### Department of Statistics and Probability

#### College of Natural Science

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Prerequisites</th>
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<tr>
<td>200</td>
<td>Statistical Methods</td>
<td>Fall, Spring. 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. 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.</td>
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<tr>
<td>201</td>
<td>Statistical Methods</td>
<td>Fall, Spring. 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.</td>
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<tr>
<td>224</td>
<td>Introduction to Probability and Statistics for Ecologists</td>
<td>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) 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: (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)</td>
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<tr>
<td>231</td>
<td>Statistics for Scientists</td>
<td>Fall, Spring. 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. Students with credit in STT 231. Probability and statistics with computer applications. Data analysis, probability models, random variables, estimation, confidence intervals, tests of hypotheses, and simple linear regression with applications to ecology.</td>
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<tr>
<td>290</td>
<td>Topics in Statistics and Probability</td>
<td>Fall, Spring. Summer. 1 to 3 credits. RB: MTH 103 R: Approval of department. Individualized study of selected topics.</td>
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<td>301</td>
<td>Computational Methods for Data Science</td>
<td>Fall. 3(3-0) P: (MTH 132 or LB 118 or MTH 152H) and (STT 200 or STT 201 or STT 231 or STT 315 or STT 421 or STT 441) Obtaining and managing data using statistical software. Data visualization and graphics. Special challenges in working with high-dimensional data.</td>
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<tr>
<td>315</td>
<td>Introduction to Probability and Statistics for Business</td>
<td>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.</td>
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<tr>
<td>317</td>
<td>Quantitative Business Research Methods</td>
<td>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 application of linear regression and correlation, analysis of variance, selected non-parametric tests, time series, and index numbers.</td>
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<td>351</td>
<td>Probability and Statistics for Engineering</td>
<td>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.</td>
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<td>421</td>
<td>Statistics I</td>
<td>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.</td>
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<td>422</td>
<td>Statistics II</td>
<td>Fall, Spring. Summer. 3(3-0) P: 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.</td>
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<td>430</td>
<td>Introduction to Probability and Statistics</td>
<td>Fall, Spring. Summer. 3(3-0) P: (MTH 234 or concurrently) or (MTH 254H or concurrently) or (LB 220 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.</td>
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<td>441</td>
<td>Probability and Statistics I: Probability</td>
<td>Fall, Spring. Summer. 3(3-0) P: MTH 234 or MTH 254H or LB 220 or approval of college 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.</td>
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<td>442</td>
<td>Probability and Statistics II: Statistics</td>
<td>Spring. 3(3-0) P: STT 441 and (MTH 309 or MTH 314 or MTH 317H 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.</td>
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<td>455</td>
<td>Actuarial Models I</td>
<td>Fall. 3(3-0) Interdepartmental with Mathematics. Administered by Statistics and Probability. P: 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.</td>
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<td>461</td>
<td>Computations in Probability and Statistics</td>
<td>Spring. 3(3-0) P: (STT 441 and CSE 231) and (MTH 309 or MTH 314 or MTH 317H or MTH 415) 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.</td>
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<td>464</td>
<td>Statistics for Biologists</td>
<td>Fall. 3(3-0) Interdepartmental with Animal Science and Crop and Soil Sciences. Administered by Statistics and Probability. P: MTH 103 or MTH 110 or MTH 116 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.</td>
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801 Design of Experiments  
Fall of even years. 3(3-0) RB: STT 422 or STT 442 or STT 471

802 Statistical Computation  
Fall of even years. 3(3-0) RB: (STT 442 and MTH 309) or (mathematical statistics and linear algebra)  

805 Statistical Modeling for Business Analytics  
Summer. 3(3-0) RB: STT 442 R: Open to master's students in the Business Analytics Major.

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

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 or 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, Food, and Resource Economics and Economics and Finance. Administered by Economics. P: EC 821A
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.

844 Time Series Analysis  
Spring of odd years. 3(3-0) RB: STT 442 or STT 862

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

849 Applied Bayesian Inference using Monte Carlo Methods for Quantitative Biologists  
Fall of even years. 3(2-2) Interdepartmental with Animal Science and Fisheries and Wildlife. Administered by Fisheries and Wildlife. RB: (STT 814 and IBIO 851) or equivalent courses. R: Not open to undergraduate students.

850 Applied Multivariate Statistical Methods  
Fall. 3(2-2) Interdepartmental with Animal Science and Fisheries and Wildlife. Administered by Fisheries and Wildlife. RB: (STT 422 or concurrently) and MTH 314 SA: FOR 976
Applications 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

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.
STT—Statistics and Probability

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) P: STT 863

866  Spatial Data Analysis  
Fall: 4.5(3-2) Interdepartmental with Geography. RB: (GEO 363 or STT 421 or STT 430) or equivalent quantitative methods courses. SA: GEO 486 Theory and techniques for statistical analysis of point patterns, spatially continuous data, and data in spatial zones.

867  Linear Model Methodology  
Fall: 3(3-0) P: STT 862 R: Open to doctoral students in the Department of Statistics and Probability or approval of department.
Properties of the multivariate normal distribution, Cochran's Theorem, simple and multiple linear regression models, Gauss-Markov Theorem, best linear unbiased prediction, one- and two-way ANOVA models, sums of squares, diagnostics and model selection, contingency tables and multinomial models, generalized linear models, logistic regression.

868  Mixed Models: Theory, Methods and Applications  
Spring: 3(3-0) P: STT 867 R: Open to doctoral students in the Statistics major or approval of department.

872  Statistical Inference I  
Spring: 3(3-0) P: STT 862 and STT 881 R: Open to doctoral students in the Statistics major or approval of department.
Statistical distributions, decision-theoretic formulation of estimation and testing of hypotheses, sufficiency, Rao-Blackwellization, admissibility, Bayes and minimax estimation, maximum likelihood estimation, inference based on order statistics, Neyman-Pearson Lemma and applications, multiple testing.

873  Statistical Learning and Data Mining  
Fall of odd years: 3(3-0) P: STT 868 and STT 872 R: Open to doctoral students in the Statistics major or approval of department.
Statistical methods focusing on machine learning and data mining, modern regression and classification techniques, support vector machines, boosting, kernel methods and ensemble methods, clustering, dimension reduction, manifold learning, and selected topics.

874  Introduction to Bayesian Analysis  
Fall of even years: 3(3-0) P: STT 868 and STT 872 R: Open to doctoral students in the Statistics major or approval of department.
Bayesian methods including empirical Bayes, hierarchical Bayes and nonparametric Bayes, computational methods for Bayesian inference including the Gibbs Sampler and Metropolis-Hastings method, and applications.

875  Theory of Probability I  
Fall: 3(3-0) P: STT 861 and MTH 421 R: Open to doctoral students in the Statistics major or approval of department.

882  Theory of Probability II  
Spring: 3(3-0) P: STT 881 R: Open to doctoral students in the Statistics major or approval of department.

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

890  Statistical Problems  
Fall, Spring, Summer. 1 or 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. 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 505
Methods for empirically testing scientific theories in organizational contexts.

920  Advanced Methods in Epidemiology and Applied Statistics  
Spring: 3(3-0) Interdepartmental with Epidemiology. Administered by Epidemiology. P: (EPI 826B or concurrently) or EPI 826 or approval of department R: Open to graduate students in the Department of Epidemiology and Biostatistics or approval of department.
Pattern recognition and cluster analysis, longitudinal data analysis, path analysis, repeated measures and time-series analysis.

953  Asymptotic Theory  
Spring of even years: 3(3-0) P: STT 872 and STT 882 R: Open to doctoral students in the Statistics major or approval of department.
Locally asymptotic normal models, empirical likelihood, U-statistics, Asymptotically efficient and adaptive procedures.

962  Fractional Processes and Power Laws  
Spring of even years: 3(3-0) P: STT 872 and STT 882 R: Open to doctoral students in the Statistics major or approval of department.
Maximal inequalities, covering numbers, symmetrization technique, Glivenko-Cantelli Theorems, Donsker Theorems and some results for Gaussian processes, Vapnik-Chervonenkis classes of sets and functions, applications to M-estimators, bootstrap, delta-method

964  Stochastic Analysis  
Spring of even years: 3(3-0) RB: STT 882

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.
Statistics and Probability—STT

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 36 credits in all enrollments for this course. R: Approval of department.
Doctoral dissertation research.