities, benefit premiums, benefit reserves, and analysis of benefit reserves.
- 456 Actuarial Models II**  
Fall. 3(3-0) Interdepartmental with Mathematics. Administered by Statistics and Probability. P: STT 455  
Continuation of STT 455. Benefit reserves. Multiple life functions. Multiple decrement models and their applications. Elements of stochastic processes for actuaries including Markov chains and Poisson processes
- 458 Financial Mathematics for Actuaries**  
Fall. 3(3-0) Interdepartmental with Mathematics. Administered by Mathematics. P: MTH 360 and STT 441 and FI 379  
Evaluate and construct interest rate models. Rational valuation of derivative securities using put-call parity and calculation of European and American options. Risk management techniques using the method of delta-hedging.
- 459 Construction and Evaluation of Actuarial Models**  
Spring. 3(3-0) Interdepartmental with Mathematics. Administered by Statistics and Probability. P: STT 442  
Severity, frequency, and aggregate models. Construction of empirical models. Parametric statistical methods. Credibility analysis. Simulation methods.
- 461 Computations in Probability and Statistics**  
Spring. 3(3-0) RB: CSE 131 and STT 441 and (MTH 309 or MTH 314)  
Computer algorithms for evaluation, simulation and visualization. Sampling and prescribed distributions. Robustness and error analysis of procedures used by statistical packages. Graphics for data display, computation of probabilities and percentiles.
- 464 Statistics for Biologists**  
Fall. 3(3-0) Interdepartmental with Animal Science and Crop and Soil Sciences. Administered by Statistics and Probability. RB: STT 421  
Biological random variables. Estimation of population parameters. Testing hypotheses. Linear correlation and regression. Analyses of counted and measured data to compare several biological groups including contingency tables and analysis of variance.

## Statistics and Probability—STT

- 481 Issues in Statistical Practice**  
Spring. 1(1-0) P: Completion of Tier I writing requirement. R: Open only to seniors in the Department of Statistics.  
Selected readings and projects illustrating special problems encountered by professional statisticians in their roles as consultants, educators, and analysts.
- 490 Directed Study of Statistical Problems**  
Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 9 credits in all enrollments for this course. R: Open only to juniors or seniors in the Department of Mathematics or Department of Statistics and Probability. Approval of department.  
Individualized study of selected topics.
- 801 Design of Experiments**  
Fall of even years. 3(3-0) RB: STT 422 or STT 442 or STT 471  
Blocking and randomization. Split-plot, latin square and factorial designs. Fractional factorial designs, aliasing and confounding of effects. Mixture and central composite designs and response surface exploration. Clinical trials.
- 802 Statistical Computation**  
Fall of even years. 3(3-0) RB: (STT 442 and MTH 309) or (mathematical statistics and linear algebra)  
Computational techniques commonly used in Statistics. Matrix decompositions. Least squares and Least Absolute Deviations. Solution of nonlinear equations. Optimization techniques including the EM algorithm and constrained optimization. Numerical integration. Generation of random numbers and stochastic simulation. Implementation in statistical software.
- 808 Biostatistics I**  
Fall. 3(3-0) Interdepartmental with Epidemiology. Administered by Epidemiology. RB: College-level algebra. R: Open to masters students or doctoral students in the Epidemiology major or approval of department. SA: STT 425  
Applications of probability and statistics in the applied health sciences. Probability distributions, estimation and tests for one-, two-, and paired samples, linear regression, correlation, and ANOVA. Use of statistical software. Critical appraisal of statistical methods in the biomedical literature.
- 809 Biostatistics II**  
Spring. 3(3-0) Interdepartmental with Epidemiology. Administered by Epidemiology. P: EPI 808 RB: MTH 103 or MTH 110 or MTH 116 R: Open to masters students or doctoral students in the Epidemiology major or approval of department. SA: STT 426  
Analysis of categorical data in epidemiologic studies. Contingency tables and logistic regression.
- 814 Advanced Statistics for Biologists**  
Spring. 4(3-2) Interdepartmental with Animal Science and Crop and Soil Sciences. Administered by Statistics and Probability. RB: STT 464  
Concepts of reducing experimental error for biological and agricultural research. Covariance, randomized block designs, latin squares, split plots, repeated-measures designs, regression applications, and response surface designs. Analyses using statistical software.
- 820A Econometrics IA**  
Fall. 3(3-0) Interdepartmental with Economics. Administered by Economics. R: Open only to doctoral students in the Economics major or the Department of Agricultural Economics or the Business Administration major or approval of department.  
Statistical tools for econometrics. Applications of statistical tools, including probability distributions, estimation, hypothesis testing, and maximum likelihood to econometric problems.
- 821A Cross Section and Panel Data Econometrics I**  
Fall. 3(3-0) Interdepartmental with Agricultural Economics and Economics and Finance. Administered by Economics. P: EC 820B SA: EC 821  
Analyses of systems of equations, panel data models, instrumental variables and generalized method of moments, M-estimation, quantile regression, maximum likelihood estimation, binary and multinomial response models, Tobit and two-part models, and other selected topics.
- 821B Cross Section and Panel Data Econometrics II**  
Spring. 3(3-0) Interdepartmental with Agricultural Economics and Economics and Finance. Administered by Economics.  
Analyses of quasi-maximum likelihood estimation, count data models, fractional response models, duration models, sample selection and attrition, stratified sampling, estimating treatment effects, stochastic frontier models, and other advanced topics.
- 822A Time Series Econometrics I**  
Fall. 3(3-0) Interdepartmental with Agricultural Economics and Economics and Finance. Administered by Economics. P: EC 820B SA: EC 822  
Analyses of time series regression, stationary time series analysis, ARMA models, Wold decomposition, spectral analysis, vector autoregressions, generalized method of moments, functional central limit theorem, nonstationary time series, unit root processes, cointegration, and other advanced topics.
- 822B Time Series Econometrics II**  
Spring. 3(3-0) Interdepartmental with Agricultural Economics and Economics and Finance. Administered by Economics. P: EC 822A  
Analyses of multivariate time series, time series volatility models, long memory, nonlinear time series models, and other advanced topics.
- 825 Sample Surveys**  
Fall. 3(3-0) RB: STT 422 or STT 442 or STT 862  
Application of statistical sampling theory to survey designs. Simple random, stratified, and systematic samples. Sub-sampling, double sampling. Ratio and regression estimators.
- 843 Multivariate Analysis**  
Spring of even years. 3(3-0) RB: STT 442 or STT 862 Not open to students with credit in FW 850.  
Multivariate normal distribution, tests of hypotheses on means, multivariate analysis of variance. Discriminant analysis. Principal components. Factor analysis. Analysis of frequency data.
- 844 Time Series Analysis**  
Spring of odd years. 3(3-0) RB: STT 442 or STT 862  
Stationary time series. Autocorrelation and spectra. ARMA and ARIMA processes: estimation and forecasting. Seasonal ARIMA models. Identification and diagnostic techniques. Multivariate time series. Time series software.
- 847 Analysis of Survival Data**  
Spring of odd years. 3(3-0) Interdepartmental with Epidemiology. Administered by Statistics and Probability. RB: STT 422 or STT 442 or STT 862  
Analysis of lifetime data. Estimation of survival functions for parametric and nonparametric models. Censored data. The Cox proportional hazards model. Accelerated failure time models. Frailty models. Use of statistical software packages.
- 850 Applied Multivariate Statistical Methods**  
Spring of even years. 4(3-2) Interdepartmental with Fisheries and Wildlife. Administered by Fisheries and Wildlife. RB: (STT 422 or concurrently) and MTH 314 SA: FOR 976  
Application of multivariate methods to research problems. Hotelling's T-test, profile analysis, discriminant analysis, canonical correlation, principal components, principal coordinates, correspondence analysis, and cluster analysis.
- 855 Statistical Genetics**  
Fall of odd years. 3(3-0) RB: STT 442 or STT 862  
Probabilistic and statistical methods for genetic linkage and association studies. Quantitative trait locus mapping.
- 861 Theory of Probability and Statistics I**  
Fall. 3(3-0) RB: MTH 234 and MTH 309  
Probability models, random variables and vectors. Special distributions including exponential family. Expected values, covariance matrices, moment generating functions. Convergence in probability and distribution. Weak Law of Large Numbers and Lyapunov Central Limit Theorem.
- 862 Theory of Probability and Statistics II**  
Spring. 3(3-0) P: STT 861  
Statistical inference: sufficiency, estimation, confidence intervals and testing of hypotheses. One and two sample nonparametric tests. Linear models and Gauss-Markov Theorem.
- 863 Statistical Methods I**  
Fall. 3(3-0) RB: (STT 442 or STT 862) and MTH 415 SA: STT 841  
Introduction to the general theory of linear models. Application of regression models. Interval estimation, prediction and hypothesis testing. Contrasts; model diagnostics; model selection. LASSO type and high dimensional variable selection. Introduction to Linear mixed effect models.
- 864 Statistical Methods II**  
Spring. 3(3-0) RB: STT 863  
Generalized linear models (GLMs). Deviance and residual analysis in GLMs. Analysis of two-way and three-way contingency tables. Logistic regression. Log-linear models. Multicategorical response models. Poisson regression. Zero-inflated Poisson regression. Negative-binomial models. Overdispersed models. Quasi-likelihood models. Introduction to generalized estimating equations. Introduction to longitudinal data. Introduction to semi-parametric regression.

- 865 Advanced Statistical Methods**  
Fall. 3(3-0) RB: STT 864  
Laplace approximations. Penalized-quasi-likelihood functions. Expectation-Maximization (E-M) and Monte Carlo EM (MCEM) algorithm for mixed effect models. Markov Chain Monte Carlo methods. Additive Models. Trees and related methods. Bagging, boosting and random forest. Cluster analysis. Introduction to functional data analysis. Integrated nested Laplace approximations for high-dimensional problems.
- 866 Spatial Data Analysis**  
Fall. 4(3-2) Interdepartmental with Geography. Administered by Geography. RB: (GEO 363 or STT 421 or STT 430) or equivalent quantitative methods courses. SA: GEO 466  
Theory and techniques for statistical analysis of point patterns, spatially continuous data, and data in spatial zones.
- 871 Theory of Statistics I**  
Fall. 3(3-0) RB: (MTH 828 or concurrently) and (STT 881 or concurrently)  
Empirical distributions, quantiles, Glivenko-Cantelli Theorem. Important distributions and families. Convergences, Slutsky Theorem, asymptotics of differentiable functions. Basic concepts of decision theory. Confidence sets. Some basic statistical methods.
- 872 Theory of Statistics II**  
Spring. 3(3-0) RB: STT 871 and (STT 882 or concurrently)  
Theory of Neyman Pearson tests and extensions. Convex loss estimation, best unbiased estimates, sufficient statistics, information lower bounds. Extensive application to linear models. LAN families and applications to estimation and tests.
- 881 Theory of Probability I**  
Fall. 3(3-0) RB: MTH 828 or concurrently  
Measures and their extensions, integration, and convergence theorems. Product measures, Lebesgue decomposition, transition probabilities, Kolmogorov consistency theorem. Independence. Classical limit theorems for partial sums.
- 882 Theory of Probability II**  
Spring. 3(3-0) RB: STT 881  
Conditional expectation, martingales, stationary processes. Brownian motion, convergence in distribution, and the invariance principle.
- 886 Stochastic Processes and Applications**  
Fall. 3(3-0) RB: STT 441 or STT 861  
Markov chains and their applications in both discrete and continuous time, including classification of states, recurrence, limiting probabilities. Queuing theory, Poisson process and renewal theory.
- 888 Stochastic Models in Finance**  
Spring of even years. 3(3-0) RB: STT 441 or STT 861 SA: STT 887  
Stochastic models used in pricing financial derivatives. Discrete-time models. Brownian motion. Stochastic integrals and Ito's formula. Basic Black-Scholes model. Risk neutral distribution. European and American options. Exotic options. Interest rate market, futures, and interest rate options.
- 890 Statistical Problems**  
Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 24 credits in all enrollments for this course. R: Approval of department.  
Individualized study on selected problems.
- 899 Master's Thesis Research**  
Fall, Spring, Summer. 1 to 6 credits. A student may earn a maximum of 36 credits in all enrollments for this course. R: Approval of department.  
Master's thesis research.
- 914 Advanced Organizational Research Methods**  
Spring. 3(3-0) Interdepartmental with Management. Administered by Management. P: MGT 906  
Methods for empirically testing scientific theories in organizational contexts.
- 920 Advanced Methods in Epidemiology and Applied Statistics**  
Spring of even years. 3(3-0) Interdepartmental with Epidemiology. Administered by Epidemiology. P: EPI 826  
Pattern recognition and cluster analysis, longitudinal data analysis, path analysis, repeated measures and time-series analysis.
- 953 Asymptotic Theory**  
Fall of even years. 3(3-0) RB: STT 872  
Asymptotics of M- and R- estimators. Asymptotically efficient and adaptive procedures.
- 954 Semi-Nonparametric Inference**  
Fall of odd years. 3(3-0) RB: STT 872  
Robust procedures in regression and time series settings, nonparametric curve estimation, survival analysis in non- and semi-parametric models.
- 961 Convergence of Measures and Stochastic Processes**  
Spring of odd years. 3(3-0) RB: STT 882  
Convergence of measures on metric spaces. Prohorov's theorem. Function spaces with the uniform and Skorokhod metric. Empirical processes. Weak convergence of Martingales. Applications.
- 964 Stochastic Analysis**  
Spring of even years. 3(3-0) RB: STT 882  
Stochastic integrals and semi-martingales, Ito formula, stochastic differential equations. Applications.
- 990 Problems in Statistics and Probability**  
Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course. RB: STT 872 R: Approval of department.  
Individual study on an advanced topic in statistics or probability.
- 996 Advanced Topics in Probability**  
Fall, Spring, Summer. 3(3-0) A student may earn a maximum of 15 credits in all enrollments for this course. RB: STT 882 R: Approval of department.  
Current topics in probability.
- 997 Advanced Topics in Statistics**  
Fall, Spring, Summer. 3(3-0) A student may earn a maximum of 15 credits in all enrollments for this course. RB: STT 872 R: Approval of department.  
Topics selected from non- and semi parametric statistics, multivariate analysis, time series analysis, Bayesian statistics, regression and kernel estimation, and other topics in advanced statistics.
- 999 Doctoral Dissertation Research**  
Fall, Spring, Summer. 1 to 24 credits. A student may earn a maximum of 120 credits in all enrollments for this course. R: Approval of department.  
Doctoral dissertation research.