

# STATISTICS AND PROBABILITY

# STT

## Department of Statistics and Probability College of Natural Science

### 200 Statistical Methods

Fall, Spring, Summer. 3(4-0) P:M: (MTH 103 or MTH 110 or MTH 116 or MTH 124 or MTH 132 or LBS 117 or LBS 118) or designated score on Mathematics Placement test Not open to students with credit in STT 201 or STT 315 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:M: (MTH 103 or MTH 110 or MTH 116 or MTH 124 or MTH 132 or LBS 117 or LBS 118) or designated score on Mathematics Placement test Not open to students with credit in STT 200 or STT 315 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.

### 231 Statistics for Scientists

Fall, Spring, Summer. 3(3-0) P:M: MTH 124 or MTH 132 or MTH 152H or LBS 118 R: Open to students in the College of Natural Science. 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.

### 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:M: MTH 124 or MTH 132 or MTH 152H or LBS 118 Not open to students with credit in STT 200 or STT 201 or STT 421.

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(3-1) Interdepartmental with Marketing and Supply Chain Management. Administered by Marketing and Supply Chain Management. P:M: (STT 315) R: Open only to juniors or seniors in The Eli Broad College of Business. Not open to students in The School of Hospitality Business. SA: ML 317, MTA 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:M: MTH 234 or MTH 254H or LBS 220 R: Open only to juniors or seniors. Not open to students with credit in STT 430.

Probability and statistics for engineering majors. Probability models and random variables. Estimation, confidence intervals, tests of hypotheses, simple linear regression. Applications to engineering.

### 421 Statistics I

Fall, Spring, Summer. 3(3-0) P:M: MTH 103 or MTH 110 or MTH 116 or LBS 117 Not open to students with credit in STT 200 or STT 201 or STT 315.

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.

### 425 Introduction to Biostatistics I

Fall. 3(3-0) P:M: (MTH 103 or MTH 110 or MTH 116 or LBS 117) or designated score on Mathematics Placement test Not open to students with credit in STT 200 or STT 201 or STT 315 or STT 421.

Basic probability. Density and specificity of diagnostic tests. Discrete and continuous distributions. Estimation. Hypothesis testing from one and two samples. Sample size and power.

### 426 Introduction to Biostatistics II

Spring. 3(3-0) P:M: STT 425

Inference from two-samples. Paired samples. Analyses of categorical data. Contingency tables. Linear regression and ANOVA. Design and analysis of epidemiologic studies. Confounding. Mantel-Haenszel tests.

### 430 Introduction to Probability and Statistics

Fall, Spring. 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, simple linear regression.

### 441 Probability and Statistics I: Probability

Fall, Spring, Summer. 3(3-0) RB: MTH 234 or MTH 254H or LBS 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 314

Estimation, tests of hypotheses, confidence intervals. Goodness of fit, non-parametric methods. Linear models, multiple regression, ANOVA.

### 455 Actuarial Models

Spring. 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.

### 461 Computations in Probability and Statistics

Spring. 3(3-0) RB: (CSE 131 or CSE 230) and (MTH 314 and STT 441)

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.

### 471 Statistics for Quality and Productivity

Fall of even years. 3(3-0) RB: STT 351 or STT 422 or STT 442

Scientific context of quality: Box, Deming, Taguchi. Graphical techniques, control charts. Design of experiments: factorials and fractional factorials, confounding and aliasing. Engineering parameter design through experimentation.

### 481 Issues in Statistical Practice

Spring. 1(1-0) P:M: 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 odd years. 3(3-0) RB: STT 422 or STT 442 or STT 465 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.

### 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.

## Statistics and Probability—STT

- 818 Introduction to Econometrics**  
Spring. 3(3-0) Interdepartmental with Agricultural Economics and Economics. Administered by Economics. P:M: STT 430 R: Not open to doctoral students in the Economics major. SA: EC 820  
The single equation regression model. Properties of least-squares estimators under various specifications. Multicollinearity, heteroskedasticity, serial correlation, and generalized least squares.
- 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.
- 821 Econometrics II**  
Fall. 3(3-0) Interdepartmental with Agricultural Economics and Economics. Administered by Economics. P:M: EC 820A and EC 820B  
Analysis of cross-sectional economic data. Qualitative and limited dependent variables. Probit, logit, tobit, and sample selectivity. Duration models. Count data. Analysis of panel data.
- 822 Econometrics III**  
Spring. 3(3-0) Interdepartmental with Agricultural Economics and Economics. Administered by Economics. P:M: EC 820A and EC 820B  
Dynamic models and time series data. ARMA models. ARCH models. Unit roots, cointegration and error correction. Rational expectations models.
- 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.
- 842 Categorical Data Analysis**  
Spring of odd years. 3(3-0) RB: STT 442 or STT 862  
Analysis of categorical and ordinal data: contingency tables; chi square tests; exact tests; log-linear models; measures of association; logistic regression; generalized linear models.
- 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 even 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. 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.
- 861 Theory of Probability and Statistics I**  
Fall. 3(3-0) RB: MTH 320 or concurrently  
Discrete and continuous random variables and vectors. Important probability models. Inequalities and limit laws. Sampling distributions and functions of random vectors. Statistical inference.
- 862 Theory of Probability and Statistics II**  
Spring. 3(3-0) RB: STT 861 and (MTH 415 or concurrently)  
Statistical inference: sufficiency, likelihood, estimation, and tests of hypotheses in parametric and nonparametric cases. Linear models, goodness of fit, and other topics.
- 863 Applied Statistics Methods I**  
Fall. 3(3-0) RB: (STT 442 or STT 862) and (MTH 415 or concurrently) SA: STT 841  
Application of regression models including simple and multiple regression, model diagnostics, model selection, one- and two-way analysis of variance, mixed effects models, randomized block designs, and logistic regression.
- 864 Applied Statistical Methods II**  
Spring of odd years. 3(3-0) RB: STT 863  
Generalized linear models, loglinear models, hierarchical models, repeated measures, discriminant analysis and classification, clustering, regression, classification trees, selected nonparametric methods.
- 865 Modern Statistical Methods**  
Spring of even years. 3(3-0) RB: STT 863  
Modern statistical methods. Applicability and computer implementation. Resampling methods, including the bootstrap. Markov chain Monte Carlo methods. Survival analysis. Nonparametric curve estimation.
- 866 Spatial Data Analysis**  
Spring. 4(3-2) Interdepartmental with Geography. Administered by Geography. RB: (GEO 463 or STT 421 or STT 430) or 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. 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, the basic Black-Scholes model, risk neutral distribution, European and American options, exotic options, the 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 Applied Regression Models in Business Research**  
Spring. 3(3-0) Interdepartmental with Management. Administered by Management. RB: (STT 430 or STT 441) or or equivalent R: Open only to Ph.D. students in the College of Business or approval of department.  
Seminar on design and analysis of regression-based statistical models. Modeling issues arising in business research.

## STT—Statistics and Probability

**920 Advanced Methods in Epidemiology and Applied Statistics**

Spring of even years. 3(3-0) Interdepartmental with Epidemiology. Administered by Epidemiology. P:M: EPI 826

Pattern recognition and cluster analysis, longitudinal data analysis, path analysis, repeated measures and time-series analysis.

**953 Asymptotic Theory**

Fall of odd 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**

Fall of even 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.