Statistics

College of Arts & Sciences

The Department of Statistics offers programs of study leading to the degrees of Master of Science (Plan A or B available), Doctor of Philosophy, and Master of Applied Statistics (Online). The M.S. degree is professionally oriented for the student who plans a career in government, business or industry and is preparatory for the Ph.D. The Ph.D. program offers a broad training in both statistical theory and methods while affording options to suit the student's interests. The statistics Ph.D. is well-suited for academic, business, government and industrial positions. In addition to formal course work and research training, the advanced student has opportunities to gain valuable practical experience by participating in consulting activities under faculty supervision. Master of Applied Statistics is an innovative online professional graduate degree which is designed to train professional, practice-oriented statisticians who have both data analytic and computing skills.

Both, the M.S. and the Ph.D. program offer a Mathematical Statistics track, as well as a Biostatistics track. The latter tracks are designed for students who envision a future at the interface of Statistics and the Life Sciences.

Course work is available in areas associated with statistics such as biological modeling, probability, inference, experimental design and analysis, computational statistics, nonparametric methods, Bayesian analysis, mixed modeling, multivariate analysis, survival analysis, clinical trials, and many other selected topics of the student's choice.

The University of Kentucky is represented on the Committee on Statistics of the Southern Regional Education Board.

Admission Requirements
Students with an undergraduate major in any of the mathematical, physical, biological, social or applied sciences are encouraged to apply.

The minimum GRE and GPA admissions requirements for the M.S. and Ph.D. programs in Statistics are the same as for the Graduate School. However, the number of admissions is limited and admissions decisions are made on a competitive basis. All M.S. applicants must have successfully completed a three or four semester sequence in calculus and a course in linear algebra and have good communication skills. In addition, all Ph.D. applicants must have mastered the equivalent of MA 471G. All Master of Applied Statistics applicants must have completed two semesters of calculus and a course in statistical methodology. Students wishing to apply for teaching assistantships and/or fellowships must submit three letters of recommendation.. Applicants wishing to be admitted directly to the Ph.D. program must have an M.S. in Statistics and the permission of the Director of Graduate Studies.

Please see the departmental website for up-to-date information and answers to frequently asked questions about the admissions process.

Master of Science

The Statistics Department offers the degree of Master of Science with (Plan A) or without (Plan B) a thesis, and in two different tracks: a Mathematical Statistics track and a Biostatistics track.

Shared Core (Required for all students)

- STA 602 (4) Introduction to Statistical Methods
- STA 603 (4) Introduction to Linear Models and Experimental Design
- STA 605 (3) Computational Inference
- STA 606 (3) Theory of Statistical Inference I
- STA 623 (3) Theory of Probability
- STA 632 (3) Longitudinal Data Analysis

Mathematical Statistics Track

Curriculum requirements for the Mathematical Statistics track are the shared core courses above, plus the following courses:

- STA 607 (3) Theory of Statistical Inference II
- STA 624 (3) Applied Stochastic Processes
- STA 643 (3) Advanced Experimental Design

Biostatistics Track

Curriculum requirements in the Biostatistics track are the shared core courses above, plus:

- STA 635 (3) Survivability and Life Testing
- STA 653 (3) Clinical Trials
- STA 665 (3) Analysis of Categorical Data
- STA 693 (2) Biostatistical Practicum, 1 unit course in each of the two semesters in the second year

Programs of study for Plan B require a total of at least 35 semester hours. Students will typically fulfill this requirement by taking electives (additional courses besides the shared core and track requirements) in the Fall and Spring of their second year. Programs of study for Plan A (with thesis) require a total of at least 29 semester hours which are satisfied by either of the two course lists above.

The electives can be selected from the menu of courses listed below. Before the end of the second semester, the M.S. candidate must present a proposed plan of study for approval by the Director of Graduate Studies. There are no formal minor requirements.

Comprehensive Exams

All master's candidates are required to pass a comprehensive departmental written examination on the content of the courses STA 602, STA 603, STA 605, STA 606, and STA 623. This examination is normally administered in late May/early June. It is truly comprehensive also in the sense that all parts must be taken together: If a student decides not to take a part of the examination, that part is automatically counted as failed. Students taking the comprehensive exam will receive either a pass at the doctoral level, a pass at the master's level, or a failure. The examination may be repeated only once. Successful completion of the comprehensive examination at the doctoral level is required for admission into the PhD program.

Electives

The electives may be chosen from any course in the following menu that is NOT used as a track requirement.

- MA 471G (3) Advanced Calculus I
- STA 607 (3) Theory of Statistical Inference II
- STA 612 (3) Sequential Analysis
- STA 616 (3) Design and Analysis of Sample Surveys
- STA 621 (3) Nonparametric Inference
- STA 624 (3) Applied Stochastic Processes
- STA 626 (3) Time Series Analysis

- STA 630 (3) Bayesian Inference
- CPH 631 (3) Design and Analysis of Health Survey
- STA 635 (3) Survivability and Life Testing
- CPH 636 (3) Data Mining in Public Health
- STA 643 (3) Advanced Experimental Design
- STA 644 (3) Advanced Linear and Nonlinear Models
- STA 653 (3) Clinical Trials
- STA 661 (3) Multivariate Analysis I
- STA 662 (3) Resampling and Related Methods
- CPH 664 (3) Design and Analysis of Clinical Trials
- STA 665 (3) Analysis of Categorical Data

Any course on this list NOT required for the chosen track may be used as an elective. Thus, for example, STA 665 would count as an elective for the Mathematical Statistics track, but it is a track requirement for the Biostatistics track. Similarly, STA 624 would be an elective for the Biostatistics track but is a track requirement for the Mathematical Statistics track.

* A student who takes both STA 653 and CPH 664 may only receive credit towards the degree for one of these two courses.

Doctor of Philosophy

The core curriculum in statistics is designed to provide doctoral candidates with a firm foundation in probability theory, inference, and classical methodology. In addition, the theory and application of computational statistics, biostatistics, and state-of-the-art inferential procedures are an integral part of the core curriculum.
Students in the doctoral program in statistics will choose one of two areas of specialization, 1) mathematical statistics/probability or 2) biostatistics. The requirements for these areas of specialization are:

Mathematical Statistics/Probability
- STA 701 – Advanced Statistical Inference I
- STA 703 – Advanced Probability
- STA 705 – Advanced Computational Inference
- STA 707 – Advanced Data Analysis
- STA 702 – Advanced Statistical Inference II

Biostatistics
- STA 701 - Advanced Statistical Inference I
- STA 703 - Advanced Probability
- STA 705 - Advanced Computational Inference
- STA 707 - Advanced Data Analysis
- STA 709 - Advanced Survival Analysis

All students must take an additional six elective courses chosen by the student and approved by the DGS. These courses must be chosen from among STA 612, STA 616, STA 621, STA 624, STA 626, STA 630, STA 635, STA 643, STA 644, STA 653, STA 661, STA 662, STA 665, CPH 631, CPH 636, and CPH 664. STA 695 will also be considered on a case by case basis. If a student completes both STA702 and STA709, the student may choose their official track and count the non-required course as an elective. Note that STA715 (reading course) may not be used to satisfy elective requirements. Students must successfully complete a common written exam over STA 701 and STA 703 plus respective prerequisites.

* A student who takes both STA 653 and CPH 664, may only receive credit towards the degree for one of these two courses.

Students must pass a uniform written exam over STA 701 and STA 703 plus respective prerequisites. This exam will normally be offered in January and students will usually sit for the written examination at the beginning of the Spring semester in the third year of the program. The uniform exam can be repeated once. After completion of tract course requirements and successful completion of the written exam, students must also successfully complete an oral qualifying exam which is scheduled through the Graduate School and administered by the student's advisory committee. A significant part of this exam is to be a dissertation proposal.
Areas of current research interest can be found by going to the Department of Statistics faculty web page https://stat.as.uky.edu/.

All students, master's and doctoral, will be required to take part in an internship program. This will usually consist of teaching (three or six semester hours) or an equivalent amount of work in a research assistantship working with researchers across campus.

Master of Applied Statistics

The Master of Applied Statistics is a thirty hour, online, Plan B, professional graduate degree that can be completed in a summer and two consecutive semesters or on a part-time basis. The program is unique in that it uses data visualization and statistical computing to teach fundamental concepts in statistical inference to students with a career-oriented focus on data analysis

Core Courses (Required for all students)

- STA 645(3) Computational Theory and Data Visualization
- STA 646(4) Foundations of Probability and Inference
- STA 647(2) Statistical Computing with SAS
- STA 648(4) Regression Modeling
- STA 649(4) Design of Experiments

The electives can be selected from the menu of courses listed below.

- STA 650(3) Applied Multivariate Analysis
- STA 651(1) Advanced Programming with R
- STA 652(3) Advanced Statistical Modeling
- STA 654(3) Applied Bayesian Analysis
- STA 656(3) Statistical Quality Control
- STA 659(3) Advanced Statistical Methods (subtitle required)

Course Descriptions

STA 515 LINEAR AND COMBINATORIAL OPTIMIZATION. (3)
Mathematical and computational aspects of linear programming and combinatorial optimization. Linear optimization is introduced by presenting solution techniques (primal and dual simplex) and studying geometric properties and duality for linear systems of inequalities. Asics of combinatorial optimization, including trees, paths, flows, matchings, and matroids, and the corresponding algorithms are presented. Prereq: A course in linear algebra or consent of instructor. (Same as MA 515.)

STA 524 PROBABILITY. (3)
Sample space, random variables, distribution functions, conditional probability and independence, expectation, combinatorial analysis, generating functions, convergence of random variables, characteristic

functions, laws of large numbers, central limit theorem and its applications. Prereq: MA 213 and MA 322. (Same as OR 524.)

STA 525 INTRODUCTORY STATISTICAL INFERENCE. (3)
Simple random sampling, statistics and their sampling distributions, sampling distributions for normal populations; concepts of loss and risk functions; Bayes and minimax inference procedures; point and interval estimation; hypothesis testing; introduction to nonparametric tests; regression and correlation. Prereq: STA 320 or STA 524 or consent of instructor. (Same as OR 525.)

STA 569 APPLIED STATISTICAL METHODS. (3)
This course is an introduction to research statistics. Topics include exploratory data analysis, random variables (binomial and normal distributions), estimation of proportions and means, correlation, regression, chi-squared tests, and ANOVA. Examples will be drawn from biomedical or professional applications with analysis illustrated in software common to data analysis. Prereq: MA 109 or consent of instructor.

STA 570 BASIC STATISTICAL ANALYSIS. (4)
Primarily in biological, behavioral and social sciences. Introduction to methods of analyzing data from experiments and surveys; the role of statistics in research, statistical concepts and models; probability and distribution functions; estimation; hypothesis testing; regression and correlation; analysis of single and multiple classification models; analysis of categorical data. Lecture, three hours; laboratory, two hours. Prereq: MA 109 or equivalent. For graduate students; undergraduates must have consent of instructor.

STA 580 BIOSTATISTICS I.(2)
STA 580 covers univariate statistical methods commonly encountered in public health studies. This includes descriptive statistics, hypothesis testing, paired and unpaired t tests, ANOVA, contingency tables, log rank test, regression and correlation. Prereq: MA 109 or higher. (Same as CPH 580.)

STA 600 COMMUNICATING IN STATISTICS. (0)
Pedagogical skills for teaching assistants in undergraduate statistics courses and effective communication skills for professional statisticians. Topics include: basic teaching techniques, use of writing assignments to increase understanding of statistical concepts, writing and grading effective exams, and recording and analyzing grades with the aid of software. Videotaped sessions will be conducted and critiqued. May be repeated a maximum of three times. Prereq: STAT major.

STA 602 INTRODUCTION TO STATISTICAL METHODS. (4)
Sampling distributions, statistical models, point estimates and conference intervals, significance testing. Experimental Design (randomized blocks, nested/hierarchical models, Latin Squares), ANOVA (one, two, and multiway factorials, fixed and random effects), multiple comparison procedures, rank-based analyses, linear and nonlinear regression, power and sample size calculations, professional presentation of results. Lecture, three hours; laboratory, two hours per week. Prereq: Graduate Standing in Statistics.

STA 603 INTRODUCTION TO LINEAR MODELS AND EXPERIMENTAL DESIGN.(4)
Multivariate normal distribution, linear models in matrix notation, multiple linear regression (distributional results, categorical predictors, interactions, connection to ANOVA, sums of squares, diagnostics, ridge and nonparametric regression). Generalized linear models (binomial, poisson, and gamma regression), overdispersion, mixed models, diagnostics, professional presentation of results. Prereq: STA 602; coreq: STA 606.

STA 605 COMPUTATIONAL INFERENCE. (3)
Statistical Packages, numerical methods in maximization and integration, bootstrapping, simulation methods, multivariate normal distribution. Prereq: Graduate Standing in Statistics.

STA 606 THEORY OF STATISTICAL INFERENCE I. (3)
Convergence concepts (Central Limit Theorem), Sampling from a Normal Distribution, Order Statistics, Methods for finding point and interval estimates, methods for finding hypothesis tests, sufficiency principle, methods for evaluating point estimators (mean square error, unbiasedness, Cramer-Rao lower bound), Asymptotics of point estimates, interval estimates, and hypothesis testing procedures. Prereq: STA 623

STA 607 THEORY OF STATISTICAL INFERENCE II. (3)
Minimal sufficiency and completeness, Lehmann-Scheffe Theorem and basic decision theory, methods for evaluating interval estimators. Methods for evaluating hypothesis testing procedures, robustness and M-estimation, sequential analysis, censored data, model selection techniques. Prereq: STA 606.

STA 612 SEQUENTIAL ANALYSIS.(3)
Survey and application of sequential sampling. Sufficiency and estimation. Two Stage sampling. The SPRT and its properties, both exact and approximate. Truncated and grouped SPRT's. Decision Theoretic approach. Sequential Estimation. Fixed width confidence intervals. Composite hypotheses and nuisance parameters. Generalized SPRT's. K hypothesis problems. Optimal Stopping. Prereq: STA 606.

STA 621 NONPARAMETRIC INFERENCE. (3)
Estimation and testing when the functional form of the population distribution is unknown; rank and sign tests; tests based on permutations of observations; power of nonparametric tests; optimum nonparametric tests and estimators. Prereq: STA 606.

STA 623 THEORY OF PROBABILITY. (3)
Axioms of Probability, conditional probability, distribution functions, density and moment generating functions, expected values, discrete and continuous distributions, joint, marginal, and conditional distributions, transformations, covariance and correlation, inequalities, properties of sums from a random sample. Prereq: Graduate Standing in Statistics.

STA 624 APPLIED STOCHASTIC PROCESSES. (3)
Definition and classification of stochastic processes, renewal theory and applications, Markov chains, continuous time Markov chains, queueing theory, epidemic processes, Gaussian processes. Prereq: STA 524 or STA 623 or consent of instructor. (Same as OR 624.)

STA 626 TIME SERIES ANALYSIS. (3)
Time series and stochastic processes, auto-correlation functions and spectral properties of stationary processes; linear models for stationary processes, moving average, auto-regressive and mixed autoregressive-moving average processes; linear nonstationary models, minimum mean square error forecasts and their properties; model identification, estimation and diagnostic checking. Prereq: STA 422G or equivalent. (Same as ECO 626.)

STA 630 BAYESIAN INFERENCE. (3)
Likelihood principles, sufficiency, natural conjugate and hierarchical priors, empirical Baysian analysis for estimation and testing. Prereq: STA 606.

STA 632 LONGITUDINAL DATA ANALYSIS. (3)
This course presents statistical techniques for analyzing longitudinal studies and repeated measures experiments that occur frequently in public health, clinical trials, and outcomes research. This course will cover linear mixed models, generalized linear mixed models and an introduction to nonlinear models as they apply to the analysis of correlated data. Prereq: BST 682 and BST 676 or equivalent. (Same as BST 762.)

STA 635 SURVIVABILITY AND LIFE TESTING. (3)
Life Table Analysis. Estimation of survival rates with censored data. Competing Risk Theory. Parameter estimation for commonly encountered reliability distribution with complete censored and truncated data. Maximum likelihood and order statistics techniques. Survivability growth models, comparison of survival distribution, and sample size determination in clinical trials. Extreme value theory. Prereq: STA 606.

STA 643 ADVANCED EXPERIMENTAL DESIGN. (3)
Linear Model interpretation in vector spaces and projections, use of generalized inverses, identifiability and estimability of contrasts, normal equations, Gauss-Markov Theorem, MVUE, distribution theory for quadratic forms, complex designs such as crossover, split-plot and repeated measures, asymptotics for general linear models, familiarity with nonparametric regression models. Prereq: STA 603.

STA 644 ADVANCED LINEAR AND NONLINEAR MODELS. (3)
Review of the general linear model. Regression methodology using Ridge, Bayes, and Stein estimaters. The use of PRESS, Cp, and R2 statistics as selection criteria. Modern computational methods. Nonlinear models and their methodology. Robust Regression. Prereq: STA 603.

STA 645 COMPUTATIONAL THEORY AND DATA VISUALIZATION. (3)
This course aims to teach students to use programming to gain intuition about statistical theory and fundamental concepts and to visualize data appropriately. Specifically, computational methods covered include simulation methods and numerical methods in maximization and integration. Appropriate graphical displays of statistical and simulation results will be emphasized. Statistical concepts covered include sampling distributions, confidence intervals and p-values, the central limit theorem, expectation, and maximum likelihood estimation. Student understanding of course ideas will rely heavily on performing simulation studies and discussing the assimilated class results online. Prereq: Graduate status in Master of Applied Statistics.

STA 646 FOUNDATIONS OF PROBABILITY AND INFERENCE. (4)
This course introduces probability, random variables, independence, and distribution theory. Inference topics include, but are not limited to, estimation, hypothesis tests, likelihood ratio tests, confidence intervals, sufficiency, and efficient estimators. Prereq: Graduate status in Master of Applied Statistics. Coreq: STA 645.

STA 647 STATISTICAL COMPUTING WITH SAS. (2)
This course aims to teach students to use the SAS statistical programming language and to apply this knowledge appropriately in a variety of settings. Student achievement in the course will rely heavily on performing computational tasks, data management, editing data, running basic statistical procedures, and producing reports using SAS. Prereq: Graduate status in Master of Applied Statistics.

STA 648 REGRESSION METHODS. (4)
Statistics (STA) 648 is an applied regression course that emphasizes data analysis and interpretation. Generally, regression is a collection of methods for determining and using models that explain how a response variable (dependent variable) relates to one or more explanatory variables (predictor variables).

This course aims to teach students about different regression models, their corresponding assumptions, and how to interpret the estimated models. Statistical computing will be central to understanding material in this course as the student will be required to perform analyses on real datasets using the learned methods. Prereq: STA 645 and admission to the Master of Applied Statistics program or permission of the instructor.

STA 649 DESIGN OF EXPERIMENTS. (4)
Statistics (STA) 649 is an introduction to the principles of experimental design. Many statistics courses are taught from the perspective of analyzing data that has already been collected. However, problems that occur at the analysis stage (e.g., violations of assumptions, too small of sample, etc.) could have been avoided if the experimenter had consulted a statistician before the experiment was conducted and the data collected. This course will introduce common experimental designs so that when the data are collected, the aforementioned shortcomings are avoided. The course will provide equal treatment to both the conceptualization of the designs and the analysis of the subsequent experiment. Prereq: STA 647, STA 648, and admission to the Master of Applied Statistics program or permission of the instructor.

STA 650 APPLIED MULTIVARIATE STATISTICS. (3)
The main objective of this course is to equip students with the traditional and modern multivariate statistical methods. Students will learn the motivation behind these methods, how to apply them and interpret the results obtained. Focus will be on understanding distributional results rather that the technical derivations. Students will gain competency in writing R scripts for applying the multivariate methods learned. Prereq: Graduate status in Master of Applied Statistics, STA 646, STA 648; corequisite: STA 649.

STA 651 ADVANCED PROGRAMMING WITH R.(1)
Statistics (STA) 651 discusses advanced programming techniques using the R language. Programming topics include how to handle various facets of data structures in R, how to produce simple and advanced graphics in R, and how to synthesize the necessary components of simulation studies. Prereq: STA 645 and admission to the Master of Applied Statistics program or permission of the instructor.

STA 652 ADVANCED STATISTICAL MODELING. (3)
This course aims to teach students to use advanced statistical modeling techniques and to interpret the results in context. Specifically, the statistical methods covered include general linear models and linear mixed models, semiparametric regression, nonlinear models, mixed models in ANOVA, generalized linear models, ridge regression, and repeated measures experiments. Prereq: STA 649 and graduate status in Master of Applied Statistics.

STA 653 CLINICAL TRIALS. (3)
Design and analysis of Phase I-III clinical trials, interim monitoring of trials, sample size, power, crossover trials, bioequivalency, mixed models, and meta analysis. Coreq: STA 603. (Same as BST 713.)

STA 654 APPLIED BAYESIAN INFERENCE. (3)
This course provides an introduction to Bayesian inference and a summary of Bayesian methods for fitting, assessing, and selecting models. Topics include Bayes' Rule and Probability, Binomial Models for Proportions, Poisson Models for Counts, Normal Models for Continuous Data, Linear Regression, Log-linear and Contingency Tables, Hierarchical Models, Hypothesis Testing, Model Comparison, and Selected Applications. Prereq: Graduate status in Master of Applied Statistics, STA 646, STA 648.

STA 655 INTRODUCTION TO STATISTICAL GENETICS. (3)
BST 655 presents an introduction to the statistical methodologies used today to investigate genetic

susceptibility to complex diseases. The course focuses on linkage and association analysis with applications to real-world data. Commonly used (and freely available) software will be presented and used throughout. Because the field is constantly evolving, a focus of the material for this course will be recent statistical human genetics literature. Prereq: STA 580 or equivalent. (Same as BST 655.)

STA 656 STATISTICAL QUALITY CONTROL. (3)
Dimensions of quality, numerical and graphical descriptions of data, discrete and continuous distributions, basic reliability concepts, control charts for variables and attributes, process capability studies, and selected additional topics as time permits such as cusum charts, acceptance sampling. Prereq: STA 645 and admission to the Master of Applied Statistics program or permission of the instructor.

STA 659 ADVANCED STATISTICAL METHODS. (3)
Supervised reading, discussion, and practice of a selected statistical methodological area. Prereq: STA 646, STA 648, and graduate status in Master of Applied Statistics.

STA 661 MULTIVARIATE ANALYSIS I. (3)
Characterization and properties of the multivariate normal distribution, random samples from this distribution; multivariate analysis of variance, related distribution theory; factor analysis. Prereq: STA 603.

STA 662 RESAMPLING AND RELATED METHODS. (3)
Theory and application of the bootstrap, jackknife and other resampling methods. Prereq: STA 605 and STA 606.

STA 665 ANALYSIS OF CATEGORICAL DATA. (3)
Multinomial and product-multinomial models; large-sample theory of estimation and testing, Pearson chi-square and modified chi-square statistics, Pearson-Fisher Theorem, Wald Statistics and generalized least squares technique; applications to problems of symmetry, association and hypotheses of no interaction in multi-dimensional contingency tables. Prereq: STA 603 and STA 606. (Same as BST 763.)

STA 671 REGRESSION AND CORRELATION. (2)
Simple linear regression, elementary matrix algebra and its application to simple linear regression; general linear model, multiple regression, analysis of variance tables, testing of subhypotheses, nonlinear regression, step-wise regression; partial and multiple correlation. Emphasis upon use of computer library routines; other special topics according to the interests of the class. Lecture, three hours per week; laboratory, two hours per week for seven and one half weeks. Offered the first or second half of each semester. Prereq: STA 570 or STA 580.

STA 672 DESIGN AND ANALYSIS OF EXPERIMENTS. (2)
Review of one-way analysis of variance; planned and unplanned individual comparisons, including contrasts and orthogonal polynomials; factorial experiments; completely randomized, randomized block, Latin square, and split-plot designs: relative efficiency, expected mean squares; multiple regression analysis for balanced and unbalanced experiments, analysis of covariance. Lecture, three hours per week; laboratory, two hours per week for seven and a half weeks. Offered the first or second half of each semester. Prereq: STA 671.

STA 673 DISTRIBUTION-FREE STATISTICAL INFERENCE AND ANALYSIS OF CATEGORICAL DATA. (2)
Inference for population quantiles, sign tests, Wilcoxon tests, Kruskal-Wallis and Friedman tests, Kendall and Spearman rank correlation. Goodness-of-fit tests for completely and partially specified distributions, rxc contingency tables, McNemar and Cochran's Q tests for matched proportions; three dimensional tables

and tests of partial and multiple associations. Lecture, three hours per week; laboratory, two hours per week for seven and a half weeks. Offered the first or second half of each semester. Prereq: STA 570 or STA 580.

STA 675 SURVEY SAMPLING. (2)
Simple random sampling and stratified random sampling, ratio and regression estimators, cluster sampling, systemic sampling, and multistage sampling. Specific problems associated with running a survey: non-response, call-backs, questionnaire construction, mail questionnaires, and area sampling. Lecture, three hours per week; laboratory, two hours per week for seven and a half weeks. Offered the first or second half of each semester. Prereq: STA 570 or STA 580.

STA 676 QUANTITATIVE INHERITANCE IN PLANT POPULATIONS. (3)
After a brief review of population genetics theory, the course is divided into two sections which cover methods of estimating genetic variances and selection methods in population improvement. The course will focus on handling and interpretation of actual data sets through data analysis and discussion of current literature. Prereq: STA 570, STA 671, and STA 672. (Same as PLS 676.)

STA 677 APPLIED MULTIVARIATE METHODS. (3)
Survey of multivariate statistical techniques. The multivariate normal distribution; the general linear model; general procedures for parameter estimation and hypothesis testing in the multivariate case; Hotelling's T2, multivariate analysis of variance and covariance; structural models for the covariance matrix; utilization of existing computer programs. Prereq: STA 671 and 672.

STA 679 DESIGN AND ANALYSIS OF EXPERIMENTS II. (3)
A continuation of STA 672. Multiplicative models in two-factor experiments. Partial factorials. Extensions and modifications of split plots and Latin squares. Confounding in factorial experiments. Response surface methods. Estimation of variance components. One restrictional and two restrictional lattice and incomplete block designs. Combining analyses of similar experiments. Prereq: STA 671 and 672 or equivalent.

*STA 681 BIOSTATISTICS II. (3)
Students will learn statistical methods used in public health studies. This includes receiver operator curves, multiple regression, logistic regression, confounding and stratification, the Mantel-Haenzel procedure, and the Cox proportional hazards model. Prereq: STA 570, CPH 603, STA 580/CPH 580, or equivalent. (Same as CPH 630.)

STA 690 SEMINAR IN STATISTICS. (1)
May be repeated to a maximum of three credits.

STA 692 STATISTICAL CONSULTING. (3)
Basic principles of statistical consulting including how to manage a consulting session, how to formulate and solve problems and how to express results both orally and in writing. Students will be expected to analyze data from a current consulting project. Lecture, two hours; laboratory, two hours per week. Coreq: STA 643 or 644 or consent of instructor.

STA 693 BIOSTATISTICAL PRACTICUM. (1-2)
This course will involve students in small consulting projects intended to illustrate practical biostatistical problems. Prereq: STA 603.

STA 695 SPECIAL TOPICS IN STATISTICAL THEORY (Subtitle required). (1-3)

To be selected by staff. May be repeated to a maximum of nine credits. Prereq: STA 601.

STA 700 FOUNDATIONS OF PROBABILITY AND INFERENCE. (3)
Measures on the real line and probability spaces, Lebesque measure, properties of distribution functions and random variables, integrals and expectations. Prereq: MA 471G.

STA 701 ADVANCED STATISTICAL INFERENCE I. (3)
Basic concepts of decision theory, sufficiency and completeness; completeness of multiparametric exponential family; unbiasedness and invariance of decision rules; Bayes, minimax and invariant estimators; testing of hypotheses and optimality properties. Prereq: STA 607 and STA 700.

STA 702 ADVANCED STATISTICAL INFERENCE II. (3)
UMP and UMP unbiased tests for multiparametric exponential families; locally best tests; invariance and permutation tests, UMP invariant tests for linear hypotheses; asymptotic aspects of classical statistics, ML estimation and concepts of efficiency; sequential probability ratio test; confidence set, UMA unbiased and invariance confidence sets. Prereq: STA 701.

STA 703 ADVANCED PROBABILITY. (3)
Probability spaces, extension theorem, random variables; independence, conditional probability, conditional expectation; laws of large numbers, law of the iterated logarithm; convergence in distribution; characteristic functions; central limit theorems; martingales. Prereq: STA 700 and STA 532.

STA 704 ADVANCED PROBABILITY - STOCHASTIC PROCESSES. (3)
Random functions; jump Markov processes; processes with independent increments; stationary stochastic processes; diffusion processes; limit theorems; applications of stochastic processes. Prereq: STA 703.

STA 705 ADVANCED COMPUTATIONAL INFERENCE. (3)
Numerical maximization and integration, resampling methods, EM algorithm, Markov Chain Monte Carlo methods. Prereq: STA 605 and STA 701.

STA 707 ADVANCED DATA ANALYSIS. (3)
Theory and data analysis involving likelihood functions, mixed models, missing responses. Prereq: STA 643.

STA 709 ADVANCED SURVIVAL ANALYSIS. (3)
Lindberg CLT, Kaplan-Meier and related estimators, Cox proportional hazards and related methods, approximations of type I and II error. Prereq: STA 635, 701.

STA 715 READINGS IN STATISTICS AND PROBABILITY (Subtitle required). (1-6)
Supervised reading and discussion of a selected research topic. May be repeated to a maximum of nine credits. Prereq: STA 701 and STA 703 and consent of instructor.

STA 748 MASTER'S THESIS RESEARCH. (0)
Half-time to full-time work on thesis. May be repeated to a maximum of six semesters. Prereq: All course work toward the degree must be completed.

STA 749 DISSERTATION RESEARCH. (0)
Half-time to full-time work on dissertation. May be repeated to a maximum of six semesters. Prereq: Registration for two full-time semesters of 769 residence credit following the successful completion of the qualifying exams.

STA 767 DISSERTATION RESIDENCY CREDIT. (2)
Residency credit for dissertation research after the qualifying examination. Students may register for this course in the semester of the qualifying examination. A minimum of two semesters are required as well as continuous enrollment (Fall and Spring) until the dissertation is completed and defended.