ACADEMIC PROGRAM

THE DEPARTMENT OF STATISTICS
TEXAS A&M UNIVERSITY
COLLEGE STATION, TEXAS

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This statement of regulations and requirements complements the University's regulations and requirements which are contained in the Graduate College Catalog. The degree requirements contained herein apply to all students entering as of September 1, 2014.

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Graduate Program in Statistics

The Department of Statistics offers a graduate program, leading to the degrees of Master of Science and Doctor of Philosophy. The Department also jointly sponsors graduate work with all subject matter area departments in setting up flexible minor programs in statistics.

The Department of Statistics offers two options in its master's degree programs: (1) the Master of Science degree (thesis option) which requires the preparation of a thesis and (2) the Master of Science (non-thesis option) which requires more formal course work in lieu of the thesis. Within either option, students are allowed to choose either a broad-based or specialized program of study. All choices, however, provide a balanced training in statistical methods, computational statistics, and statistical theory, and are intended to prepare the student to adapt statistical methodologies to practical problems.

The aim of the Ph.D. program is to provide comprehensive and balanced training in statistical methods, computational statistics, and the theory of statistics. Particular emphasis is placed on training students to independently recognize the relevance of statistical methods to the solution of specific problems and to enable them to develop new methods when they are needed. The training aims to convey a sound knowledge of existing statistical theory, including the mathematical facility to develop new results in statistical methodology. At the same time, the program is kept sufficiently flexible to permit students to develop their specific interests.

Master of Science Program

Non-Thesis Option

A student seeking the Master of Science degree under the Non-Thesis Option must fulfill the following requirements:

A. Coursework. Note that STAT 601, 651, 652, and 658 may not be used to fulfill any of the coursework requirements listed below.

1) STAT 604, 608, 641 and 642.
2) One credit hour of STAT 681.
3) Two semester credit hours of statistical consulting experience (STAT 684) earned in a minimum of two semesters. Rules governing completing this requirement are given below in Item B.
4) Three semester credit hours of STAT 685 for the preparation of a special problem (see item C below).
5) Eighteen semester credit hours based on one of the emphasis areas outlined below.
6) A total of 36 semester credit hours.

Broad-Based Plan

1) STAT 610, 611
2) Four additional courses from the MS elective courses list.

Biostatistics Emphasis

1) STAT 610, 611, 645 and 646
2) Two additional courses from the MS elective courses list.

Computational Emphasis

1) STAT 610 and 611
2) Two courses in Mathematics (e.g., MATH 609, MATH 610 or MATH 660).
3) Two courses in Computer Science (e.g., CPSC 603, CPSC 654 or CPSC 659).

Applied Emphasis

1) STAT 630, 657
2) Four additional courses from the MS elective courses list.

MS Elective Courses:
STAT 607, 626, 636, 638, 645, 646, 647, 656, 657, 659

B. Substitution of STAT Ph.D. Courses for MS Coursework.
With the approval of the Graduate Advisor and/or Associate Department Head, STAT Ph.D. courses can be used as substitutes for any of the MS courses listed in part A.

C. Consulting Experience. One semester credit hour of STAT 684 can be obtained through the completion of any of the experiences listed below.

1) One semester of service in the Statistical Consulting Center.
2) One semester of a departmentally approved internship.
3) Special experiences, with prior approval from the Department Head or the Associate Department Head that involves the following:
    a. At least one semester of activity
    b. The application of statistical knowledge
    c. Working with non-statisticians
    d. Sufficient statistical supervision.

D. Form a master's advisory committee and complete a special project under the direction of the chairman of the advisory committee. Three semester credit hours of STAT 685 are earned by completion of this project. Upon completion, the student is required to compose a written report and make an oral presentation on the work. The purpose of this project is to familiarize the student with the type of problems that may be encountered in future work and to give the student a chance to develop the ability to present results both verbally and in writing. In many cases, work done during an internship may be used as the basis for the student's master's project. However, this project must be completed under the supervision of the chairperson of the student's advisory committee.

E. Pass the departmental MS examination (see below).

F. Pass a final oral examination. This examination is concerned with the student's coursework and special problem. It is administered by the student's advisory committee.

Thesis Option

A student seeking the Master of Science degree under the Thesis Option must fulfill the following requirements:

A. Coursework. Note that STAT 601, 651, 652, and 658 may not be used to fulfill any of the coursework requirements listed below.
   1) STAT 604, 608, 610, 611, 641 and 642.
   2) One credit hour of STAT 681.
   3) Six semester credit hours of STAT 691 for preparation of a thesis (see item B below).
   4) Nine semester credit hours based on one of the emphasis areas outlined below. STAT 691 semester credit hours may not be used to satisfy this requirement.
   5) A total of 34 semester credit hours.

Broad-Based Plan
   1) Three additional courses from the MS elective courses list.

Biostatistics Emphasis
   1) STAT 643 and 644
   2) One additional courses from the MS elective courses list.

Computational Emphasis
   1) At least one course in Mathematics (e.g., MATH 609, MATH 610 or MATH 660).
   2) At least one course in Computer Science (e.g., CPSC 603, CPSC 654 or CPSC 659).

B. Substitution of STAT Ph.D. Courses for MS Coursework.
   With the approval of the Graduate Advisor and/or Associate Department Head, STAT Ph.D. courses can be used as substitutes for any of the MS courses listed in part A.

C. Form an advisory committee and complete a thesis under the direction of the chairman of the advisory committee. The Department does not insist that this represent an original contribution to the field of statistics. It is intended to train the student in carrying out independently a piece of research; this may represent

an application of existing statistical methods in a new area or a comparative evaluation of statistical methods.

D. Pass the departmental MS examination (see below).

E. Pass a final oral examination. This examination is concerned with the student's coursework and thesis. It is administered by the student's advisory committee.

Master's Diagnostic Examination

The MS examination covers basic statistical methods. The examination is evaluated with the performance judged to be "Pass" or "Fail." To receive a Master's Degree, a student must take and pass the exam.

The diagnostic exam is offered twice a year--prior to the beginning of the fall semester and prior to the beginning of the spring semester, and must be taken at the earliest possible time after the student has completed the required courses: STAT 610, 611 (or 630), 604, 608, 641, and 642. Any exception to this time limit must be obtained in writing from the head of the Department.

The results of a student's examination are reported to the faculty of the Statistics Department. If the student's performance is judged to be deficient, the examination may be retaken the next time it is offered. Only one retake of the examination is allowed.

The Ph.D. Qualifying Examination can be taken as a substitution for the Master's Diagnostic Examination. A student must receive a Pass at the MS level or a Pass at the Ph.D. level on the Ph.D. Qualifying Examination in order for the results from the Ph.D. Exam to qualify as a Pass on the MS Exam.

Doctor of Philosophy Program

The breadth of the field of statistics as well as the frontiers of knowledge in a particular research area are emphasized in the Ph.D. program. The student seeking a Ph.D. in statistics is required to fulfill the following requirements. A Ph.D. selection committee will examine the background of entering students to determine if they have the appropriate mathematics/statistics background to successfully complete the program. Those students determined to not have the appropriate background will need to complete some courses in the MS STAT program and/or courses in mathematics.

A. Courses

1) Required Courses – STAT 605, 612, 613, 614, 620, 632, 648
2) At least five courses from the elective course list provided below.
3) Two semester credit hours of statistical consulting experience (STAT 684) earned in a minimum of two semesters. Rules governing acceptable methods for completing this requirement are given below in Item B.
4) Four semester credit hours of STAT 681.
5) A sufficient number of research hours, STAT 691, or additional courses from the Ph.D. Elective Course list or M.S. Elective Courses to achieve a total of at least 96 semester credit hours beyond a Bachelor's degree or 64 semester credit hours beyond a Master's degree.

Ph.D. Elective Courses:
STAT - 615, 616, 618, 621, 627, 631, 633, 642, 643, 644, 647, 665, 673, 674, 689

B. Consulting Experience. One semester credit hour of STAT 684 can be obtained through the completion of any of the experiences listed below.

1) One semester of service in the Statistical Consulting Center.
2) One semester of a departmentally approved Internship.
3) Special experiences, with prior approval from either the Department Head or the Associate Department Head that involve the following:
   a. At least one semester of activity

b. The application of statistical knowledge
c. Working with non-statisticians
d. Sufficient statistical supervision.

C. Ph.D. Qualifying Examination. The Ph.D. Qualifying Exam will cover the material from the required courses: STAT 614, 620, 612, 613, 605, 648. The student's performance on the Ph.D. Qualifying Exam combined with the student's performance in the required courses will then be evaluated as

1) Pass at the Ph.D. level
2) Pass at the Ph.D. level conditional on retaking specified courses
3) Pass at the M.S. level with no option to retake the Ph.D. exam
4) Fail the exam with no option to retake the Ph.D. exam.

The exams will be offered in May every year approximately two weeks after the spring semester final exams. There are two schedules for a student to take the Ph.D. qualifying exam.

Schedule I: Exam is taken in May of the first academic year student is enrolled in the Ph.D. program.

Schedule II: Exam is taken in May of the second academic year that student is enrolled in the Ph.D. program. This schedule is for students that are taking background courses in statistics or mathematics prior to taking the required Ph.D. courses. A student using Schedule II will be evaluated at the end of their second and third semesters in the Ph.D. program regarding whether they will be allowed to continue in the Ph.D. program. Any student who has not taken the Ph.D. exam within two years of their entering the program will automatically be disqualified from the Ph.D. program.

D. Ph.D. Advisory Committee. After passing the Ph.D. qualifying exam, a student must select a faculty member of the Department of Statistics to be the student's Ph.D. advisor and to direct the student's research. The student and the selected faculty member should work together to form a Ph.D. advisory committee consisting of two more members from the statistics faculty and a faculty member outside of the department of statistics. A degree plan must be submitted using the electronic degree plan at the OGAPS website. The degree plan will

include all required courses, five courses from the Elective Courses list, and sufficient hours to meet OGAPS requirements as listed above.

E. Take and pass the Preliminary Examination administered by the advisory committee within three semesters after passing the Ph.D. qualifying exam (see below).

F. Write a Ph.D. Dissertation and pass the final Defense of Dissertation Examination (see below). The presentation of student's research in their dissertation defense will be open to the public.

Preliminary Examination

After a student has passed the departmental Ph.D. qualifying examination, formed an advisory committee, submitted a degree plan and has it approved by OGAPS, a student must take the OGAPS required preliminary examination. The prelim exam consists of the following parts:

1) A written examination developed by the statistics members of the student's advisory committee. This exam is usually waived at the discretion of the departmental committee members.
2) A written examination administered by the member of the student's advisory committee from outside the Statistics Department. This examination is usually waived.
3) An oral examination administered by the members of the student's advisory committee. The oral exam generally consists of the student presenting a proposal for the student's Ph.D. dissertation research and discussing any research results completed at the point of the exam.

Scheduling the preliminary examination can only take place after the student has an approved Ph.D. degree plan on file with OGAPS. The student must successfully pass the preliminary examination within three semesters after passing the Ph.D. qualifying exam and at least 14 weeks prior to the date of the dissertation defense. The results of the examination are reported to OGAPS using the *Report of the Preliminary Examination*, a form found at the OGAPS website.

The Ph.D. Dissertation

After successfully completing all the required courses and passing the Ph.D. Qualifying Exam, a period of time is to be devoted to formulating a research topic in either statistical methodology or statistical theory under the guidance of the student's dissertation advisor. The proposed research will be presented to the student's advisory committee during the Preliminary Exam in order to obtain the committees input on the appropriateness of the research. The results of this research must be communicated in a written dissertation satisfying the guidelines established by OGAPS. The research must constitute an original contribution to the science of statistics and may derive new results in statistical theory or methodology or may be concerned with developing statistical methodology in new areas of application.

Once the student's advisory committee feels that the student has completed the dissertation, a final oral examination is conducted by the advisory committee in which the student defends the dissertation. This exam must be scheduled by submitting the Request and Announcement of the Final Examination form to OGAPS at least 10 working days before the final exam date.

Internship Program

Students after one year of coursework are eligible to participate in an internship with a sponsoring company, hospital, or federal agency. The internships are generally a semester's stay at the sponsor's site. If a student participates in one of the internship programs approved by the department head, then:

1) The student is given credit for one hour of STAT 684.
2) In many cases, work done during the internship may be used as the basis for a Master's project. However, this project must be completed under the supervision of the chairperson of the student's advisory committee.

Faculty, 2014-2015

V. E. Johnson, *Professor and Head*; Ph.D. in Statistics: University of Chicago, 1989; longitudinal data, nonparametric statistics, applied statistics, biostatistics, categorical data, Bayesian methods.

M. T. Longnecker, *Professor and Associate Head*; Ph.D. in Statistics: Florida State University, 1976; statistical education and consulting.

D. Akleman, Senior Lecturer; Ph.D. in Agricultural Economics: Texas A&M University, 1996; time series, stochastic processes, risk analysis, artificial intelligence, econometrics.

A. Bhattacharya, Assistant Professor; Ph.D. in Statistics: Duke University, 2012; Factor models, Gaussian process, high-dimensional data, large contingency tables.

J. H. Carroll, Senior Lecturer; MS in Statistics: Texas A&M University, 1990; Statistics education.

R. J. Carroll, Distinguished Professor; Ph.D. in Statistics: Purdue University, 1974; longitudinal data, measurement error, nutritional epidemiology, bioinformatics.

W. Chen, Professor; Ph.D. in Statistics: New York University, 2001; long memory time series, econometrics

D. B. H. Cline, Professor; Ph.D. in Statistics: Colorado State University, 1983; Nonlinear time series, Markov chains, subexponential distributions, Tauberian theorems, heavy-tailed distributions.

A. Dabney, Associate Professor; Ph.D. in Biostatistics: University of Washington, 2006; microarrays, bioinformatics, classification methods.

P. F. Dahm, Professor and Graduate Advisor; Ph.D. in Statistics: Iowa State University, 1979; measurement error models, biostatistics, econometrics.

C. E. Gates, Professor Emeritus; Ph.D. in Experimental Statistics: North Carolina State University, 1955; design and analysis of experimental data, estimation of wildlife abundance and modeling non-linear growth curves.

J. D. Hart, Professor; Ph.D. in Statistics: Southern Methodist University, 1981; nonparametric function estimation, time series, bootstrap methods.

K. Hatfield, Lecturer; MBA in Operations Research**:** North Texas State University, 1980; Statistics education and consulting.

R. R. Hocking, Professor Emeritus; Ph.D. in Statistics: Iowa State University, 1962; regression, mixed models and multivariate analysis.

J. Huang, Professor; Ph.D. in Statistics: University of California, Berkeley, 1997; nonparametric and semiparametric methods, statistical function estimation using polynomial splines, statistical methods for longitudinal data/panel data, multivariate/functional data analysis, survival analysis, duration data, event history analysis, statistics application in business.

O. C. Jenkins, Professor Emeritus; Ph.D. in Statistics: Texas A&M University, 1972; statistical sampling and experimental design.

E. R. Jones, Executive Professor, Ph.D. in Statistics: Virginia Polytechnic and State University, 1976; applied statistics, statistical computing, data mining/machine learning.

M. Jun, Associate Professor, Ph.D. in Statistics: University of Chicago, 2005; statistical methodologies, environmental problems, space-time covariance modeling, numerical model evaluation in air quality problems, combining numerical model output with observed data.

M. Katzfuss, Assistant Professor, Ph.D. in Statistics: Ohio State University, 2011; Spatial and spatio-temporal statistics, Bayesian inference, massive datasets, probabilistic forecasting, applications to environmental data.

E. Y. Kolodziej, Senior Lecturer, Ph.D. in Statistics: Texas A&M University, 2010; spatial statistics, statistics education, consulting.

F. Liang, Professor, Ph.D. in Statistics: University of Hong Kong, 1998; Bayesian computation and bioinformatics.

H.-C. Liang, Senior Lecturer, Ph.D. in Statistics: University of New Mexico, 2003; Linear models, statistical education, undergraduate research.

J. P. Long, Assistant Professor, Ph.D. in Statistics: University of California, Berkeley, 2013; Applied statistics, machine learning, time series, classification, astrostatistics, errors-in-variables.

B. Mallick, Distinguished Professor; Ph.D. in Statistics: University of Connecticut, 1994; Bayesian hierarchical modeling, nonparametric regression and classification, bioinformatics, spatio-temporal modeling, machine learning, functional data analysis, Bayesian nonparametrics, petroleum reservoir characterization, uncertainty analysis of computer model outputs.

J. H. Matis, Professor Emeritus; Ph.D. in Statistics: Texas A&M University, 1970; biomathematics, compartmental analysis, statistical ecology and applied stochastic processes.

U. Müller-Harknett, Professor; Ph.D. in Mathematics: University of Bremen, 1997; non- and semi-parametrics, efficient estimation.

H. J. Newton, Professor and Dean; Ph.D. in Statistics: State University of New York at Buffalo, 1975; time series analysis, computational statistics.

E. Parzen, Distinguished Professor Emeritus; Ph.D. in Mathematics: University of California (Berkeley), 1953; statistical science-developing statistical methods for time series analysis, data analysis, and change analysis.

M. Pourahmadi, Professor, Ph.D. in Statistics: Michigan State University, 1980, time series analysis and prediction theory, multivariate analysis, longitudinal data analysis, mixed-effects models, data mining, stochastic volatility models.

L. J. Ringer, Professor Emeritus; Ph.D. in Statistics: Texas A&M University, 1966; applied statistics, survey sampling and reliability.

H. Sang, Associate Professor, Ph.D. in Statistics: Duke University, 2008; Bayesian statistics with focus on spatial and spatio-temporal statistics.

H. Schmiediche, Director of Information Technology; Ph.D. in Statistics: Texas A&M University, 1993; computational statistics.

S. J. Sheather, Professor and Academic Director of MS Analytics & Online Programs; Ph.D. in Statistics: LaTrobe University, 1986; development of regression diagnostics and robust and flexible regression methods, statistical models of wine quality.

M. Sherman, Professor; Ph.D. in Statistics: University of North Carolina at Chapel Hill, 1992; biostatistics, spatial statistics.

S. Sinha, Associate Professor, Ph.D. in Statistics: University of Florida, 2004; methodological research: missing data technique, measurement error, splines, Bayesian methods: parametric and nonparametric methods, application: epidemiology, genetic epidemiology.

W. B. Smith, Professor Emeritus; Ph.D. in Statistics: Texas A&M University, 1967; multivariate analysis, missing data methods, correspondence analysis.

F. M. Speed, Professor Emeritus; Ph.D. in Statistics: Texas A&M University, 1969; computational statistics, biostatistics, linear models, applied statistics, multivariate methods, environmental and industrial statistics, teaching statistics real time.

C. H. Spiegelman, Distinguished Professor; Ph.D. in Statistics & Applied Mathematics: Northwestern University, 1976; calibration curves, measurement error models, applied statistics, especially to chemistry.

S. Subba Rao, Associate Professor; Ph.D. in Statistics: University of Bristol, UK, 2001; time series, nonstationary processes, nonlinear processes, recursive online algorithms, spatio-temporal models.

E. Toby, Senior Lecturer; Ph.D. in Mathematics: University of California, San Diego, 1988; biostatistics, diffusions processes.

S. Wang, Professor; Ph.D. in Statistics: University of Texas at Austin, 1988; biostatistical inferences, missing and mis-measured data modeling and analysis, non- and semi-parametric methodology, resampling methods, small sample asymptotics, survey sampling.

T. E. Wehrly, Professor; Ph.D. in Statistics: University of Wisconsin, 1976; stochastic models, directional data, mathematical statistics, nonparametric function estimation.

L. Zhou, Associate Professor, Ph.D. in Statistics: University of California, 1997; statistical Methodology and application in bioinformatics, nutrition and epidemiology, functional/longitudinal data analysis.

J. Zinn, Professor of Mathematics and Statistics; Ph.D. in Mathematics: University of Wisconsin, 1972; empirical processes, bootstrapping.

Undergraduate Course Offerings

201. Elementary Statistical Inference. (3-0). Credit 3. Data collection, tabulation, and presentation. Elementary description of the tools of statistical inference; probability, sampling, and hypothesis testing. Applications of statistical techniques to practical problems. May not be taken for credit after or concurrently any other course in statistics or INFO 303 has been taken.

211. Principles of Statistics I. (3-0). Credit 3. Introduction to probability and probability distributions. Sampling and descriptive measures. Inference and hypothesis testing. Linear regression, analysis of variance. Prerequisite: MATH 152 or 172.

212. Principles of Statistics II. (3-0). Credit 3. Design of experiments, model building, multiple regression, nonparametric techniques, contingency tables, and short introductions to response surfaces, decision theory and time series data. Prerequisite: STAT 211.

301. Introduction to Biometry. (3-0). Credit 3. Intended for students in animal sciences. Introduces fundamental concepts of biometry including measures of location and variation, probability, tests of significance, regression, correlation, and analysis of variance which are used in advanced courses and are being widely applied to animal-oriented industry. Credit will not be allowed for more than one of STAT 301, 302 or 303. Prerequisite: MATH 141 or 166 or equivalent.

302. Statistical Methods. (3-0). Credit 3. Intended for undergraduate students in the biological sciences and agriculture (except agricultural economics). Introduction to concepts of random sampling and statistical inference; estimation and testing hypotheses of means and variances; analysis of variance; regression analysis; contingency tables. Credit will not be allowed for more than one of STAT 301, 302 or 303. Prerequisite: MATH 141 or 166 or equivalent.

303. Statistical Methods. (3-0). Credit 3. Intended for undergraduate students in the social sciences. Introduction to concepts of random sampling and statistical inference, estimation and testing hypotheses of means and variances, analysis of variance, regression analysis, contingency tables. Credit will not be allowed for more than one of STAT 301, 302 or 303. Prerequisite: MATH 141 or 166 or equivalent.

307. Sample Survey Techniques. (3-0). Credit 3. Concepts of population and sample; the organization of a sample survey; questionnaire design. Basic survey designs and computation of

estimates and variances. Prerequisites: STAT 301, 302, 303, or INFO 303.

407. Principles of Sample Surveys. (3-0). Credit 3. Principles of sample surveys and survey design; techniques for variance reduction; simple, stratified and multi-stage sampling; ratio and regression estimates; post-stratification; equal and unequal probability sample. Prerequisite: STAT 212.

408. Introduction to Linear Models. (3-0). Credit 3. Introduction to the formulation of linear models and the estimation of the parameters of such models, with primary emphasis on least squares. Application to multiple regression and curve fitting. Prerequisites: MATH 304; STAT 212.

414. Mathematical Statistics. (3-0). Credit 3. Introduction to the mathematical theory of statistics, including random variables and their distributions, expectation and variance, point estimation, confidence intervals and hypothesis testing. Prerequisite: MATH 221, 251 or 253.

485. Problems. Credit 1 to 6. Special problems in statistics not covered by another course in the curriculum. Work may be in either theory or methodology. Prerequisite: Approval of instructor.

Graduate Course Offerings

601. Statistical Analysis. (3-2). Credit 4. For students in engineering, physical, and mathematical sciences. Introduction to probability, probability distributions, and statistical inference; hypotheses testing; introduction to methods of analysis such as tests of independence, regression, analysis of variance with some consideration of planned experimentation. Prerequisite: MATH 152 or 172.

604. Topics in Statistical Computations. (3-0). Credit 3. Efficient uses of existing statistical computer programs (SAS, R, etc.), generation of random numbers; using and creating functions and subroutines; statistical graphics; programming of simulations studies; and data management issues. Prerequisites: MATH 221, 251, or 253.

605. Advanced Statistical Computations. (3-0). Credit 3. Programming languages, statistical software, and computing environments; development of programming skills using modern methodologies; data extraction and code management; interfacing lower-level languages with data analysis software; simulation; MC integration; MC-MC procedures; permutation tests; bootstrapping. Prerequisite: STAT 612 and STAT 648.

607. Sampling. (3-0). Credit 3. Planning, execution and analysis of sampling from finite populations; simple, stratified, multistage and systematic sampling; ratio estimates. Prerequisite: STAT 601 or 652 or concurrent enrollment in STAT 641.

608. Regression Analysis. (3-0). Credit 3. Multiple, curvilinear, nonlinear, robust, logistic and principal components regression analysis; regression diagnostics, transformations, analysis of covariance. Prerequisite: STAT 601 or 641.

610. Theory of Statistics - Distribution Theory. (3-0). Credit 3. Brief introduction to probability theory; distributions and expectations of random variables, transformations of random variables, and order statistics; generating functions and basic limit concepts. Prerequisite: MATH 409 or concurrent enrollment in MATH 409.

611. Theory of Statistics - Inference. (3-0). Credit 3. Theory of estimation and hypothesis testing; point estimation, interval estimation, sufficient statistics, decision theory, most powerful tests, likelihood ratio tests, chi-square tests. Prerequisite: STAT 610 or equivalent.

612. Theory of Linear Models. (3-0). Credit 3. Matrix algebra for statisticians, Gauss-Markov theorem; estimability; estimation subject to linear restrictions; multivariate normal distribution; distribution of quadratic forms; inferences for linear models; theory of multiple regression and AOV; random- and mixed-effects models. Prerequisite: Course in linear algebra.

613. Statistical Methodology I. (3-0). Credit 3. Elements of likelihood inference; exponential family models; group transformation models; survival data; missing data; estimation and hypothesis testing; nonlinear regression models; conditional and marginal inferences; complex models-Markov chains, Markov random fields, time series, and point processes. Prerequisite: STAT 612.

614. Probability for Statistics. (3-0). Credit 3. Probability and measures; expectation and integrals, Kolmogorov's extension theorem; Fubini's theorem; inequalities; uniform integrability; conditional expectation; laws of large numbers; central limit theorems. Prerequisite: STAT 610 or its equivalent.

615. Stochastic Processes. (3-0). Credit 3. Survey of the theory of Poisson processes, discrete and continuous time Markov chains, renewal processes, birth and death processes, diffusion processes, and covariance stationary processes. Prerequisites: STAT 611; MATH 409.

616. Statistical Aspects of Machine Learning I: Classical Multivariate Methods. (3-0). Credit 3. Core methods from traditional multivariate analysis and various extensions. Probability distributions of random vectors and matrices, multivariate normal distributions, model assessment and selection in multiple regression, multivariate regression, dimension reduction, linear discriminant analysis, logistic discriminant analysis, cluster analysis, multidimensional scaling and distance geometry, and correspondence analysis Prerequisites: STAT 611 and 612.

618. Statistical Aspects of Machine Learning II: Modern Techniques. (3-0). Credit 3. Second course in statistical machine learning. Recursive partition and tree-based methods, artificial neural networks, support vector machines, reproducing kernels, committee machines, latent variable methods, component analysis, nonlinear dimensionality reduction and manifold learning, matrix factorization and matrix completion, statistical analysis of tensors and multi-indexed data. Prerequisites: STAT 610, 611, and 613.

620. Asymptotic Statistics. (3-0). Credit 3. Review of basic concepts and important convergence theorems; elements of decision theory; delta method; Bahadur representation theorem; asymptotic distribution of MLE and the LRT statistics; asymptotic efficiency; limit theory for U-statistics and differential statistical functionals with illustration from M-,L-,R-estimation; multiple testing. Prerequisite: STAT 614.

621. Advanced Stochastic Processes. (3-0). Credit 3. Conditional expectation; stopping times; discrete Markov processes; birth-death processes; queuing models; discrete semi-Markov processes; Brownian motion; diffusion processes, Ito integrals, theorem and limit distributions; differential statistical functions and their limit distributions; M-,L-,R-estimation. Prerequisite: STAT 614 or STAT 615.

623. Statistical Methods for Chemistry. (3-0). Credit 3. Chemometrics topics of process optimization, precision and accuracy; curve fitting; chi-squared tests; multivariate calibration; errors in calibration standards; statistics of instrumentation. Prerequisites: STAT 601 or STAT 652 or STAT 641 or approval of instructor.

626. Methods in Time Series Analysis. (3-0). Credit 3. Introduction to statistical time series analysis; autocorrelation and spectral characteristics of univariate, autoregressive, moving average models; identification, estimation and forecasting. Prerequisite: STAT 601 or 642 or approval of instructor.

627. Nonparametric Function Estimation. (3-0). Credit 3. Nonparametric function estimation; kernel, local polynomials, Fourier series and spline methods; automated smoothing methods including cross-validation; large sample distributional properties of estimators; recent advances in function estimation. Prerequisites: STAT 611.

630. Overview of Mathematical Statistics. (3-0). Credit 3. Basic probability theory including distributions of random variables and expectations. Introduction to the theory of statistical inference from the likelihood point of view including maximum likelihood estimation, confidence intervals, and likelihood ratio tests. Introduction to Bayesian methods. Prerequisites: Math 221, 251, or 253.

631. Statistical Methods in Finance. (3-0). Credit 3. Regression and the capital asset pricing model, statistics for portfolio analysis, resampling, time series models, volatility models, option pricing and Monte Carlo methods, copulas, extreme value theory, value at risk, spline smoothing of term structure. Prerequisites: STAT 610, 611, 608.

632. Statistical Methodology II-Bayesian Modeling and Inference. (3-0). Credit 3. Decision theory; fundamentals of Bayesian inference; single and multi-parameter models, Gaussian model; linear and generalized linear models; Bayesian computation; asymptotic methods; non-interative MC; MCMC; hierarchical models; nonlinear models; random effect models; survival analysis; spatial models. Prerequisite: STAT 613.

633. Advanced Bayesian Modeling and Computation. (3-0). Credit 3. Bayesian methodology, and applications of Bayesian methods in bioinformatics, biostatistics, signal processing, machine learning, and related fields. Prerequisite: STAT 608, 613, 632.

636. Applied Multivariate Analysis. (3-0). Credit 3. Multivariate extensions of the chi-square and t-tests, discrimination and classification procedures; applications to diagnostic problems in biological, medical, anthropological, and social research; multivariate analysis of variance, principal component and factor analysis, canonical correlations. Prerequisites: MATH 423 and STAT 653 or approval of instructor. Cross-listed with INFO 657.

638. Introduction to Applied Bayesian Methods. (3-0). Credit 3. Students will learn how uncertainty regarding parameters can be explicitly described as a posterior distribution which blends information from a sampling model and prior distribution Course will emphasize modeling and computations under the Bayesian paradigm. Topics include: prior distributions, Bayes Theorem, conjugate and non-conjugate models, posterior simulation via the Gibbs sampler and MCMC, hierarchical modeling. Prerequisite: STAT 604, 608, 630.

641. The Methods of Statistics I. (3-0). Credit 3. An application of the various disciplines in statistics to data analysis, introduction to statistical software; demonstration of interplay between probability models and statistical inference. Prerequisites: Concurrent Enrollment in STAT 610 or approval of instructor.

642. The Methods of Statistics II (3-0). Credit 3. Design and analysis of experiments; scientific method; graphical displays; analysis of nonconventional designs and experiments involving categorical data. Prerequisites: STAT 641.

643. Biostatistics I. (3-0). Credit 3. Bio-assay for quantitative and quantal responses; statistical analysis of contingency, including effect estimates, matched samples and misclassification. Prerequisites: STAT 608, 630, and 642 or STAT 610.

644. Biostatistics II. (3-0). Credit 3. Generalized linear models; survival analysis with emphasis on nonparametric models and methods. Prerequisites: STAT 643 or approval of instructor.

645. Applied Biostatistics and Data Analysis. (3-0). Credit 3. Survey of crucial topics in biostatistics; application of regression in biostatistics; analysis of correlated data; logistic and Poisson regression for binary or count data; survival analysis for censored outcomes; design and analysis of clinical trials; sample size calculation bysimulation; bootstrap techniques for assessing statistical significance; data analysis using R. Prerequisites: STAT 651, 652, and 659, or equivalent or prior approval of instructor.

646. Statistical Bioinformatics. (3-0). Credit 3. An overview of relevant biological concepts and technologies of genomic/proteomic applications; methods to handle, visualize, analyze, and interpret genomic/proteomic data; exploratory data analysis for genomic/proteomic data; data preprocessing and normalization; hypotheses testing; classification and prediction techniques for using genomic/proteomic data to predict disease status. Prerequisites: STAT 604, 651, 652 or equivalent or prior approval of instructor.

647. Spatial Statistics. (3-0). Credit 3. Spatial correlation and its effects; spatial prediction (kriging); spatial regression; analysis of point patterns (tests for randomness and modelling patterns); sub sampling methods for spatial data. Prerequisite: STAT 601 or STAT 611 or equivalent.

648. Applied Statistics and Data Analysis. (3-0). Credit 3. Background to conduct research in the development of new methodology in applied statistics. Topics covered will include: exploratory data analysis; sampling; testing; smoothing; classification; time series; and spatial data analysis. Prerequisite: Approval of instructor.

651. Statistics in Research I. (3-0). Credit 3. For graduate students in other disciplines; non-calculus exposition of the concepts, methods and usage of statistical data analysis; T-tests, analysis of variance, and linear regression. Prerequisite: MATH 102 or equivalent.

652. Statistics in Research II. (3-0). Credit 3. Continuation of STAT 651. Concepts of experimental design, individual treatment comparisons, randomized blocks and factorial experiments, multiple regression, chi-square tests and a brief introduction to covariance, non-parametric methods, and sample surveys. Prerequisite: STAT 651.

653. Statistics in Research III. (3-0). Credit 3. Advanced topics in ANOVA; analysis of covariance; and regression analysis including analysis of messy data; non-linear regression; logistic and weighted regression, diagnostics and model building; emphasis on concepts, computing and interpretation. Prerequisite: STAT 652.

656. Applied Analytics Using SAS Enterprise Miner. (3-0) Credit 3. Introduction to data mining and will demonstrate the procedures; Optimal prediction decisions; comparing and deploying predictive models; neural networks; constructing and adjusting tree models; the construction and evaluation of multi-stage models. Prerequisite: STAT 657.

657. Advanced Programming Using SAS. (3-0). Credit 3. Programming with SAS/IML, programming in SAS data step, advanced use of various SAS procedures. Prerequisites: STAT 604, 642.

658. Transportation Statistics. (3-0). Credit 3. Design of experiments, estimation, hypotheses testing, modeling, and data mining for transportation specialists. Prerequisites: STAT 211 or STAT 651.

659. Applied Categorical Data Analysis. (3-0). Credit 3. Introduction to analysis and interpretation of categorical data using ANOVA/regression analogs; includes contingency tables, loglinear models, logistic regression; use of computer software such as SAS, GLIM, SPSSX. Prerequisite: STAT 601 or 641 or 652 or equivalent.

661. Statistical Genetics. (3-0), Credit 3. Basic concepts in human genetics, sampling designs, gene frequency estimation, Hardy-Weinberg equilibrium, linkage disequilibrium, association and transmission disequilibrium test studies, linkage and pedigree analysis, segregation analysis, polygenic models, DNA sequence analysis. Prerequisites: STAT 610 and 611.

662. Advanced Statistical Genetics. (3-0). Credit 3. This course is a continuation of the course, STAT 661 Statistical Genetics. A strong background in statistics, genetics, and mathematics is required. Topics include counting methods, EM algorithm, Newton's method, scoring in genetics, genetic identity coefficients, descent graph, molecular phylogeny, models of recombination, sequence analysis, diffusion processes and linkage disequilibrium mappings. Prerequisite: STAT 610, 611, and 661.

665. Statistical Application of Wavelets. (3-0). Credit 3. This is a course on the use of wavelets methods in statistics. The course introduces wavelet theory, provides an overview of wavelet-based

statistical methods. Topics include smoothing of noisy signals, estimation function data and representation of stochastic processes. Some emphasis is given to Bayesian procedures. Prerequisite: STAT 611 or approval by the instructor.

673. Time Series Analysis I. (3-0). Credit 3. An introduction to diverse modes of analysis now available to solve for univariate time series; basic problems of parameter estimation, spectral analysis, forecasting and model identification. Prerequisite: STAT 611 or equivalent.

674. Time Series Analysis II. (3-0). Credit 3. Continuation of STAT 673. Multiple time series, ARMA models, test of hypotheses, estimation of spectral density matrix, transfer function and forecasting. Prerequisites: STAT 673.

681. Seminar. Credit 1. Oral presentations of special topics and current research in statistics. May be repeated for credit. Prerequisite: Graduate classification in statistics.

684. Professional Internship. Credit 1 to 3. Practicum in statistical consulting for students in Ph.D. program. Students will be assigned consulting problems brought to the Department of Statistics by researchers in other disciplines. Prerequisite: STAT 642 or equivalent.

685. Directed Studies. Credit 1 to 6. Individual instruction in selected fields in statistics; investigation of special topics not within scope of thesis research and not covered by other formal courses. Prerequisites: Graduate classification and approval of department head.

689. Special Topics in Statistics. Credit 1 to 4. Selected topics in an identified area of statistics. Open to non-majors. May be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more. Research for thesis or dissertation. Prerequisite: Graduate classification.

Scheduling Coursework

The following list indicates the Department's usual schedule of course offerings. Those courses marked even or odd are offered only in even numbered and odd numbered years, respectively. Because several courses are offered only every other year, it is important to plan a program of study and schedule of courses as early as possible.

Course	Semester(s) Offered	Course	Semester(s) Offered
201	1,2	631	1 (even)
211	1,2,3	632	1
212	1,2	633	2
301	1,2	636	1
302	1,2,3	638	1
303	1,2,3	641	1
307	2	642	2
407	1	643	4
408	2	644	4
414	1	645	1
485	1,2,3	646	2
601	1	647	1
604	1,2,3	648	1
605	2	651	1,2,3
607	1	652	1,2,3
608	2,3	653	2
610	1	656	2
611	2	657	2
612	1	658	4
613	2	659	2,3
614	1	661	4
615	1 (odd)	662	4
616	1	665	4
618	2	673	1 (even)
620	2	674	2 (odd)
621	2 (even)	681	1,2
623	4	684	1,2,3
626	3	685	1,2,3
627	2 (odd)	689	4
630	1,2,3	691	1,2,3

1: Fall, 2: Spring, 3: Summer, 4: As resources allow.

Notes