STATISTICS AND PROBABILITY

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. Week day lab using statistical software.

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.

301 Computational Methods for Data Science
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.

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 MTH 152H or LB 118) or designated score on Mathematics Placement test Not open to students with credit in STT 430. 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) P: STT 421 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) P: (MTH 234 or MTH 254H 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.

441 Probability and Statistics I: Probability
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.

442 Probability and Statistics II: Statistics
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.

455 Actuarial Models I
Fall, Spring, Summer. 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.

456 Actuarial Models II

458 Financial Mathematics for Actuaries

459 Construction and Evaluation of Actuarial Models

461 Computations in Probability and Statistics
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.
Statistics and Probability—STT

464 Computational techniques commonly used in Statis-
Biostatistics II
Spring. 3(3-0) Interdepartmental with Epidemi-
biological random variables. Estimation of popula-
Stochastic simulation. Implementation in statistical
ical integration. Generation of random numbers and
Least Absolute Deviations. Solution of nonlinear

465 Bayesian Statistical Methods
Fall. 3(3-0) A student may earn a maximum of 0
Probability, belief, and exchangeability. Objective,
erial and empirical Bayes approaches. Applications
to one-parameter models, linear regression models,
and multivariate normal models. Hierarchi-
chical modeling. Computational methods.

481 Capstone in Statistics (W)
Spring. 3(3-0) P: (STT 442 or approval of
approval of department. Selected readings and projects illustrating special
problems encountered by statisticians in their roles as
consultants, educators, researchers and analy-
sists.

490 Directed Study of Statistical Problems
Fall, Spring. Summer. 1 to 3 credits. A stu-
dent may earn a maximum of 9 credits in all
enrollments for this course. R: Open to seniors in the
Department of Statistics and Probability. Approval of department.

491 Design of Experiments
Fall. 3(3-0) RB: MTH 314 SA: FOR
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.

801 Statistical Computation
Fall of even years. 3(3-0) RB: MTH 309
Computational techniques commonly used in Statis-
tics. Matrix decompositions. Least squares and
Least Absolute Deviations. Solution of nonlinear
equations. Optimization techniques including the
EM algorithm and constrained optimization. Numer-
ical integration. Generation of random numbers and
stochastic simulation. Implementation in statistical
software.

808 Biostatistics I
Fall. 3(3-0) Interdepartmental with Epidemi-
Biostatistics II
Spring. 3(3-0) Interdepartmental with Epi-
demology. 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 stud-
ies. Contingency tables and logistic regression.

814 Advanced Statistics for Biologists
Spring. 4(3-2) Interdepartmental with Animal
Science and Crop and Soil Sciences. Ad-
ministered by Statistics and Probability. RB:
STT 464
Concepts of reducing experimental error for biological and agronomic research. Covariance, random-
ized block designs, latin squares, split plots, repeat-
ed-measures designs, regression applications, and
response surface designs. Analyses using statisti-
cal software.

820A Econometrics IA
Fall. 3(3-0) Interdepartmental with Econom-
ics. 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.

821A Cross Section and Panel Data
Econometrics I
Fall. 3(3-0) Interdepartmental with Agricul-
tural Economics and Economics and Fi-
bine. Administered by Economics. P: EC
820B SA: EC 821
Analyses of systems of equations, panel data mod-
els, instrumental variables and generalized method
of moments, M-estimation, quantile regression,
maximum likelihood estimation, binary and multinu-
merial 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 Agri-
cultural Economics and Economics and Fi-
bine. Administered by Economics.
Analyses of quasi-maximum likelihood estimation,
count data, fractional response models, duration models, sample selection and attrition,
stratified sampling, estimating treatment effects,
stoichiometric frontier models, and other advanced
topics.

822A Time Series Econometrics I
Fall. 3(3-0) Interdepartmental with Agricul-
tural Economics and Economics and Fi-
bine. Administered by Economics. P: EC
820B SA: EC 822
Analyses of time series regression, stationary time
series analysis. ARMA models, Wold decomposi-
tion, spectral analysis, vector autoregressions,
generalized method of moments, functional central
limit theorem, nonstationary time series, unit root
processes, cointegration, and other advanced top-
ics.

822B Time Series Econometrics II
Spring. 3(3-0) Interdepartmental with Agri-
cultural Economics and Economics and Fi-
bine. 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 442 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. Discri-
minant analysis. Principal components. Factor anal-
ysis. 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 fore-
casting. 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) Interdepart-
mental with Epidemiology. Administered by Statistics and Probability. RB: STT 442 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.

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 ZOL 851) or
equivalent courses. R: Not open to under-
graduate students.

Applications of Bayesian inference using software in
quantitative biology and genetics. Hierarchical and
non-hierarchical models. Model checking, model
selection and model comparison. Markov chain
Monte Carlo methods.

850 Applied Multivariate Statistical Methods
Spring of even years. 4(3-2) Interdepart-
mental with Fisheries and Wildlife. Adminis-
tered by Fisheries and Wildlife. RB: (STT
442 or concurrently) and MTH 314 SA: FOR
976
Application of multivariate methods to research
problems. Hotelling's T-test, profile analysis, discrimi-
nant 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) P: STT 863

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
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.

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

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 866 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 odd 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.

881 Theory of Probability I

882 Theory of Probability II
Spring. 3(3-0) R: Open to doctoral students in the Statistics major or approval of department. Random walks, transience and recurrence. Martin-gales, martingale convergence theorem, Doob's inequality, optional stopping theorem. Stationary processes and Ergodic theorem. Brownian motion. Kolmogorov's continuity theorem, strong Markov property, the reflection principle, martingales related to Brownian motion. Weak convergence in C([0,1]) and D([0,1]), Donsker's invariance principle, empirical processes.

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. 2(2-0) SA: STT 887

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.

951 Statistical Inference II
Spring of odd years. 3(3-0) P: STT 872 and STT 882 R: Open to doctoral students in the Statistics major or approval of department. Decision theoretic estimation: Minimaxity, admissibility, shrinkage estimators, James-Stein estimators. Advanced estimation theory, maximal invariant tests, multiple testing, FDR, and related methods. Permutation and rank tests, unbiasedness and invariance, Hunt Stein theorem.

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.

961 Weak Convergence and Asymptotic Theory
Fall of odd years. 3(3-0) P: STT 872 and STT 882 R: Open to doctoral students in the Statistics major or approval of department. Weak convergence, 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

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. Self-similar processes. Fractional Brownian motion, fractional stable motions. Fractional calculus, Laplace and Fourier transforms, semigroups and generators. Continuous time random walks. Conne ctions between long range dependence, heavy tails, and fractional calculus. Inference for processes with long range dependence and heavy tails, including fractional ARIMA models, ARCH/GARCH models, and random difference equations.

964 Stochastic Analysis
Spring of even years. 3(3-0) RB: STT 882
Statistics and Probability—STT

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