

# Statistics

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College of Arts and Science  
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Information is needed to solve the many problems of today's world. How much information? What kind? After it is obtained, what must be done with it? Statisticians are trained to help answer these questions. Early admission into the Statistics Department will allow students to plan their programs so that the math and statistics prerequisites can be taken in the most efficient sequence.

The department offers BA, BS, MA and PhD degrees with a major in Statistics. A minor is also available.

## Faculty

**Professor** Z. He\*\*, S. Holan\*\*, J. Sun\*\*, C. K. Wikle\*\*

**Teaching Professor** S. Lee\*, L. D. Ries\*

**Associate Professor** S. Chakraborty\*\*, A. Micheas\*\*

**Assistant Professor** M. Krock\*, X. Liu\*, S. Majumder\*, W. Wright\*, L. Zhang\*\*

**Assistant Teaching Professor** P. Deming\*, N. Grieshop\*, M. McIntosh\*

**Adjunct Assistant Professor** J. Snyder\*, I. Zaniletti\*

**Instructor** T. Christiansen\*

\* Graduate Faculty Member - membership is required to teach graduate-level courses, chair master's thesis committees, and serve on doctoral examination and dissertation committees.

\*\* Doctoral Faculty Member - membership is required to chair doctoral examination or dissertation committees. Graduate faculty membership is a prerequisite for Doctoral faculty membership.

## Undergraduate

- BA in Statistics (<http://catalog.missouri.edu/collegeofartsandscience/statistics/ba-statistics/>)
- BS in Statistics (<http://catalog.missouri.edu/collegeofartsandscience/statistics/bs-statistics/>)
- Minor in Statistics (<http://catalog.missouri.edu/collegeofartsandscience/statistics/minor-statistics/>)

## Credit for Beginning Courses

(Applies to all students and all majors)

- A student may not receive credit toward an undergraduate degree for more than one of STAT 1200, STAT 1300 and STAT 1400.
- A student may not receive credit toward an undergraduate degree for more than one of STAT 2500 and STAT 2530.
- Subject to the above restrictions, a student may receive a maximum of 4 credits toward an undergraduate degree for any combination of STAT 1200, STAT 1300, STAT 1400, STAT 2200, STAT 2500 and STAT 2530.
- A student may not receive credit toward an undergraduate degree for any statistics course numbered 2999 or below if a statistics course numbered 4000 or above was successfully completed prior to or

concurrent with the course in question. Exceptions may be approved at the discretion of the department.

## Department Degree Requirements - Statistics

The Department of Statistics approves majors in statistics only for students who have met the following criteria:

- Completion of at least one statistics course at the 3000-level or above (or equivalent)
- Cumulative GPA of at least 2.50 overall
- Have earned a grade of C or higher in each statistics course completed

Students are encouraged to supplement their work in statistics with courses from areas such as economics, biology, accounting, finance, marketing, management, psychology, sociology, engineering, agriculture and atmospheric science. In addition, students must complete all degree, college and university graduation requirements (<http://catalog.missouri.edu/academicdegreerequirements/universityrequirements/>), including university general education (<http://catalog.missouri.edu/academicdegreerequirements/generaleducationrequirements/>).

## Options

Students may pursue either a BA or a BS degree. For both degrees, students may pursue either a traditional track or an applied track. Students who are interested in graduate study in statistics are strongly encouraged to follow the traditional track.

## Departmental Honors

To be admitted to the undergraduate honors program in the Department of Statistics, a student must have completed at least 12 of the 21 credits of statistics courses required for the major, have a grade-point average of at least 3.25 in all completed statistics courses, and identify a faculty member from the department who agrees to supervise the student's honors research project.

In order to receive the departmental honors designation, students who have been accepted into the program must graduate with a grade-point average of at least 3.25 in statistics courses, prepare a senior thesis based on their honors project, and present the results of the thesis in a departmental colloquium or other public forum approved by their mentor. They also must earn a grade of "B" or better in 3 credits of STAT 4999 .

## Graduate

- MA in Statistics (<http://catalog.missouri.edu/collegeofartsandscience/statistics/ma-statistics/>)
  - with emphasis in Biostatistics (<http://catalog.missouri.edu/collegeofartsandscience/statistics/ma-statistics-emphasis-biostatistics/>)
  - with emphasis in Data Analytics (<http://catalog.missouri.edu/collegeofartsandscience/statistics/ma-statistics-emphasis-data-analytics/>)
- PhD in Statistics (<http://catalog.missouri.edu/collegeofartsandscience/statistics/phd-statistics/>)
- Graduate Minor in Statistics (<http://catalog.missouri.edu/collegeofartsandscience/statistics/grad-minor-statistics/>)

Rose Runyon, Coordinator of Graduate Studies

146 Middlebush  
 Columbia, MO 65211  
 (573) 882-6376  
<https://stat.missouri.edu/>

**Director of Graduate Studies:** Chong Z. He

## About Statistics

The statistics department faculty is known for both cutting edge methodological and collaborative research and for outstanding teaching. Faculty members are currently investigating statistical problems in the fields of ecology, genetics, economics, meteorology, wildlife management, epidemiology, AIDS research, geophysics, and climatology. The program's faculty members have ongoing collaborative programs across disciplines such as biostatistics, bioinformatics, economics, atmospheric science, psychology and with the Missouri Department of Conservation.

The graduate program provides opportunities for graduate study and thesis direction in various areas of probability and statistics, both theoretical and applied. A variety of consulting and collaborative opportunities allow both faculty and graduate students to conduct cooperative and interdisciplinary research. Regular statistics colloquia provide opportunities for faculty and outside speakers to present the results of their research. Faculty and graduate students also participate in weekly seminar series in Bayesian statistics, bioinformatics, and biostatistics.

## Dual Master's Degree in Economics and Statistics

The department offers a cooperative MA degree with the Economics Department. Students may obtain MA degrees in economics and statistics with 48 hours of course work numbered 7000 or higher from the University of Missouri instead of the 52 or more required for separate degrees. (These 48 hours may not include any of the following: ECONOM 7351, ECONOM 7353, or STAT 7510, STAT 7530, STAT 7710.) Eighteen or more hours are required from the Department of Economics. At least 15 hours must be numbered 8000 or higher with no more than four hours of 8090. Students must take the core economics courses ECONOM 8451 and ECONOM 8453 and research workshop ECONOM 8413 (3 credit hours). Eighteen or more hours are required from the Department of Statistics. At least 15 hours must be numbered 8000 or higher with no more than three hours of 8090. STAT 8710 and STAT 8720 and MATH 7140 are required if equivalent courses were not taken as an undergraduate.

All candidates must submit a thesis or written project demonstrating an independent effort towards producing original work satisfactory for each degree. The candidate may complete separate theses/projects for both economics and statistics or a single joint thesis/project satisfying both requirements. Alternatively, the candidate may satisfy the statistics degree requirement by taking the qualifying examination (see Doctorate of Statistics requirements for more details).

## Career Opportunities

Statisticians are in demand in education, medicine, government, business and industry as well as in the biological, social and physical sciences.

## Facilities & Resources

The Department of Statistics maintains a state-of-the-art computer network with Linux workstations and servers for research and personal productivity software on PCs. Students have access to the network through PCs in student offices and through the statistics department computer laboratory. An extensive library of software including R, SAS, and common programming languages is maintained. Students also have access to the campus computing network. The statistics department is located in newly renovated space in Middlebush, with easy access to the main library's outstanding collection of books and journals in statistics.

## Financial Aid from the Program

Fellowships and teaching and research assistantships are available to qualified graduate students. Some programs require an extra form or statement from those who wish to be considered for internal assistantships, fellowships, or other funding packages. Graduate teaching assistantship offers are contingent on satisfactory completion of an English language proficiency assessment unless the applicant completed their entire elementary and secondary education in English in a country in which English is the predominant Language. As stated in Missouri statute 170.012 and University policy, non-native speakers of English must have sufficient oral-English proficiency before taking on a teaching assistantship. International graduate teaching assistants who have no direct contact with students (e.g., responsible only for grading assignments) are not required to complete the language proficiency assessment. If the assistantship involves direct contact with students, then offers of funding are contingent upon the international student successfully passing Mizzou's Assessment of Classroom Communication Skills (MACCS) oral speaking test at the level needed for the teaching assignment. The MACCS is given each month and additional dates are provided at the end of each semester. When testing must be expedited, the International Teaching Assistant Program (ITAP) will work with academic departments to accommodate their needs.

## Application and Admission Information

### Dates

Fall Admission: deadline for MA and PhD: January 31 (Applicant has once month to get all materials submitted.)

Spring Admission: deadline for MA and PhD: October 15

### Admission Criteria

- Minimum GPA: 3.0 to enter Master's or PhD program
- Bachelor's degree from accredited college or university in related area
- Minimum TOEFL scores:

Internet-based test (iBT)	Paper-based test (PBT)
80	535

- (*International applicants*): TOEFL: 80 and above (20, 20, 20, 20) or IELTS: 6.5 and above

Undergraduate courses in statistics are recommended but not required. Consideration also is given to rank in graduating class, trends in grade records, maturity and experience, and other criteria bearing on qualifications.

Before entering the graduate program, a student should have a background that includes three semesters of calculus (or equivalent),

one semester of matrix theory, and at least one post-calculus course in probability and statistics. Some required courses at the 7000 level not taken as an undergraduate may be taken for graduate credit as part of the graduate program.

## Required Application Materials

### Submit all materials electronically using the Graduate School website at *the Graduate School*.

- All required Graduate School documents and
- 3 letters of recommendation
- Letter of intent

#### **STAT 1006: Topics in Statistics-Mathematical Science**

Organized study of selected topics. Subjects and earnable credit may vary from semester to semester. Repeatable with departmental consent.

**Credit Hour:** 1-5

**Prerequisites:** Instructor's consent

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#### **STAT 1200: Introductory Statistical Reasoning**

Statistical concepts for critically evaluation quantitative information. Descriptive statistics, probability, estimation, hypothesis testing, correlation and regression. Students may not receive credit if they have received or are concurrently receiving credit for a higher numbered course offered by the Statistics Department. Math Reasoning Proficiency Course. Mathematical Sciences distribution course (requirement terms prior to fall 2019).

**Credit Hours:** 3

**Prerequisites:** C- or higher in MATH\_0110 or MyMathTest Intermediate Algebra score of 70% or higher

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#### **STAT 1300: Elementary Statistics**

Collection, presentation of data; averages; dispersion; introduction to statistical inference, correlation and regression. Students may not receive credit if they have received or are concurrently receiving credit for another course offered by the Statistics Department. Math Reasoning Proficiency Course.

**Credit Hours:** 3

**Prerequisites:** grade in C- or higher in MATH 1100 or MATH 1120 or MATH 1160 or MATH 1180 or exemption from college algebra by examination

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#### **STAT 1300H: Elementary Statistics - Honors**

Collection, presentation of data; averages; dispersion; introduction to statistical inference, correlation and regression. Students may not receive credit if they have received or are concurrently receiving credit for another course offered by the Statistics Department. Math Reasoning Proficiency course.

**Credit Hours:** 3

**Prerequisites:** grade of C-or higher in MATH 1100 or MATH 1120 or MATH 1160 or MATH 1180 or exemption from college algebra by examination. Honors eligibility required

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#### **STAT 1400: Elementary Statistics for Life Sciences**

Designed for students studying agriculture and other life sciences. Descriptive statistics, probability, estimation, hypothesis testing, correlation and regression. Students may not receive credit if they have received or are concurrently receiving credit for another course offered by the Statistics Department. Math Reasoning Proficiency Course.

**Credit Hours:** 3

**Prerequisites:** grade in C- or higher in MATH 1050 or MATH 1100 or MATH 1120 or MATH 1160 or MATH 1180 or exemption from college algebra by examination

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#### **STAT 2006: Topics in Statistics-Mathematical Science**

Organized study of selected topics. Subjects and earnable credit may vary from semester to semester. Repeatable with departmental consent.

**Credit Hour:** 1-5

**Prerequisites:** Instructor's consent

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#### **STAT 2200: Introductory Statistical Methods**

Designed to upgrade the curriculum of STAT 1200 or STAT 1300 or STAT 1400 to the level of STAT 2500. Students may not receive credit for STAT 2200 if they have completed a course from the Department of Statistics numbered 2500 or higher.

**Credit Hour:** 1

**Prerequisites:** grade in C- or higher in STAT 1200 or STAT 1300 or STAT 1400

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#### **STAT 2500: Introduction to Probability and Statistics I**

Designed primarily for students in College of Business. Descriptive statistics, probability, random variables, sampling distributions, estimation, confidence intervals, hypothesis tests.

**Credit Hours:** 3

**Prerequisites:** C- or better in MATH 1100 or MATH 1160

**Recommended:** MATH 1300. Students who will take MATH 1300 would be best-served to take it prior to enrollment in STAT 2500

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#### **STAT 2500H: Introduction to Probability and Statistics I - Honors**

Designed primarily for students in College of Business. Descriptive statistics, probability, random variables, sampling distributions, estimation, confidence intervals, hypothesis tests.

**Credit Hours:** 3

**Prerequisites:** C- or better in MATH 1100 or MATH 1160. Honors eligibility required

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**STAT 2530: Statistical Methods in Natural Resources**

Statistical methods, with emphasis on applications to natural resources and including computer exercises. Math Reasoning Proficiency Course.

**Credit Hours:** 3

**Prerequisites:** a college-level computing course and a grade in the C range or better in MATH 1100, MATH 1120, MATH 1160, or MATH 1180

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**STAT 2800: Intuition, Simulation, and Data**

This course develops the probabilistic foundations of inference in data science and builds a comprehensive view of modeling and decision-making. Emphasis is on the nature of randomness, the power and limitations of inference, and the consequences of decision making. Students will experience probability, statistical inference, and the modeling of processes through the lens of simulation using the statistical programming language R.

**Credit Hours:** 3

**Prerequisites:** Any one of DATA\_SCI 1030 or STAT 1200 or STAT 2500 or instructor's consent

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**STAT 3006: Topics in Statistics-Mathematical Science**

Organized study of selected topics. Subjects and earnable credit may vary from semester to semester. Repeatable with departmental consent.

**Credit Hour:** 1-5

**Prerequisites:** Consent of instructor required

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**STAT 3500: Introduction to Probability and Statistics II**

Continuation of STAT 2500. Coverage of additional topics including: Regression; model building; ANOVA; nonparametric methods; use of a statistical computer package.

**Credit Hours:** 3

**Prerequisites:** grade in the C - or higher in STAT 2200 or STAT 2500 or STAT 2530, or STAT 4710 or concurrent enrollment in STAT 2200

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**STAT 4006: Topics in Statistics-Mathematical**

Organized study of selected topics. Subjects and earnable credit may vary from semester to semester. Repeatable with departmental consent.

**Credit Hour:** 1-5

**Prerequisites:** Consent of instructor required

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**STAT 4050: Connecting Statistics to Middle and Secondary Schools**

(cross-leveled with STAT 7050). Primarily for middle and secondary mathematics education majors. Uses standards-based curricular materials to demonstrate connections between college-level statistics

and content taught in middle and secondary schools. No credit toward a graduate degree in statistics.

**Credit Hours:** 3

**Prerequisites:** STAT 1200 or STAT 1300 or STAT 1400 or STAT 2500 or STAT 4710 or ESC\_PS 4170 or MATH 2320

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**STAT 4085: Problems in Statistics for Undergraduates**

Independent investigations. Reports on approved topics.

**Credit Hour:** 1-3

**Prerequisites:** instructor's consent

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**STAT 4110: Statistical Software and Data Analysis**

(cross-leveled with STAT 7110). Programming with major statistical packages emphasizing data management techniques and statistical analysis for regression, analysis of variance, categorical data, descriptive statistics, non-parametric analyses, and other selected topics.

**Credit Hours:** 3

**Prerequisites:** STAT 3500 or STAT 7070 or STAT 4710 or STAT 7710 or STAT 4760 or STAT 7760

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**STAT 4150: Applied Categorical Data Analysis**

(cross-leveled with STAT 7150). The study of statistical models and methods used in analyzing categorical data. The use of computing is emphasized and calculus is not required. No credit for students who have previously completed STAT 4830. No credit toward a graduate degree in statistics.

**Credit Hours:** 3

**Prerequisites:** STAT 3500 or STAT 7070 or STAT 4710 or STAT 7710 or STAT 4760 or STAT 7760

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**STAT 4210: Applied Nonparametric Methods**

(cross-leveled with STAT 7210). Statistical methods when the functional form of the population is unknown. Applications emphasized. Comparisons with parametric procedures. Goodness of-fit, chi-square, comparison of several populations, measures of correlation.

**Credit Hours:** 3

**Prerequisites:** STAT 3500 or STAT 7070 or STAT 4710 or STAT 7710 or STAT 4760 or STAT 7760

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**STAT 4310: Sampling Techniques**

Theory of probability sampling designs. Unrestricted random sampling. Stratified sampling. Cluster sampling. Multistage or subsampling. Ratio estimates. Regression estimates. Double sampling.

**Credit Hours:** 3

**Prerequisites:** STAT 3500 or STAT 7070 or STAT 4710 or STAT 7710 or STAT 4760 or STAT 7760

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**STAT 4330: Methods in Sports Analytics I**

(cross-leveled with STAT 7330). Introductory course on collecting, processing, visualizing, and analyzing data in sports. Technologies used in data collection and processing will be explored, along with methods for measuring and comparing individual and team performance.

**Credit Hours:** 3

**Prerequisites:** Any one of STAT 3500, STAT 7020, STAT 7070, STAT 4710/7710, STAT 4760/7760, or instructor's consent

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**STAT 4340: Methods in Sports Analytics II**

(cross-leveled with STAT 7340). Advanced course in methods for analyzing individual and team based performance in sports and the use of data to drive strategy and tactics. Emphasis will be put on analytical methods to improve skills and optimize the performance of athletes.

**Credit Hours:** 3

**Prerequisites:** Both STAT 4330/7330 and STAT 4510/7510

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**STAT 4410: Biostatistics and Clinical Trials**

(cross-leveled with STAT 7410). Study of statistical techniques for the design and analysis of clinical trials, laboratory studies and epidemiology. Topics include randomization, power and sample size calculation, sequential monitoring, carcinogenicity bioassay and case-cohort designs. Prerequisites: any of the following: STAT 3500, STAT 7070, STAT 4710, STAT 7710, STAT 4760, STAT 7760, or instructor's consent.

**Credit Hours:** 3

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**STAT 4420: Applied Survival Analysis**

(cross-leveled with STAT 7420). Parametric models; Kaplan-Meier estimator; nonparametric estimation of survival and cumulative hazard functions; log-rank test; Cox model; Stratified Cox model; additive hazards model partial likelihood; regression diagnostics; multivariate survival data.

**Credit Hours:** 3

**Prerequisites:** STAT 3500 or STAT 7070 or STAT 4710 or STAT 7710 or STAT 4760 or STAT 7760

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**STAT 4510: Applied Statistical Models I**

(cross-leveled with STAT 7510). Introduction to applied statistical models including regression and ANOVA, logistic regression, discriminant analysis, tree-based methods, semi-parametric regression, support vector machines, and unsupervised learning through principal component and clustering. No credit toward a graduate degree in statistics. Prerequisites: Any one of: STAT 3500 or STAT 7070 or STAT 4710 or STAT 7710 or STAT 4760 or STAT 7760.

**Credit Hours:** 3

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**STAT 4520: Applied Statistical Models II**

(cross-leveled with STAT 7520). Advanced course in applied statistical modeling focusing on extensions of the linear model. Topics include generalized linear models, such as logistic and Poisson regression. Random effects models will also be introduced, with emphasis on linear and generalized linear mixed models, repeated measures, and longitudinal data. These methods will extend to general models for dependent data, such as spatially-referenced data and time series. Lastly, nonlinear models through neural networks and deep learning will also be discussed.

**Credit Hours:** 3

**Prerequisites:** Stat 4510 or 7510 or instructor's consent

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**STAT 4540: Experimental Design**

(cross-leveled with STAT 7540). Examination and analysis of modern statistical techniques applicable to experimentation in social, physical or biological sciences.

**Credit Hours:** 3

**Prerequisites:** STAT 3500 or STAT 4510 or STAT 7510 or STAT 4530 or STAT 7530

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**STAT 4560: Applied Multivariate Data Analysis**

(cross-leveled with STAT 7560). Testing mean vectors; Discriminant analysis; Principal components; Factor analysis; Cluster analysis; Structural equation modeling; Graphics.

**Credit Hours:** 3

**Prerequisites:** STAT 3500, STAT 7070 STAT 4710 or STAT 7710 or STAT 4760 or STAT 7760 or instructor's consent. No credit towards a graduate degree in statistics

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**STAT 4580: Introduction to Statistical Methods for Customized Pricing**

(cross-leveled with STAT 7580). Introduction to basic concepts of and statistical methods used in customized pricing. Focuses on applying statistical methods to real customized pricing problems. Students will gain an understanding of customized pricing and some hands on experience with SAS Enterprise Miner.

**Credit Hours:** 3

**Prerequisites:** STAT 3500 or STAT 4510 or STAT 7510 or instructor's consent

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**STAT 4610: Applied Spatial Statistics**

(cross-leveled with STAT 7610). Introduction to spatial random processes, spatial point patterns, kriging, simultaneous and conditional autoregression, and spatial data analysis.

**Credit Hours:** 3

**Prerequisites:** STAT 4510 or instructor's consent

**Recommended:** basic knowledge of calculus and matrices

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**STAT 4640: Introduction to Bayesian Data Analysis**

(cross-leveled with STAT 7640). Bayes formulas, choices of prior, empirical Bayesian methods, hierarchical Bayesian methods, statistical computation, Bayesian estimation, model selection, predictive analysis, applications, Bayesian software.

**Credit Hours:** 3

**Prerequisites:** STAT 3500 or STAT 4510 or STAT 7510

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**STAT 4710: Introduction to Mathematical Statistics**

(same as MATH 4315; cross-leveled with STAT 7710, MATH 7315). Introduction to theory of probability and statistics using concepts and methods of calculus. No credit for Math 4315.

**Credit Hours:** 3

**Prerequisites:** MATH 2100 or MATH 2300

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**STAT 4750: Introduction to Probability Theory**

(same as MATH 4320; cross-leveled with STAT 7750, MATH 7320). Probability spaces; random variables and their distributions; repeated trials; probability limit theorems.

**Credit Hours:** 3

**Prerequisites:** MATH 2300

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**STAT 4760: Statistical Inference**

(same as MATH 4520; cross-leveled with STAT 7760, MATH 7520). Sampling; point estimation; sampling distribution; tests of hypotheses; regression and linear hypotheses.

**Credit Hours:** 3

**Prerequisites:** STAT 4750 or STAT 7750

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**STAT 4830: Categorical Data Analysis**

(cross-leveled with STAT 7830). Discrete distributions, frequency data, multinomial data, chi-square and likelihood ratio tests, logistic regression, log linear models, rates, relative risks, random effects, case studies.

**Credit Hours:** 3

**Prerequisites:** STAT 4710 or STAT 7710 or STAT 4760 or STAT 7760

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**STAT 4850: Introduction to Stochastic Processes**

(cross-leveled with STAT 7850). Study of random processes selected from: Markov chains, birth and death processes, random walks, Poisson processes, renewal theory, Brownian motion, Gaussian processes, white noise, spectral analysis, applications such as queuing theory, sequential tests.

**Credit Hours:** 3

**Prerequisites:** STAT 4750 or STAT 7750

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**STAT 4870: Time Series Analysis**

(cross-leveled with STAT 7870). A study of univariate and multivariate time series models and techniques for their analyses. Emphasis is on methodology rather than theory. Examples are drawn from a variety of areas including business, economics and soil science.

**Credit Hours:** 3

**Prerequisites:** STAT 4710 or STAT 7710 or STAT 4760 or STAT 7760

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**STAT 4887: Experiential Learning in Statistics**

Learning experience combining observation, reflection, and application of statistical concepts in an internship setting. Course appears on transcript for zero credit and does not count toward full-time enrollment. No tuition or fees are charged. Graded on S/U basis only.

**Credit Hours:** 0

**Prerequisites:** Consent of the department required

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**STAT 4940: Statistics Internship**

Used to provide credit and transcription of an undergraduate internship experience in a role that utilizes statistical methods.

**Credit Hour:** 1-3

**Recommended:** Students should have completed sufficient statistics coursework so that the internship experience involves meaningful applications of their coursework

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**STAT 4970: Junior/Senior Seminar**

A capstone course required of and open only to junior or senior statistics majors. Students will participate in statistical consulting, attend colloquia, and review articles in professional journals. Writing of reports will be emphasized.

**Credit Hours:** 3

**Prerequisites:** Statistics major with Junior or Senior class standing or instructor's consent

**Recommended:** 12 completed hours of statistics courses with grade of C or better; STAT 4110

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**STAT 4970W: Junior/Senior Seminar - Writing Intensive**

A capstone course required of and open only to junior or senior statistics majors. Students will participate in statistical consulting, attend colloquia, and review articles in professional journals. Writing of reports will be emphasized.

**Credit Hours:** 3

**Prerequisites:** Statistics major with Junior or Senior class standing or instructor's consent

**Recommended:** 12 completed hours of statistics courses with grade of C or better; STAT 4110

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**STAT 4999: Departmental Honors in Statistics**

Special work for Honors candidates in statistics. May be repeated for credit.

**Credit Hour:** 1-3

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**STAT 7006: Topics in Statistics-Mathematics**

Organized study of selected topics. Subjects and earnable credit may vary from semester to semester. Repeatable with departmental consent.

**Credit Hour:** 1-5

**Prerequisites:** instructor's consent

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**STAT 7020: Statistical Methods in the Health Sciences**

Basic inference methods, both parametric and non-parametric, appropriate for answering questions arising in health sciences research. Computer exercises involving data from real experiments from health science area.

**Credit Hours:** 3

**Prerequisites:** MATH 1100 or MATH 1120 and instructor's consent

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**STAT 7050: Connecting Statistics to Middle and Secondary Schools**

(cross-leveled with STAT 4050). Primarily for middle and secondary mathematics education majors. Uses standards-based curricular materials to demonstrate connections between college-level statistics and content taught in middle and secondary schools. No credit toward a graduate degree in statistics.

**Credit Hours:** 3

**Prerequisites:** an introductory course in statistics or MATH 2320 or instructor's consent

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**STAT 7070: Statistical Methods for Research**

Designed for graduate students who have no previous training in statistics. Topics include descriptive statistics, probability distributions, estimation, hypothesis testing, regression, and ANOVA. No credit toward a degree in statistics.

**Credit Hours:** 3

**Prerequisites:** either MATH 1100 or MATH 1120

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**STAT 7085: Problems in Statistics for Non-majors**

Approved reading and study, independent investigations, and reports on approved topics.

**Credit Hour:** 1-99

**Prerequisites:** instructor's consent

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**STAT 7110: Statistical Software and Data Analysis**

(cross-leveled with STAT 4110). Programming with major statistical packages emphasizing data management techniques and statistical analysis for regression, analysis of variance, categorical data, descriptive statistics, non-parametric analyses, and other selected topics.

**Credit Hours:** 3

**Prerequisites:** STAT 3500, STAT 7070, STAT 4710 or STAT 7710, STAT 4760 or STAT 7760, or instructor's consent

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**STAT 7150: Applied Categorical Data Analysis**

(cross-leveled with STAT 4150). The study of statistical models and methods used in analyzing categorical data. The use of computing is emphasized and calculus is not required. No credit for students who have previously completed STAT 4830. No credit toward a graduate degree in statistics.

**Credit Hours:** 3

**Prerequisites:** STAT 3500, STAT 7070, STAT 4710 or STAT 7710, or STAT 4760 or STAT 7760 or instructor's consent

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**STAT 7210: Applied Nonparametric Methods**

(cross-leveled with STAT 4210). Statistical methods when the functional form of the population is unknown. Applications emphasized. Comparisons with parametric procedures. Goodness of-fit, chi-square, comparison of several populations, measures of correlation.

**Credit Hours:** 3

**Prerequisites:** STAT 3500, STAT 7070, STAT 4710 or STAT 7710, STAT 4760 or STAT 7760, or instructor's consent

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**STAT 7310: Sampling Techniques**

Theory of probability sampling designs. Unrestricted random sampling. Stratified sampling. Cluster sampling. Multistage or subsampling. Ratio estimates. Regression estimates. Double sampling.

**Credit Hours:** 3

**Prerequisites:** STAT 3500, STAT 7070, STAT 4710 or STAT 7710, STAT 4760 or STAT 7760, or instructor's consent

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**STAT 7330: Methods in Sports Analytics I**

(cross-leveled with STAT 4330). Introductory course on collecting, processing, visualizing, and analyzing data in sports. Technologies used in data collection and processing will be explored, along with methods for measuring and comparing individual and team performance.

**Credit Hours:** 3

**Prerequisites:** Any one of STAT 3500, STAT 7020, STAT 7070, STAT 4710/7710, STAT 4760/7760, or instructor's consent

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**STAT 7340: Methods in Sports Analytics II**

(cross-leveled with STAT 4340). Advanced course in methods for analyzing individual and team based performance in sports and the use of data to drive strategy and tactics. Emphasis will be put on analytical methods to improve skills and optimize the performance of athletes.

**Credit Hours:** 3

**Prerequisites:** Both STAT 4330 or STAT 7330 and STAT 4510 or STAT 7510

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**STAT 7410: Biostatistics and Clinical Trials**

(cross-leveled with STAT 4410). Study of statistical techniques for the design and analysis of clinical trials, laboratory studies and epidemiology. Topics include randomization, power and sample size calculation, sequential monitoring, carcinogenicity bioassay and case-cohort designs. Prerequisites: any of the following: STAT 3500, STAT 7070, STAT 4710, STAT 7710, STAT 4760, STAT 7760, or instructor's consent.

**Credit Hours:** 3

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**STAT 7420: Applied Survival Analysis**

(cross-leveled with STAT 4420). Parametric models; Kaplan-Meier estimator; nonparametric estimation of survival and cumulative hazard functions; log-rank test; Cox model; Stratified Cox model; additive hazards model partial likelihood; regression diagnostics; multivariate survival data.

**Credit Hours:** 3

**Prerequisites:** STAT 3500, STAT 7070, STAT 4710 or STAT 7710 or STAT 4760 or STAT 7760 or instructor's consent

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**STAT 7510: Applied Statistical Models I**

(cross-leveled with STAT 4510). Introduction to applied statistical models including regression and ANOVA, logistic regression, discriminant analysis, tree-based methods, semi-parametric regression, support vector machines, and unsupervised learning through principal component and clustering. No credit toward a graduate degree in statistics.. Prerequisites: Any one of: STAT 3500 or STAT 7070 or STAT 4710 or STAT 7710 or STAT 4760 or STAT 7760.

**Credit Hours:** 3

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**STAT 7520: Applied Statistical Models II**

(cross-leveled with STAT 4520). Advanced course in applied statistical modeling focusing on extensions of the linear model. Topics include generalized linear models, such as logistic and Poisson regression. Random effects models will also be introduced, with emphasis on linear and generalized linear mixed models, repeated measures, and longitudinal data. These methods will extend to general models for dependent data, such as spatially-referenced data and time series. Lastly, nonlinear models through neural networks and deep learning will also be discussed.

**Credit Hours:** 3

**Prerequisites:** STAT 4510 or STAT 7510 or instructor's consent

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**STAT 7530: Analysis of Variance**

Study of analysis of variance and related modeling techniques for cases with fixed, random, and mixed effects. Exposure to designs other than completely randomized designs including factorial arrangements, repeated measures, nested, and unequal sample size designs.

**Credit Hours:** 3

**Prerequisites:** STAT 3500, STAT 7070, STAT 4710 or STAT 7710, STAT 4760 or STAT 7760, or instructor's consent

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**STAT 7540: Experimental Design**

(cross-leveled with STAT 4540). Examination and analysis of modern statistical techniques applicable to experimentation in social, physical or biological sciences.

**Credit Hours:** 3

**Prerequisites:** STAT 3500 or STAT 4510 or STAT 7510 or STAT 4530 or STAT 7530 or instructor's consent

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**STAT 7560: Applied Multivariate Data Analysis**

(cross-leveled with STAT 4560). Testing mean vectors; discriminant analysis; principal components; factor analysis; cluster analysis; structural equation modeling; graphics.

**Credit Hours:** 3

**Prerequisites:** STAT 3500, STAT 7070, STAT 4710 or STAT 7710 or STAT 4760 or STAT 7760. No credit toward a graduate degree in statistics

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**STAT 7580: Introduction to Statistical Methods for Customized Pricing**

(cross-leveled with STAT 4580). Introduction to basic concepts of and statistical methods used in customized pricing. Focuses on applying statistical methods to real customized pricing problems. Students will gain an understanding of customized pricing and some hands on experience with SAS Enterprise minor.



**Credit Hours:** 3

**Prerequisites:** STAT 3500 or STAT 4510 or STAT 7510 or instructor's consent

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**STAT 7610: Applied Spatial Statistics**

(cross-leveled with STAT 4610). Introduction to spatial random processes, spatial point patterns, kriging, simultaneous and conditional autoregression, and spatial data analysis.

**Credit Hours:** 3

**Prerequisites:** STAT 4510 or STAT 7510 or instructor's consent

**Recommended:** Basic knowledge of calculus and matrices

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**STAT 7640: Introduction to Bayesian Data Analysis**

(cross-leveled with STAT 4640). Bayes formulas, choices of prior, empirical Bayesian methods, hierarchical Bayesian methods, statistical computation, Bayesian estimation, model selection, predictive analysis, applications, Bayesian software.

**Credit Hours:** 3

**Prerequisites:** STAT 3500 or STAT 4510 or STAT 7510 or instructor's consent

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**STAT 7710: Introduction to Mathematical Statistics**

(same as MATH 7315; cross-leveled with MATH 4315, STAT 4710). Introduction to theory of probability and statistics using concepts and methods of calculus.

**Credit Hours:** 3

**Prerequisites:** MATH 2100 or MATH 2300. No credit MATH 7315

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**STAT 7750: Introduction to Probability Theory**

(same as MATH 7320; cross-leveled with STAT 4750, MATH 4320). Probability spaces; random variables and their distributions; repeated trials; probability limit theorems.

**Credit Hours:** 3

**Prerequisites:** MATH 2300 or instructor's consent

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**STAT 7760: Statistical Inference**

(same as MATH 7520; cross-leveled with STAT 4760, MATH 4520). Sampling; point estimation; sampling distribution; tests of hypotheses; regression and linear hypotheses.

**Credit Hours:** 3

**Prerequisites:** STAT 4750 or STAT 7750 or instructor's consent

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**STAT 7830: Categorical Data Analysis**

(cross-leveled with STAT 4830). Discrete distributions, frequency data, multinomial data, chi-square and likelihood ratio tests, logistic regression, log linear models, rates, relative risks, random effects, case studies.

**Credit Hours:** 3

**Prerequisites:** STAT 4710 or STAT 7710 or instructor's consent

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**STAT 7850: Introduction to Stochastic Processes**

(cross-leveled with STAT 4850). Study of random processes selected from: Markov chains, birth and death processes, random walks, Poisson processes, renewal theory, Brownian motion, Gaussian processes, white noise, spectral analysis, applications such as queuing theory, sequential tests.

**Credit Hours:** 3

**Prerequisites:** STAT 4750 or STAT 7750 or instructor's consent

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**STAT 7870: Time Series Analysis**

(cross-leveled with STAT 4870). A study of univariate and multivariate time series models and techniques for their analyses. Emphasis is on methodology rather than theory. Examples are drawn from a variety of areas including business, economics and soil science.

**Credit Hours:** 3

**Prerequisites:** STAT 7710 or STAT 7760 or instructor's consent

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**STAT 8085: Problems in Statistics for Majors - Masters**

Approved reading and study, independent investigations, and reports on approved topics.

**Credit Hour:** 1-99

**Prerequisites:** instructor's consent

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**STAT 8090: Master's Thesis Research in Statistics**

Graded on a S/U basis only.

**Credit Hour:** 1-99

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**STAT 8100: Special Topics in Statistics**

**Credit Hour:** 1-99

**Prerequisites:** instructor's consent

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**STAT 8110: Software for Statistical Learning**

Advanced use of R and Python for data analysis, including statistical programming, data manipulation, database operations, and interfacing between languages. Course will provide critical tools for the practice and application of statistics to data from a wide variety of fields using up-to-date tooling.

**Credit Hours:** 3

**Recommended:** Prior completion of the equivalent of at least two undergraduate statistics courses

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**STAT 8310: Data Analysis I**

Applications of linear models including regression (simple and multiple, subset selection, regression diagnostics), analysis of variance (fixed, random and mixed effects, contrasts, multiple comparisons) and analysis of covariance; alternative nonparametric methods.

**Credit Hours:** 3

**Prerequisites:** STAT 4710 or STAT 7710 or STAT 4760 or STAT 7760 or instructor's consent

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**STAT 8320: Data Analysis II**

Advanced applications including analysis of designs (e.g. repeated measures, hierarchical models, missing data), multivariate analysis (Hotelling's T<sup>2</sup>, MANOVA, discriminant analysis, principal components, factor analysis), nonlinear regression, generalized linear models, categorical data analysis.

**Credit Hours:** 3

**Prerequisites:** STAT 8310 or instructor's consent

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**STAT 8330: Data Analysis III**

An introduction to data analysis techniques associated with supervised and unsupervised statistical learning. Resampling methods, model selection, regularization, generalized additive models, trees, support vector machines, clustering, nonlinear dimension reduction.

**Credit Hours:** 3

**Prerequisites:** STAT 8320

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**STAT 8370: Statistical Consulting**

Participation in statistical consulting under faculty supervision. Formulation of statistical problems. Planning of surveys and experiments. Statistical computing. Data analysis. Interpretation of results in statistical practice.

**Credit Hours:** 3

**Prerequisites:** STAT 4760 or STAT 7760 and STAT 8320 or instructor's consent

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**STAT 8410: Statistical Theory of Bioinformatics**

Study of statistical theory and methods underpinning bioinformatics. Topics include statistical theory used in biotechnologies such as gene sequencing, gene alignments, microarrays, phylogenetic trees, evolutionary models, proteomics and imaging.

**Credit Hours:** 3

**Prerequisites:** STAT 4760 or STAT 7760

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**STAT 8640: Bayesian Analysis I**

Bayes' theorem, subjective probability, non-informative priors, conjugate prior, asymptotic properties, model selection, computation, hierarchical models, hypothesis testing, inference, predication, applications.

**Credit Hours:** 3

**Prerequisites:** STAT 4760 or STAT 7760 and MATH 4140 or MATH 7140 or instructor's consent

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**STAT 8710: Intermediate Mathematical Statistics I**

Sample spaces, probability and conditional probability, independence, random variables, expectation, distribution theory, sampling distributions, laws of large numbers and asymptotic theory, order statistics.

**Credit Hours:** 3

**Prerequisites:** STAT 4760 or STAT 7760 or instructor's consent

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**STAT 8720: Intermediate Mathematical Statistics II**

Further development of estimation theory, including sufficiency, minimum variance principles and Bayesian estimation. Tests of hypotheses, including uniformly most powerful and likelihood ratio tests.

**Credit Hours:** 3

**Prerequisites:** STAT 8710 or instructor's consent

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**STAT 9085: Problems in Statistics for Majors - PhD**

Approved reading and study, independent investigations, and reports on approved topics.

**Credit Hour:** 1-99

**Prerequisites:** instructor's consent

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**STAT 9090: Doctoral Dissertation Research in Statistics**

Graded on a S/U basis only.

**Credit Hour:** 1-99

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**STAT 9100: Recent Developments in Statistics**

The content of the course which varies from semester to semester, will be the study of some statistical theories or methodologies which are currently under development, such as bootstrapping, missing data, non-parametric regression, statistical computing, etc.

**Credit Hours:** 3

**Prerequisites:** STAT 4760 or STAT 7760 and instructor's consent

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**STAT 9250: Statistical Computation and Simulation**

Random number generation, acceptance/rejection methods; Monte Carlo; Laplace approximation; the EM algorithm; importance sampling; Markov chain Monte Carlo; Metropolis-Hasting algorithm; Gibbs sampling, marginal likelihood.

**Credit Hours:** 3

**Prerequisites:** STAT 4760 or STAT 7760 or instructor's consent

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**STAT 9310: Theory of Linear Models**

Theory of multiple regression and analysis of variance including matrix representation of linear models, estimation, testing hypotheses, model building, contrasts, multiple comparisons and fixed and random effects.

**Credit Hours:** 3

**Prerequisites:** STAT 4760 or STAT 7760 and MATH 4140 or MATH 7140, and instructor's consent

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**STAT 9340: Data Analysis IV**

This course will explore advanced statistical learning methods for analyzing complex data, including statistical optimization, multi-level models, random processes, neural computing, Bayesian methods, and alternative learning strategies. The course will require significant involvement from the students in terms of highly computationally-oriented homework and project participation.

**Credit Hours:** 3

**Prerequisites:** STAT 8330

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**STAT 9370: Multivariate Analysis**

Distribution of sample correlation coefficients. Derivation of generalized T-squared and Wishart distributions. Distribution of certain characteristic roots, vectors. Test of hypotheses about covariance matrices and mean vectors. Discriminant analysis.

**Credit Hours:** 3

**Prerequisites:** STAT 4760 or STAT 7760 and MATH 4140 or MATH 7140 or instructor's consent

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**STAT 9410: Survival Analysis**

Statistical failure models, Kaplan-Meier estimator, Log-rank test, Cox's regression model, Multivariate failure time data analysis, Counting process approaches.

**Credit Hours:** 3

**Prerequisites:** STAT 4760 or STAT 7760 or instructor's consent

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**STAT 9530: Data Mining and Machine Learning Methods**

Approaches to estimating unspecified relationships and findings unexpected patterns in high dimensional data. Computationally intensive

methods including splines, classifications, tree-based and bagging methods, support vector machines.

**Credit Hours:** 3

**Prerequisites:** STAT 4110 or STAT 7110, STAT 4760 or STAT 7760 and STAT 8320 or instructor's consent

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**STAT 9640: Bayesian Analysis II**

Likelihood principle, decision theory, asymptotic properties, advanced topics in Bayesian analysis at the instructor's discretion.

**Credit Hours:** 3

**Prerequisites:** STAT 8640 and STAT 9710 or instructor's consent

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**STAT 9710: Advanced Mathematical Statistics I**

Advanced study of mathematical statistics appropriate for PhD students in statistics. Elements of probability theory, principles of data reduction, point and interval estimation, methods of finding estimators and their properties, hypothesis testing, methods of finding test functions and their properties. Decision theoretic, classical and Bayesian perspectives.

**Credit Hours:** 3

**Prerequisites:** STAT 8720 or instructor's consent

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**STAT 9720: Advanced Mathematical Statistics II**

Continuation of STAT 9710. Topics include distribution theory and convergence, laws of large numbers, central limit theorems, efficiency, large sample theory, and elements of advanced probability.

**Credit Hours:** 3

**Prerequisites:** STAT 9710 or instructor's consent

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**STAT 9810: Advanced Probability**

(same as MATH 8480). Measure theoretic probability theory. Characteristic functions; conditional probability and expectation; sums of independent random variables including strong law of large numbers and central limit problem.

**Credit Hours:** 3

**Prerequisites:** STAT 4750 STAT 7750 or MATH 4700 or MATH 7700 or instructor's consent

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**STAT 9820: Stochastic Processes**

(same as MATH 8680). Markov processes, martingales, orthogonal sequences, processes with independent and orthogonal increments, stationarity, linear prediction.

**Credit Hours:** 3

**Prerequisites:** STAT 9810 or instructor's consent

