Statistics

Undergraduate Study

For the undergraduate curriculum in liberal arts and sciences, major in statistics, leading to the degree bachelor of science, see Liberal Arts and Sciences, Curriculum.

The curriculum in liberal arts and sciences with a major in statistics is designed to prepare students for (1) entry level statistics positions requiring the B.S. degree in statistics in business, industry or commerce, nonprofit institutions, and in state or federal government; (2) graduate study in statistics. Entry-level positions include the following types of work: statistical design, analysis and interpretation of experiments and surveys; data processing and analysis using modern computation facilities and statistical computing systems; application of statistical principles and methods in commercial areas such as finance, insurance, industrial research, marketing, manufacturing, and quality control. Nonprofit organizations such as large health study institutions have entry-level positions for B.S. graduates in statistics. Also, there are opportunities for work in statistics that require a major in a subject-matter field and a minor in statistics.

Students completing the undergraduate degree in statistics should have a broad understanding of the discipline of statistics. They should have a clear comprehension of the theoretical basis of statistical reasoning and should be proficient in the use of modern statistical methods and computing. Such graduates should have an ability to apply and convey statistical concepts and knowledge in oral and written form. They should be aware of ethical issues associated with polling and surveys and in the summarization of the outcomes of statistical studies.

Undergraduate majors in this department usually include in their programs:

STAT 201	Introduction to Statistical Concepts and Methods	4
One of the following options		
Option I		
MATH 165	Calculus I	
MATH 166	Calculus II	
MATH 265	Calculus III	
Option II		
MATH 165	Calculus I	
MATH 166H	Calculus II, Honors	
MATH 265H	Calculus III, Honors	
MATH 207	Matrices and Linear Algebra	3-4
or MATH 317	Theory of Linear Algebra	
COM S 207	Fundamentals of Computer Programming	3
STAT 301	Intermediate Statistical Concepts and Methods	4
STAT 341	Introduction to the Theory of Probability and Statistics I	3
STAT 342	Introduction to the Theory of Probability and Statistics II	3
STAT 402	Statistical Design and the Analysis of Experiments	3
STAT 421	Survey Sampling Techniques	3
STAT 479	Computer Processing of Statistical Data	3
STAT 480	Statistical Computing Applications	3

These courses plus at least six additional credits in statistics at the 400 level or above constitute the major. With the permission of the department, I E 361 Statistical Quality Assurance/STAT 361 Statistical Quality Assurance may be substituted for three credits of 400 level courses. It is advisable to have a minor in a field of application. See also: A 4-year plan of study grid showing course template by semester (https://nextcatalog.registrar.iastate.edu/planofstudy/liberalartsandsciences/#statisticsbs) .

Minor

The department offers a minor in statistics which may be earned by completing an introductory course in statistics plus additional courses from 301, 326, 341, 342, 361, and 400 level or above to yield a total of at least 15 credits in statistics courses.

English and Speech proficiency requirement: The department requires a grade of C– or better in each of ENGL 150 Critical Thinking and Communication and ENGL 250 Written, Oral, Visual, and Electronic Composition (or ENGL 250H Written, Oral, Visual, and Electronic Composition: Honors), and completion of one of ENGL 302 Business Communication or ENGL 314 Technical Communication with a grade of C- or better. The department requires a passing grade in COMST 102 Introduction to Interpersonal Communication or SP CM 212 Fundamentals of Public Speaking.

Students intending to do graduate work in statistics normally will take additional courses in mathematics.

Graduate Study

The department offers work for the degrees master of science and doctor of philosophy with a major in statistics, and for a minor for students majoring in other departments. Within the statistics major the student choose to emphasize topics such as experimental design, probability, statistical methods, statistical theory, statistical computing, survey sampling, quality control, spatial statistics, time series, reliability, or applied statistics (e.g., bioinformatics, biometrics, econometrics, environmental statistics, psychometrics, sociometrics, etc.). A major in operations research leading to a master of science degree is offered in cooperation with the Department of Industrial and Manufacturing Systems Engineering. The doctor of philosophy degree is offered as a co-major with other graduate programs. Such programs have included graduate majors in Agronomy, Animal Ecology, Animal Science, Bioinformatics, Chemical and Biological Engineering, Computer Science, Electrical Engineering, Ecology, Evolution and Organismal Biology (EEOB), Economics, Educational Leadership and Policy Studies, Food Science and Human Nutrition, Genetics, Development and Cell Biology (GDCB), Industrial and Manufacturing Systems Engineering, Mathematics, Meteorology, Psychology and Sociology.

M.S. graduates have a basic understanding of statistical theory and methods. Elective courses in statistics provide the opportunity for the student to emphasize particular areas within the field of statistics, based on interest and future career goals. Communication skills are developed through course projects, assistantship duties and creative components. Ph.D. graduates study advanced theory and methods and are able to do independent research in statistics and collaborative research outside of statistics.

Prerequisite to major graduate work is the completion of an undergraduate curriculum essentially equivalent to the curriculum in liberal arts and sciences at this institution including at least a year of calculus.

The degree master of science may be earned on either a thesis or nonthesis basis. The nonthesis option requires the completion of at least 34 credits of acceptable graduate work, including the completion of a creative component and satisfactory performance on a written examination. The thesis option requires the completion of 30 credits of acceptable graduate work, including the completion of a thesis and satisfactory performance on a written examination. Ph.D. candidates must complete at least 72 semester credits (half or more from Iowa State) with a minimum 3.0 (B) average and submit an original thesis representing a substantial contribution to statistics as a science.

The department encourages students to prepare themselves in foreign languages and in computer languages, but specific requirements for the degrees master of science and doctor of philosophy are at the discretion of the student's advisory committee.

The department participates in the interdepartmental programs in bioinformatics and computational biology, ecology and evolutionary biology, forensic research, genetics, human computer interaction, and nutrition.

Courses primarily for undergraduates:

STAT 100. Orientation in Statistics.
(1-0) Cr. R. F.
Opportunities, challenges, and the scope of the curriculum in statistics. For students planning or considering a career in this area.

STAT 101. Principles of Statistics.
(3-2) Cr. 4. F.S.SS. *Prereq: 1 1/2 years of high school algebra*
Statistical concepts in modern society; descriptive statistics and graphical displays of data; the normal distribution; data collection (sampling and designing experiments); elementary probability; elements of statistical inference; estimation and hypothesis testing; linear regression and correlation; contingency tables. Credit for only one of the following courses may be applied toward graduation: Stat 101, 104, 105, 201, or 226.

STAT 104. Introduction to Statistics.
(2-2) Cr. 3. F.S.SS. *Prereq: 1 1/2 years of high school algebra*
Statistical concepts and their use in science; collecting, organizing and drawing conclusions from data; elementary probability; binomial and normal distributions; regression; estimation and hypothesis testing. For students in the agricultural and biological sciences. Credit for only one of the following courses may be applied toward graduation: Stat 101, 104, 105, 201, 226.

STAT 105. Introduction to Statistics for Engineers.
(3-0) Cr. 3. F.S. *Prereq: MATH 165 (or MATH 165H)*
Statistical concepts with emphasis on engineering applications. Data collection; descriptive statistics; probability distributions and their properties; elements of statistical inference; regression; statistical quality control charts; use of statistical software; team project involving data collection, description and analysis. Credit for only one of the following courses may be applied toward graduation: Stat 101, 104, 105, 201, 226. Credit for both Stat 105 and 305 may not be applied for graduation.

STAT 201. Introduction to Statistical Concepts and Methods.
(3-2) Cr. 4. S. *Prereq: Credit or enrollment in MATH 165*
Statistical thinking and applications of statistical concepts and methods in modern society. Display and summary of categorical and numerical data. Exploring relationships between variables, association, correlation, and regression. Observational studies and experiments. Probability concepts, random variables, discrete and continuous distributions. Elements of statistical inference; estimation and hypothesis testing. Credit for only one of the following courses may be applied toward graduation: Stat 101, 104, 105, 201, and 226.

STAT 226. Introduction to Business Statistics I.
(3-0) Cr. 3. F.S.SS. *Prereq: MATH 150 or MATH 165*
Obtaining, presenting, and organizing statistical data; measures of location and dispersion; the Normal distribution; sampling and sampling distributions; elements of statistical inference; estimation and confidence intervals; hypothesis testing; inference for simple linear regression analysis; use of computers to visualize and analyze data. Credit for only one of the following courses may be applied toward graduation: Stat 101, 104, 105, 201, 226.

STAT 231. Probability and Statistical Inference for Engineers.
(4-0) Cr. 4. F.S. *Prereq: Credit or enrollment in MATH 265*
Emphasis on engineering applications. Basic probability; random variables and probability distributions; joint and sampling distributions. Descriptive statistics; confidence intervals; hypothesis testing; simple linear regression; multiple linear regression; one way analysis of variance; use of statistical software.

STAT 301. Intermediate Statistical Concepts and Methods.
(3-2) Cr. 4. F.S. *Prereq: STAT 101 or STAT 104 or STAT 105 or STAT 201*
Statistical concepts and methods used in the analysis of data. Statistical models. Analysis of single sample, two sample and paired sample data. Simple and multiple linear regression including polynomial regression. Analysis of residuals. Regression diagnostics. Model building. Regression with indicator variables. Credit for only one of the following courses may be applied toward graduation: STAT 301, STAT 326, and STAT 401

STAT 305. Engineering Statistics.
(3-0) Cr. 3. F.S.SS. *Prereq: MATH 165 (or MATH 165H)*
Statistics for engineering problem solving. Principles of engineering data collection; descriptive statistics; elementary probability distributions; principles of experimentation; confidence intervals and significance tests; one-, two-, and multi-sample studies; regression analysis; use of statistical software; team project involving engineering experimentation and data analysis. Credit for both Stat 105 and 305 may not be applied for graduation.

STAT 322. Probabilistic Methods for Electrical Engineers.
(Cross-listed with E E). (3-0) Cr. 3. F.S. *Prereq: E E 224*
Introduction to probability with applications to electrical engineering. Sets and events, probability space, conditional probability, total probability and Bayes' rule. Discrete and continuous random variables, cumulative distribution function, probability mass and density functions, expectation, moments, moment generating functions, multiple random variables, functions of random variables. Elements of statistics, hypothesis testing, confidence intervals, least squares. Introduction to random processes.

STAT 326. Introduction to Business Statistics II.
(2-2) Cr. 3. F.S. *Prereq: STAT 226*
Multiple regression analysis; regression diagnostics; model building; applications in analysis of variance and time series; random variables; distributions; conditional probability; statistical process control methods; use of computers to visualize and analyze data.

STAT 330. Probability and Statistics for Computer Science.
(3-0) Cr. 3. F.S. *Prereq: MATH 166*
Topics from probability and statistics applicable to computer science. Basic probability; Random variables and their distributions; Stochastic processes including Markov chains; Queuing models; Basic statistical inference; Introduction to regression. Nonmajor graduate credit.

STAT 332. Visual Communication of Quantitative Information.
(Cross-listed with ENGL). (3-0) Cr. 3. Alt. S., offered 2012. *Prereq: STAT 101, STAT 104, STAT 201 or STAT 226; ENGL 250*
Communicating quantitative information using visual displays; visualizing data; interactive and dynamic data displays; evaluating current examples in the media; color, perception, and representation in graphs; interpreting data displays. Nonmajor graduate credit.

STAT 341. Introduction to the Theory of Probability and Statistics I.
(Cross-listed with MATH). (3-0) Cr. 3. F.S. *Prereq: MATH 265 (or MATH 265H)*
Probability; distribution functions and their properties; classical discrete and continuous distribution functions; multivariate probability distributions and their properties; moment generating functions; simulation of random variables and use of the R statistical package. Credit for both Stat 341 and 447 may not be applied toward graduation.

STAT 342. Introduction to the Theory of Probability and Statistics II.
(Cross-listed with MATH). (3-0) Cr. 3. F.S. *Prereq: STAT 341; MATH 307 or MATH 317*
Transformations of random variables; sampling distributions; confidence intervals and hypothesis testing; theory of estimation and hypothesis tests; linear model theory; use of the R statistical package for simulation and data analysis.

STAT 361. Statistical Quality Assurance.
(Cross-listed with I E). (2-2) Cr. 3. F.S. *Prereq: STAT 231, STAT 301, STAT 326 or STAT 401*
Statistical methods for process improvement. Simple quality assurance principles and tools. Measurement system precision and accuracy assessment. Control charts. Process capability assessment. Experimental design and analysis for process improvement. Significant external project in process improvement. Nonmajor graduate credit.

STAT 398. Cooperative Education.
Cr. R. F.S.SS. *Prereq: Permission of department chair*
Off-campus work periods for undergraduate students in a field of statistics.

STAT 401. Statistical Methods for Research Workers.
(3-2) Cr. 4. F.S.SS. *Prereq: STAT 101 or STAT 104 or STAT 105 or STAT 201 or STAT 226*
Graduate students without an equivalent course should contact the department. Methods of analyzing and interpreting experimental and survey data. Statistical concepts and models; estimation; hypothesis tests with continuous and discrete data; simple and multiple linear regression and correlation; introduction to analysis of variance and blocking. Nonmajor graduate credit. Only one of STAT 301 and 401 may count toward graduation.

STAT 402. Statistical Design and the Analysis of Experiments.
(3-0) Cr. 3. F.S. *Prereq: STAT 301 or STAT 326 or STAT 401*
The role of statistics in research and the principles of experimental design. Experimental units, randomization, replication, blocking, subdividing and repeatedly measuring experimental units; factorial treatment designs and confounding; extensions of the analysis of variance to cover general crossed and nested classifications and models that include both classificatory and continuous factors. Determining sample size. Nonmajor graduate credit.

STAT 404. Regression for Social and Behavioral Research.
(2-2) Cr. 3. F.S. *Prereq: STAT 301 or STAT 326 or STAT 401*
Lorenz. Applications of generalized linear regression models to social science data. Assumptions of regression; diagnostics and transformations; analysis of variance and covariance; path analysis; logistic, multinomial and Poisson regression. Nonmajor graduate credit.

STAT 406. Statistical Methods for Spatial Data.
(3-0) Cr. 3. Alt. S., offered 2014. *Prereq: Six hours of statistics at the 400-level*
The analysis of spatial data; geostatistical methods and spatial prediction; discrete index random fields and Markov random field models; models for spatial point processes. Emphasis on application and practical use of spatial statistical analysis. Nonmajor graduate credit.

STAT 407. Methods of Multivariate Analysis.
(2-2) Cr. 3. F. *Prereq: STAT 301 or STAT 326 or STAT 401, knowledge of matrix algebra*
Techniques for displaying and analyzing multivariate data including plotting high-dimensional data using interactive graphics, comparing group mean vectors using Hotelling's T2, multivariate analysis of variance, reducing variable dimension with principal components, grouping/classifying observations with cluster analysis and discriminant analysis. Imputation of missing multivariate observations. Nonmajor graduate credit.

STAT 410. Statistical Methods for Mathematics Teachers.
(6-0) Cr. 6. Alt. SS., offered 2014. *Prereq: STAT 341 or equivalent*
Descriptive statistics; data collection through experimentation and sampling; univariate statistical inference; contingency tables; design of experiments and ANOVA; simple linear regression; logistic regression; multiple linear regression; statistics pedagogy.

STAT 415. Advanced Statistical Methods for Research Workers.
(1-0) Cr. 1. Repeatable, maximum of 3 credits. S. *Prereq: STAT 301 or STAT 326 or STAT 401*
Advanced statistical methods for modeling and analyzing data. Taught as separate 1 cr. sections, each of 5 weeks. Three sections taught in one semester. Areas covered: Logistic and Poisson regression; Structural equation modeling; Smoothing and nonparametric regression; Nonparametric and distribution free methods; Bootstrapping and randomization tests; Visualization of high dimensional data; Analysis of species composition data; Missing data and measurement error. Nonmajor graduate credit.

STAT 416. Statistical Design and Analysis of Gene Expression Experiments.
(3-0) Cr. 3. S. *Prereq: STAT 301 or STAT 326 or STAT 401*
Introduction to two-color microarray technology and single-channel platforms (Affymetrix GeneChips); introduction to next-generation sequencing (especially RNA sequencing)technology; the role of blocking, randomization, and biological and technical replication in gene expression experiments; design of single-channel microarray experiments, two-color microarray experiments, and RNA sequencing experiments; normalization methods for microarray data and RNA sequencing data; methods for identifying differentially expressed genes including mixed linear model analysis, empirical Bayes analysis, and resampling based approaches; procedures for controlling false discovery rate for multiple testing; clustering and classification problems for gene expression data; testing gene categories; emphasis on practical use of methods. Nonmajor graduate credit.

STAT 421. Survey Sampling Techniques.
(2-2) Cr. 3. S. *Prereq: STAT 301 or STAT 326 or STAT 401*
Concepts of sample surveys and the survey process; methods of designing sample surveys, including: simple random, stratified, and multistage sampling designs; methods of analyzing sample surveys including ratio, regression, domain estimation and nonresponse. Nonmajor graduate credit.

STAT 430. Empirical Methods for the Computational Sciences.
(3-0) Cr. 3. F. *Prereq: STAT 330 or an equivalent course, MATH 166, knowledge of linear algebra.*
Statistical methods for research involving computers; exploratory data analysis; selected topics from analysis of designed experiments - analysis of variance, hypothesis testing, interaction among variables; linear regression, logistic regression, Poisson regression; parameter estimation, prediction, confidence regions, dimension reduction techniques, model diagnostics and sensitivity analysis; Markov chains and processes; simulation techniques and bootstrap methods; applications to computer science, bioinformatics, computer engineering - programs, models and systems as objects of empirical study; communicating results of empirical studies. Statistical software: R. Nonmajor graduate credit.

STAT 432. Applied Probability Models.
(3-0) Cr. 3. F. *Prereq: STAT 231 or STAT 341 or STAT 447*
Probabilistic models in biological, engineering and the physical sciences. Markov chains; Poisson, birth-and-death, renewal, branching and queing processes; applications to bioinformatics and other quantitative problems. Nonmajor graduate credit.

STAT 444. Bayesian Data Analysis.
(3-0) Cr. 3. S. *Prereq: STAT 301 or STAT 326 or STAT 401 and either STAT 447 or enrollment in STAT 342*
Probability models and prior distributions; updating priors through the likelihood function. Computational and simulation-based methods for deriving posterior distributions and for estimating parameters. Basic statistical and hierarchical models. Model adequacy and posterior predictive checks. Markov Chain Monte Carlo methods and introduction to WinBUGS or similar software. Emphasis on applications and examples from the social, biological and physical sciences. Nonmajor graduate credit.

STAT 447. Statistical Theory for Research Workers.
(4-0) Cr. 4. F.S.SS. *Prereq: MATH 151 and permission of instructor, or MATH 265*
Primarily for graduate students not majoring in statistics. Emphasis on aspects of the theory underlying statistical methods. Probability, probability density and mass functions, distribution functions, moment generating functions, sampling distributions, point and interval estimation, maximum likelihood and likelihood ratio tests, linear model theory, conditional expectation and minimum mean square error estimation, introduction to posterior distributions and Bayesian analysis, use of simulation to verify and extend theory. Nonmajor graduate credit. Credit for both STAT 341 and STAT 447 may not be applied toward graduation.

STAT 451. Applied Time Series.
(3-0) Cr. 3. S. *Prereq: STAT 301 or STAT 326 or STAT 401*
Meeker. Methods for analyzing data collected over time; review of multiple regression analysis. Elementary forecasting methods: moving averages and exponential smoothing. Autoregressive-moving average (Box-Jenkins) models: identification, estimation, diagnostic checking, and forecasting. Transfer function models and intervention analysis. Introduction to multivariate time series methods. Nonmajor graduate credit.

STAT 457. Applied Categorical Data Analysis.
(3-0) Cr. 3. Alt. S., offered 2013. *Prereq: STAT 301 or STAT 326 or STAT 401*
Statistical methods for the analysis of categorical data: estimation of proportions, chi-square tests, sample size determination, measures of association and relative risk, measures of agreement, logistic regression, Poisson regression and log-linear models, matched-pair and repeated measures designs, conditional inference. Applications to social, behavioral, and health sciences. Nonmajor graduate credit.

STAT 479. Computer Processing of Statistical Data.
(3-0) Cr. 3. F. *Prereq: STAT 301 or STAT 326 or STAT 401*
Structure, content and programming aspects of the Statistical Analysis System (SAS) software package. Advanced techniques in the use of SAS for data analysis including statistical graphics, regression diagnostics, and complex analysis of variance models. The SAS graphical interfaces Enterprise Guide and Enterprise Miner will be introduced. Nonmajor graduate credit.

STAT 480. Statistical Computing Applications.
(3-0) Cr. 3. S. *Prereq: STAT 301 or STAT 326 or STAT 401*
Modern statistical computing. Data management; spread sheets, verifying data accuracy, transferring data between software packages. Data and graphical analysis with statistical software packages. Algorithmic programming concepts and applications. Simulation. Software reliability. Nonmajor graduate credit.

STAT 490. Independent Study.
Cr. arr. Repeatable, maximum of 9 credits. *Prereq: 10 credits in statistics*
No more than 9 credits in Stat 490 may be counted toward graduation.

STAT 490H. Independent Study: Honors.
Cr. arr. Repeatable, maximum of 9 credits. *Prereq: 10 credits in statistics*
No more than 9 credits in Stat 490 may be counted toward graduation.

STAT 495. Applied Statistics for Industry I.
(3-0) Cr. 3. Alt. F., offered 2012. *Prereq: STAT 101 or STAT 104 or STAT 105 or STAT 201 or STAT 226; MATH 166 (or MATH 166H)*
Graduate students without an equivalent course should consult the department. Statistical thinking applied to industrial processes. Assessing, monitoring and improving processes using statistical methods. Analytic/enumerative studies; graphical displays of data; fundamentals of six sigma; process monitoring; control charts; capability analysis. Nonmajor graduate credit.

STAT 496. Applied Statistics for Industry II.
(3-0) Cr. 3. Alt. S., offered 2013. *Prereq: STAT 495*
Statistical design and analysis of industrial experiments. Concepts of control, randomization and replication. Simple and multiple regression; factorial and fractional factorial experiments; application of ideas of six sigma; reliability; analysis of lifetime data. Nonmajor graduate credit.

Courses primarily for graduate students, open to qualified undergraduates:

STAT 500. Statistical Methods I.
(3-2) Cr. 4. F. *Prereq: STAT 447 or current enrollment in STAT 542; knowledge of matrix algebra.*
Analysis of data from designed experiments and observational studies. Randomization-based inference; inference on group means; nonparametric bootstrap; pairing/blocking and other uses of restricted randomization. Use of linear models to analyze data; least squares estimation; estimability; sampling distributions of estimators; general linear tests; inference for parameters and contrasts. Model assessment and diagnostics; remedial measures; alternative approaches based on ranks.

STAT 501. Multivariate Statistical Methods.
(3-0) Cr. 3. S. *Prereq: STAT 500 or STAT 402; STAT 447 or STAT 542; STAT 579 or equivalent; knowledge of matrix algebra.*
Statistical methods for analyzing and displaying multivariate data; the multivariate normal distribution; inference in multivariate populations, simultaneous analysis of multiple responses, multivariate analysis of variance; summarizing high dimensional data with principal components, factor analysis, canonical correlations, classification methods, clustering, multidimensional scaling; introduction to basic nonparametric multivariate methods. Statistical software: SAS or R.

STAT 503. Exploratory Methods and Data Mining.
(2-2) Cr. 3. Alt. S., offered 2013. *Prereq: STAT 401; STAT 341 or STAT 447*
Approaches to finding the unexpected in data; pattern recognition, classification, association rules, graphical methods, classical and computer-intensive statistical techniques, and problem solving. Emphasis is on data-centered, non-inferential statistics for large or high-dimensional data, topical problems, and building report writing skills.

STAT 505. Environmental Statistics.
(3-0) Cr. 3. Alt. S., offered 2014. *Prereq: STAT 341 or STAT 447; STAT 401*
Statistical methods and models for environmental applications. Emphasis on environmental toxicology. Analysis of data with below detection-limit values. Dose-response curve modeling, including overdispersion and estimation of safe doses. Trend analysis; analysis of autocorrelated data. Equivalence testing.

STAT 506. Statistical Methods for Spatial Data.
(3-0) Cr. 3. Alt. S., offered 2013. *Prereq: STAT 447 or STAT 542*
The analysis of spatial data; geostatistical methods and spatial prediction; discrete index random fields and Markkov random field models; models for spatial point processes.

STAT 510. Statistical Methods II.
(3-0) Cr. 3. S. *Prereq: STAT 500, STAT 447 or credit/enrollment in STAT 543*
Model selection and collinearity in linear regression. Likelihood analysis for general models and models with non-normal random components; linear model results in the context of likelihood; linear mixed models and their application; estimation, inference, and prediction. Computational issues in iterative algorithms; expectation-,maximization algorithm and its use in mixed models. Case studies of applications including problem formulation, exploratory analysis, model development, estimation and inference, and model assessment.

STAT 512. Design of Experiments.
(3-0) Cr. 3. F. *Prereq: STAT 511*
Basic techniques of experimental design developed in the context of the general linear model; completely randomized, randomized complete block, and Latin Square designs; factorial experiments, confounding, fractional replication; split-plot and incomplete block designs.

STAT 513. Response Surface Methodology.
(3-0) Cr. 3. Alt. S., offered 2014. *Prereq: STAT 402 or STAT 512, knowledge of elementary matrix theory and matrix formulation of regression*
Morris. Analysis techniques for locating optimum and near-optimum operating conditions: standard experimental designs for first- and second-order response surface models; design performance criteria; use of data transformations; mixture experiments; optimization for multiple-response problems. Requires use of statistical software with matrix functions.

STAT 515. Theory and Applications of Nonlinear Models.
(3-0) Cr. 3. Alt. F., offered 2013. *Prereq: STAT 447 or STAT 543; STAT 510*
Construction of nonlinear statistical models; random and systematic model components, additive error nonlinear regression with constant and non-constant error variances, generalized linear models, transform both sides models. Iterative algorithms for estimation and asymptotic inference. Basic random parameter models, beta-binomial and gamma-Poisson mixtures. Requires use of instructor-supplied and student-written R functions.

STAT 516. Statistical Design and Analysis of Gene Expression Experiments.
(3-0) Cr. 3. S. *Prereq: STAT 500; STAT 447 or STAT 542*
Introduction to two-color microarray technology including cDNA and oligo microarrays; introduction to single-channel platforms (Affymetrix GeneChips); introduction to RNA sequencing technology; the role of blocking, randomization, and biological and technical replication in gene expression experiments; design of single-channel microarray experiments, two-color microarray experiments and RNA sequencing experiments; normalization methods; methods for identifying differentially expressed genes including mixed linear model analysis, empirical Bayes analysis, and resampling based approaches; adjustments for multiple testing; clustering and classification using gene expression data; emphasis on current research topics for statistical analysis of high dimensional gene expression data.

STAT 520. Statistical Methods III.
(3-0) Cr. 3. F. *Prereq: STAT 510, STAT 447 or STAT 543*
Nonlinear regression; generalized least squares; asymptotic inference. Generalized linear models; exponential dispersion families; maximum likelihood and inference. Designing Monte Carlo studies; bootstrap; cross-validation. Fundamentals of Bayesian analysis; data models, priors and posteriors; posterior prediction; credible intervals; Bayes Factors; types of priors; simulation of posteriors; introduction to hierarchical models and Markov Chain Monte Carlo methods.

STAT 521. Theory and Applications of Sample Surveys.
(3-0) Cr. 3. S. *Prereq: STAT 401; STAT 447 or STAT 542*
Practical aspects and basic theory of design and estimation in sample surveys for finite populations. Simple random, systematic, stratified, cluster multistage and unequal-probability sampling. Horvitz-Thompson estimation of totals and functions of totals: means, proportions, regression coefficients. Linearization technique for variance estimation. Model-assisted ratio and regression estimation. Two-phase sampling and sampling on two occasions. Non-response effects. Imputation.

STAT 522. Advanced Applied Survey Sampling.
(3-0) Cr. 3. Alt. F., offered 2013. *Prereq: STAT 521 or both STAT 421 and STAT 447*
Advanced topics in survey sampling and methodology: clustering and stratification in practice, adjustments and imputation for missing data, variance estimation in complex surveys, methods of panel and/or longitudinal surveys, procedures to increase response rates, and computing. Examples are taken from large, well-known surveys in various subject areas. Prior exposure to mathematical statistics, probability, and at least one course in survey sampling theory is assumed.

STAT 531. Quality Control and Engineering Statistics.
(Cross-listed with I E). (3-0) Cr. 3. Alt. S., offered 2013. *Prereq: STAT 401; STAT 342 or STAT 447*
Wu. Statistical methods and theory applicable to problems of industrial process monitoring and improvement. Statistical issues in industrial measurement; Shewhart, CUSUM, and other control charts; feedback control; process characterization studies; estimation of product and process characteristics; acceptance sampling, continuous sampling and sequential sampling; economic and decision theoretic arguments in industrial statistics.

STAT 533. Reliability.
(Cross-listed with I E). (3-0) Cr. 3. Alt. S., offered 2014. *Prereq: STAT 342 or STAT 432 or STAT 447*
Meeker. Probabilistic modeling and inference in engineering reliability; lifetime models, product limit estimator, probability plotting, maximum likelihood estimation for censored data, Bayesian methods in reliability, system reliability models, competing risk analysis, acceleration models and analysis of accelerated test data; analysis of recurrence data; planning studies to obtain reliability data.

STAT 534. Ecological Statistics.
(3-0) Cr. 3. Alt. F., offered 2012. *Prereq: STAT 447 or STAT 542*
Dixon. Statistical methods for non-standard problems, illustrated using questions and data from ecological field studies. Specific topics include: Estimation of abundance and survival from mark-recapture studies. Deterministic and stochastic matrix models of population trends. Estimation of species richness and diversity. Ordination and analysis of complex multivariate data. Statistical methods discussed will include randomization and permutation tests, spatial point processes, bootstrap estimation of standard error, partial likelihood and Empirical Bayes methods.

STAT 536. Statistical Genetics.
(Cross-listed with GDCB). (3-0) Cr. 3. Alt. F., offered 2012. *Prereq: STAT 401, STAT 447; GEN 320 or BIOL 313*
Statistical models and methods for genetics covering models of population processes: selection, mutation, migration, population structure, and linkage disequilibrium, and inference techniques: genetic mapping, linkage analysis, and quantitative trait analysis. Applications include genetic map construction, gene mapping, genome-wide association studies (GWAS), inference about population structure, phylogenetic tree construction, and forensic and paternity identification.

STAT 542. Theory of Probability and Statistics I.
(4-0) Cr. 4. F. *Prereq: MATH 414.*
Sample spaces, basic probability results, conditional probability. Random variables, univariate distributions, moment generating functions. Joint distributions, conditional distributions and independence, correlation and covariance. Probability laws and transformations. Introduction to the multivariate normal distribution. Sampling distributions, normal theory, sums and order statistics. Convergence concepts, the law of large numbers, the central limit theorem and delta method. Basics of stochastic simulation.

STAT 543. Theory of Probability and Statistics II.
(3-0) Cr. 3. S. *Prereq: STAT 542.*
Point estimation including method of moments, maximum likelihood and Bayes. Properties of point estimators, mean squared error, unbiasedness, consistency, loss functions. Large sample properties of maximum likelihood estimators. Exponential families, sufficiency, completeness, ancilarity, Basu's theorem. Hypothesis tests, Neyman-Pearson lemma, uniformly most powerful tests, likelihood ratio tests, Bayes tests. Interval estimation, inverting tests, pivotal quantities. Nonparametric theory, bootstrap.

STAT 544. Bayesian Statistics.
(3-0) Cr. 3. S. *Prereq: STAT 543*
Specification of probability models; subjective, conjugate, and noninformative prior distributions; hierarchical models; analytical and computational techniques for obtaining posterior distributions; model checking, model selection, diagnostics; comparison of Bayesian and traditional methods.

STAT 546. Nonparametric Methods in Statistics.
(3-0) Cr. 3. Alt. F., offered 2012. *Prereq: STAT 510, STAT 542*
Overview of parametric versus nonparametric methods of inference; introduction to rank-based tests and/or nonparametric smoothing methods for estimating density and regression functions; smoothing parameter selection; applications to semiparametric models and goodness-of-fit tests of a parametric model.

STAT 551. Time Series Analysis.
(3-0) Cr. 3. F. *Prereq: STAT 447 or STAT 542*
Concepts of trend and dependence in time series data; stationarity and basic model structures for dealing with temporal dependence; moving average and autoregressive error structures; analysis in the time domain and the frequency domain; parameter estimation, prediction and forecasting; identification of appropriate model structure for actual data and model assessment techniques. Possible extended topics include dynamic models and linear filters.

STAT 554. Introduction to Stochastic Processes.
(Cross-listed with MATH). (3-0) Cr. 3. F. *Prereq: STAT 542*
Markov chains on discrete spaces in discrete and continuous time (random walks, Poisson processes, birth and death processes) and their long-term behavior. Optional topics may include branching processes, renewal theory, introduction to Brownian motion.

STAT 557. Statistical Methods for Counts and Proportions.
(3-0) Cr. 3. F. *Prereq: STAT 500 or STAT 401; STAT 543 or STAT 447*
Statistical methods for analyzing simple random samples when outcomes are counts or proportions; measures of association and relative risk, chi-squared tests, loglinear models, logistic regression and other generalized linear models, tree-based methods. Extensions to longitudinal studies and complex designs, models with fixed and random effects. Use of statistical software: SAS, S-Plus or R.

STAT 565. Methods in Biostatistics and Epidemiology.
(Cross-listed with TOX). (3-0) Cr. 3. Alt. F., offered 2013. *Prereq: STAT 500 or STAT 401; STAT 543 or STAT 447*
Statistical methods commonly used in epidemiology and human and animal health studies. Overview of cohort studies, case-control studies and randomized clinical trials. topics include inference procedures for disease risk factors, analysis of time-to-event and survival data, analysis of longitudinal studies of disease progression and health status, approaches to handling missing data, and meta-analysis. Examples will come from recent studies of physical and mental health, nutrition and disease progression in human and animal populations. Use of statistical software: SAS or R.

STAT 568. Bioinformatics II (Advanced Genome Informatics).
(Cross-listed with GDCB, BCB, COM S). (3-0) Cr. 3. S. *Prereq: BCB 567, BBMB 301, BIOL 315, STAT 430, credit or enrollment in GEN 411*
Advanced sequence models. Basic methods in molecular phylogeny. Hidden Markov models. Genome annotation. DNA and protein motifs. Introduction to gene expression analysis.

STAT 570. Bioinformatics IV (Computational Functional Genomics and Systems Biology).
(Cross-listed with CPR E, COM S, GDCB, BCB). (3-0) Cr. 3. S. *Prereq: BCB 567, BIOL 315, COM S 311 and either 208 or 228, GEN 411, STAT 430*
Algorithmic and statistical approaches in computational functional genomics and systems biology. Elements of experiment design. Analysis of high throughput gene expression, proteomics, and other datasets obtained using system-wide measurements. Topological analysis, module discovery, and comparative analysis of gene and protein networks. Modeling, analysis, simulation and inference of transcriptional regulatory modules and networks, protein-protein interaction networks, metabolic networks, cells and systems: Dynamic systems, Boolean, and probabilistic models. Multi-scale, multi-granularity models. Ontology-driven, network based, and probabilistic approaches to information integration.

STAT 579. An Introduction to R.
(0-2) Cr. 1. F. *Prereq: Enrollment in STAT 500*
An introduction to the logic of programming, numerical algorithms, and graphics. The R statistical programming environment will be used to demonstrate how data can be stored, manipulated, plotted, and analyzed using both built-in functions and user extensions. Concepts of modularization, looping, vectorization, conditional execution, and function construction will be emphasized.

STAT 580. Statistical Computing.
(3-0) Cr. 3. S. *Prereq: STAT 579; STAT 447 or STAT 542*
Introduction to scientific computing for statistics using tools and concepts in R: programming tools, modern programming methodologies, modularization, design of statistical algorithms. Introduction to C programming for efficiency; interfacing R with C. Building statistical libraries. Use of algorithms in modern subroutine packages, optimization and integration. Implementation of simulation methods; inversion of probability integral transform, rejection sampling, importance sampling. Monte Carlo integration.

STAT 590. Special Topics.
Cr. arr. Repeatable.

STAT 590A. Special Topics: Theory.
Cr. arr. Repeatable.

STAT 590B. Special Topics: Methods.
Cr. arr. Repeatable.

STAT 590C. Special Topics: Design of Experiments.
Cr. arr. Repeatable.

STAT 590D. Special Topics: Sample Surveys.
Cr. arr. Repeatable.

STAT 590E. Special Topics: Statistics Education.
Cr. arr. Repeatable.
4/19/12 Added new section for stat education.

STAT 598. Cooperative Education.
Cr. R. F.S.SS. *Prereq: Permission of the department chair*
Off-campus work periods for graduate students in a field of statistics.

STAT 599. Creative Component.
Cr. arr.

Courses for graduate students:

STAT 601. Advanced Statistical Methods.
(3-0) Cr. 3. S. *Prereq: STAT 520, STAT 543 and MATH 414 or enrollment in STAT 641*
Methods of constructing complex models including adding parameters to existing structures, incorporating stochastic processes and latent variables. Use of modified likelihood functions; quasi-likelihoods; profiles; composite,likelihoods. Asymptotic normality as a basis of inference; Godambe information. Sample reuse; block bootstrap; resampling with dependence. Simulation for model assessment. Issues in Bayesian analysis.

STAT 602. Modern Multivariate Statistical Learning.
(3-0) Cr. 3. Alt. S., offered 2013. *Prereq: STAT 520, STAT 543, STAT 579*
Statistical theory and methods for modern data mining and machine learning, inference, and prediction. Variance-bias trade-offs and choice of predictors; linear methods of prediction; basis expansions; smoothing, regularization, and reproducing kernel Hilbert spaces; kernel smoothing methods; neural networks and radial basis function networks; bootstrapping, model averaging, and stacking; linear and quadratic methods of classification; support vector machines; trees and random forests; boosting; prototype methods; unsupervised learning including clustering, principal components, and multi-dimensional scaling; kernel mechanics.

STAT 606. Advanced Spatial Statistics.
(3-0) Cr. 3. Alt. S., offered 2013. *Prereq: STAT 506, STAT 642*
Consideration of advanced topics in spatial statistics, including areas of current research. Topics may include construction of nonstationary covariance structures including intrinsic random functions, examination of edge effects, general formulation of Markov random field models, spatial subsampling, use of pseudo-likelihood and empirical likelihood concepts in spatial analysis, the applicability of asymptotic frameworks for inference, and a discussion of appropriate measures for point processes.

STAT 611. Theory and Applications of Linear Models.
(3-0) Cr. 3. F. *Prereq: STAT 510; STAT 542 or STAT 447; a course in matrix algebra*
Matrix preliminaries, estimability, theory of least squares and of best linear unbiased estimation, analysis of variance and covariance, distribution of quadratic forms, extension of theory to mixed and random models, inference for variance components.

STAT 612. Advanced Design of Experiments.
(3-0) Cr. 3. Alt. S., offered 2014. *Prereq: STAT 512*
General theory of factorial experiments. Design optimality criteria, approximate design and general equivalence theory, computational approaches to constructing optimal designs for linear models, and extensions to nonlinear models. Advanced topics of current interest in the design of experiments, including one or more of: distance based design criteria and construction of spatial process models, screening design strategies for high-dimensional problems, and design problems associated with computational experiments.

STAT 615. Advanced Bayesian Methods.
(3-0) Cr. 3. Alt. S., offered 2014. *Prereq: STAT 544 and STAT 601*
Complex hierarchical and multilevel models, dynamic linear and generalized linear models, spatial models. Bayesian nonparametric methods. Specialized Markov chain Monte Carlo algorithms and practical approaches to increasing mixing and speed convergence. Summarizing posterior distributions, and issues in inference. Model assessment, model selection, and model averaging.

STAT 621. Advanced Theory of Survey Statistics.
(3-0) Cr. 3. Alt. F., offered 2013. *Prereq: STAT 521*
Advanced topics of current interest in the design of surveys and analysis of survey data, including: asymptotic theory for design and model-based estimators, use of auxiliary information in estimation, variance estimation techniques, small area estimation, non-response modeling and imputation.

STAT 641. Foundations of Probability Theory.
(Cross-listed with MATH). (3-0) Cr. 3. F. *Prereq: MATH 414 or MATH 501 or equivalent course.*
Sequences and set theory; Lebesgue measure, measurable functions. Absolute continuity of functions, integrability and the fundamental theorem of Lebesgue integration. General measure spaces, probability measure, extension theorem and construction of Lebesgue-Stieljes measures on Euclidean spaces. Measurable transformations and random variables, induced measures and probability distributions. General integration and expectation, Lp-spaces and integral inequalities. Uniform integrability and absolute,continuity of measures. Probability densities and the Radon-Nikodym theorem. Product spaces and Fubini-Tonelli theorems.

STAT 642. Advanced Probability Theory.
(Cross-listed with MATH). (3-0) Cr. 3. S. *Prereq: STAT 641 or STAT 543 and MATH 514.*
Probability spaces and random variables. Kolmogorov's consistency theorem. Independence, Borel-Cantelli lemmas and Kolmogorov's 0 - 1 Law. Comparing types of convergence for random variables. Sums of independent random variables, empirical distributions, weak and strong laws of large numbers. Convergence in distribution and its characterizations, tightness, characteristic functions, central limit theorems and Lindeberg-Feller conditions. Conditional probability and expectation. Discrete parameter martingales and their properties and applications.

STAT 643. Advanced Theory of Statistical Inference.
(3-0) Cr. 3. F. *Prereq: STAT 543, STAT 642*
Sufficiency and related concepts, completeness, exponential families and statistical information. Elements of decision theory, decision rules, invariance and Bayes rule. Maximum likelihood and asymptotic inference. Generalized estimating equations and estimating functions, M-estimation, U-statistics. Likelihood ratio tests, simple and composite hypotheses, multiple testing. Bayesian inference. Nonparametric inference, bootstrap, empirical likelihood, and tests for nonparametric models.

STAT 645. Advanced Stochastic Processes.
(Cross-listed with MATH). (3-0) Cr. 3. S.
Weak convergence. Random walks and Brownian motion. Martingales. Stochastic integration and Ito's Formula. Stochastic differential equations and applications.

STAT 647. Multivariate Analysis.
(3-0) Cr. 3. Alt. F., offered 2012. *Prereq: STAT 543, knowledge of matrix algebra*
Multivariate normal distribution, estimation of the mean vector and the covariance matrix, multiple and partial correlation, Hotelling's T2 statistic, Wishart distribution, multivariate regression, principle components, discriminant analysis, high dimensional data analysis, latent variables.

STAT 648. Seminar on Theory of Statistics and Probability.
Cr. arr. F. *Prereq: STAT 543.*
Seminar topics change with each offering.

STAT 651. Time Series.
(3-0) Cr. 3. Alt. S., offered 2014. *Prereq: STAT 551, STAT 642*
Stationary and nonstationary time series models, including ARMA, ARCH, and GARCH. Covariance and spectral representation of time series. Fourier and periodogram analyses. Predictions. CLT for mixing processes. Estimation and distribution theory. Long range dependence.

STAT 680. Advanced Statistical Computing.
(3-0) Cr. 3. F. *Prereq: STAT 543 and STAT 580*
Normal approximations to likelihoods. The delta-method and propagation of errors. Topics in the use of the E-M algorithm including; its use in the exponential family, computation of standard errors, acceleration. Resampling methods: brief theory and application of the jackknife and the bootstrap. Randomization tests. Stochastic simulation: Markov Chain, Monte Carlo, Gibbs' sampling, Hastings-Metropolis algorithms, critical slowing-down and remedies, auxiliary variables, simulated tempering, reversible-jump MCMC and multi-grid methods.

STAT 690. Advanced Special Topics.
Cr. arr. Repeatable. *Prereq: Permission of instructor*

STAT 690A. Advanced Special Topics: Theory.
Cr. arr. Repeatable. *Prereq: Permission of instructor*

STAT 690B. Advanced Special Topics: Methods.
Cr. arr. Repeatable. *Prereq: Permission of instructor*

STAT 690C. Advanced Special Topics: Design of Experiments.
Cr. arr. Repeatable. *Prereq: Permission of instructor*

STAT 690D. Advanced Special Topics: Sample Surveys.
Cr. arr. Repeatable. *Prereq: Permission of instructor*

STAT 690E. Advanced Special Topics: Statistical Computing.
Cr. arr. Repeatable. *Prereq: Permission of instructor*

STAT 690F. Advanced Special Topics: Graphics.
Cr. arr. Repeatable. *Prereq: Permission of instructor*

STAT 699. Research.
Cr. arr. Repeatable.