# A ST- APPLIED STATISTICS

**A ST 311. Statistical Applications**
**3 Credits (3)**
Techniques for describing and analyzing economic and biological data; estimation, hypothesis testing, regression and correlation; basic concepts of statistical inference. May be repeated up to 3 credits.
**Prerequisite:** MATH 1215 or higher.
**Learning Outcomes**
1. Describe a data set with graphical tools and computed measures.
2. Explain the relationship between two numerical variables using correlation and regression.
3. Understand how probability and sampling methods are used to make statistical inferences.
4. Draw inference from a sample to a population using confidence intervals and hypothesis tests.
5. Understand the relationship between population parameters and sample statistics.
6. Understand the basic procedure of data production with sampling and experimental design.

**A ST 450. Special Topics**
**1-4 Credits**
Specific subjects and credits announced in the Schedule of Classes. Maximum of 4 credits per semester and a grand total of 9 credits.

**A ST 465. Statistical Analysis I**
**3 Credits (3)**
An analytic introduction to the theory and methods of statistical inference. Sampling, frequency distributions (z, t, x2, F), estimation, testing, and simulation. Crosslisted with: A ST 565.
**Prerequisite(s):** MATH 2530G or consent of instructor.

**A ST 466. Statistical Analysis II**
**3 Credits (2+2P)**
Continuation of A ST 465. An analytic introduction to the theory and methods of statistical inference. Sampling, frequency distributions (z, t, x2, F), estimation, testing, and simulation. Crosslisted with: A ST 566.
**Prerequisite(s):** A ST 465 or consent of instructor.

**A ST 498. Independent Study**
**1-3 Credits**
Individual studies directed by consenting faculty with prior approval of the department head. Maximum of 3 credits per semester and a grand total of 3 credits.

**A ST 503. SAS Basics**
**3 Credits (2+2P)**
An introduction to the statistical software package, SAS, and its utilization in an interactive computing environment, primarily PC/SAS. Provides a fundamental understanding of the structure of SAS, its data management capabilities, and how to invoke a variety of descriptive and simple statistical SAS procedures.
**Corequisite(s):** A ST 505.

**A ST 504. Statistical Software Applications**
**1 Credit (1)**
Optional Computing course to accompany A ST 506. Computer analysis of topics covered in A ST 505 and A ST 506.
**Prerequisite(s):** A ST 503.
**Corequisite(s):** A ST 506.

**A ST 505. Statistical Inference I**
**4 Credits (3+2P)**
A qualitative introduction to the concepts and methods of statistical inference. Sampling, frequency distributions (z, t, x2, F), estimation, and testing. One-way analysis of variance. Simple linear regression.
**Prerequisite:** consent of the instructor.

**A ST 506. Statistical Inference II**
**3 Credits (2+2P)**
Introduction to multiple regression; the analysis of variance for balanced studies; multiple comparisons, contrasts, factorials, experimental designs through split plots. May be repeated up to 3 credits.
**Prerequisite:** A ST 505 and the ability to use a standard computer package such as SAS (may be satisfied by A ST 503) or consent of instructor.
**Learning Outcomes**
1. Formulate models, construct ANOVA tables for balanced designs, and conduct complete analyses accounting for factorial treatment structures, and standard experimental design structures, including the completely randomized design, the randomized complete block design, completely randomized design with subsampling, the completely randomized design with a covariate, and the split-plot design.
2. Assess model adequacy including assessing constancy of variance and normality assumptions.
3. Choose an appropriate multiple comparisons procedure to control the experiment wise or family wise Type I error rate.
4. Use contrasts to conduct pre-planned comparisons.
5. Identify the experimental unit(s) in an experiment; formulate a model and conduct an analysis appropriately accounting for the experimental unit(s).
6. Conduct a complete analysis of data from a designed experiment and interpret findings.

**A ST 507. Advanced Regression**
**3 Credits (3)**
Examination of multiple regression; residual analysis, collinearity, variable selection, weighted least squares, polynomial models, and nonlinear regression: linearizable and intrinsically nonlinear models. May be repeated up to 3 credits.
**Prerequisite:** A ST 503 and A ST 505 or consent of instructor.
**Learning Outcomes**
1. Understand the fundamental philosophy behind regression.
2. Conduct a proper regression analysis, including making inferences and predictions.
3. Address common pitfalls in regression, including model assumption and collinearity issues.
4. Use the R language to perform regression analysis.

**A ST 509. Statistical Models for Complex Data Structures**
**3 Credits (3)**
Statistical models for data that are not normally distributed or data with correlated observations. Covers generalized linear models for discrete and mixed models for correlated data structures. Analysis of data with unbalanced and missing cells.
**Prerequisite:** A ST 506 with a grade of B or higher, or A ST 507 with a grade of B or higher.
**Learning Outcomes**
1. Analyze data using classical regression and generalized linear models.
2. Derive quantities of interest from fitted models.
3. Formulate the appropriate hierarchical model for different analytical goals and data structures.

4. Use statistical software to fit hierarchical models and assess the adequacy of the model.
5. Interpret summaries of fitted hierarchical models.

**A ST 511. Statistical Methods for Data Analytics**
**3 Credits (3)**
Statistics fundamentals, with an emphasis on inferential methods, linear regression, and practical applications to data analytics. A ST majors should not take this course if they have already completed A ST 505.
**Learning Outcomes**
1. Understand descriptive and inferential methods commonly used in data analytics
2. Formulate linear regression models and fit models using statistical software
3. Properly interpret the results of statistical analyses
4. Effectively communicate statistical methods and results orally and in writing

**A ST 512. Quantitative Analysis for Business Decisions**
**3 Credits (3)**
Identification, collection, and analysis of an organization's data both internal and external, and use of the resultant information in managerial decision making. Crosslisted with: MGMT 512.
**Learning Outcomes**
1. Understand statistical methods commonly used in business.
2. Identify statistical considerations in the design of studies.
3. Properly interpret the results of statistical analyses and use results to make decisions regarding business problems.
4. Effectively communicate business decisions orally and in writing, using statistics to defend decisions, as appropriate.

**A ST 515. Statistical Analysis with R**
**3 Credits (3)**
Introduction to R data types, basic calculations and programming, data input and manipulation, one and two sample tests, ANOVA, regression, diagnostics, graphics, probability distributions, and basic simulations in the R software environment.
**Prerequisite(s):** A ST 505 or equivalent with consent of instructor.

**A ST 540. Predictive Analytics**
**3 Credits (3)**
This course covers data analytic techniques that can be used to predict and classify observations outside of the original data. Material includes linear and nonlinear regression models, linear and nonlinear classification models, and classification and regression trees. Students will gain hands-on experience using modern software packages to build predictive models and quantify the accuracy of these models.
**Prerequisite(s):** A ST 507 or consent of instructor.

**A ST 550. Special Topics**
**1-4 Credits**
Specific subjects to be announced in the Schedule of Classes. Maximum of 4 credits per semester. No more than 9 credits toward a degree.

**A ST 554. Practicum in Statistics**
**3 Credits (3)**
Practical experience in data analysis and the reporting of results; selecting and using statistical methods to analyze and interpret real-world problems; written and oral communication of findings
**Prerequisite:** A ST 503, A ST 506, A ST 507, and A ST 566.
**Learning Outcomes**
1. Work with real data to gain substantial experience in data analysis, writing, and presentation.
2. Research and apply a variety of statistical methods, some of which students may not have encountered in prior coursework.
3. Apply knowledge and skills gained throughout the program of study, integrating content from across the MS in A ST curriculum.

**A ST 555. Applied Multivariate Analysis**
**3 Credits (3)**
Multivariate analysis of linear statistical models, including MANOVA and repeated measures. Analysis of correlation and covariance structures, including principal components, factor analysis, and canonical correlation. Classification and discrimination techniques. May be repeated up to 3 credits.
**Prerequisite:** A ST 506 and A ST 504.
**Learning Outcomes**
1. Understand the details of various multivariate techniques, emphasizing connections to univariate techniques where applicable.
2. Select appropriate multivariate techniques for a given data set and problem.
3. Use statistical software to perform multivariate analyses.
4. Correctly interpret, write about, and present the results of multivariate analyses.

**A ST 565. Statistical Analysis I**
**3 Credits (3)**
An analytic introduction to the theory and methods of statistical inference. Sampling, frequency distributions (z, t, x2, F), estimation, testing, and simulation. Crosslisted with: A ST 465.
**Prerequisite(s):** MATH 2530G or consent of instructor.

**A ST 566. Statistical Analysis II**
**3 Credits (2+2P)**
Continuation of A ST 565. Crosslisted with: A ST 466.
**Prerequisite(s):** A ST 565 or consent of instructor.

**A ST 568. Applied Linear Models II**
**3 Credits (3)**
The relation of full to less-than-full rank linear models; complex data structures, including messy data, empty cells, and components of variance: extensions to categorical data analysis and nonparametric methods. Continues some emphasis on computational aspects.
**Prerequisite:** A ST 567.

**A ST 596. Independent Study**
**1-3 Credits**
Individual studies directed by consenting faculty with prior approval by department head. May be repeated for a maximum of 3 credits.
**Prerequisite:** consent of instructor.

**A ST 598. Special Research Problems**
**1-6 Credits**
Individual analytical or experimental projects. Restricted to majors. Graded S/U.

**A ST 599. Master's Thesis**
**1-6 Credits**
Thesis.

**A ST 609. Linear Model Theory**
**3 Credits (3)**
Theoretical treatment of linear models. Covers fixed effects and mixed effects models; models that are full rank, less than full rank, and over-parametrized. Some computational aspects are discussed in relation to statistical packages. Prior to enrollment students should have a basic understanding of undergraduate-level matrix algebra.
**Prerequisite:** A ST 565, A ST 566, and A ST 509.

**Learning Outcomes**

1. Derive estimators of model parameters using design matrices, including models that are full rank, less than full rank, and over-parameterized
2. Derive the expectation vector and variance matrix of a linear transformation of a random data vector
3. Derive common test statistics and their distributions for fixed effects and mixed effects models with a balanced design
4. Understand the mathematical properties of variance-covariance matrices and their implications for model estimation and inference
5. Derive and interpret diagnostics for linear models

**A ST 616. Computational Statistics**
**3 Credits (3)**
An introduction to topics in computational statistics including: methods for generating random variables, large scale hypothesis testing, resampling, bootstrapping, permutation tests, the Expectation-Maximization algorithm, Markov chain Monte Carlo methods, and computational approaches in Bayesian inference. Includes some applications of computational statistics in the sciences. Previous experience with programming, while helpful, is not required.
**Prerequisite:** A ST 505 and A ST 566.
**Learning Outcomes**

1. Conduct large-scale hypothesis testing
2. Generate random numbers and random variables
3. Implement Markov chain Monte Carlo methods for conducting Bayesian inference
4. Import and manipulate data using R
5. Employ bootstrapping methods for making inferences and conduct statistical hypothesis testing using permutation tests

**A ST 645. Time Series Methods**
**3 Credits (3)**
Theory and methods for analyzing, modeling, and forecasting time series. Covers ARIMA models, spectral analysis, filtering, and state-space models. Previous experience using the R programming language is helpful but not required. Students should have a basic understanding of undergraduate-level matrix algebra and trigonometry.
**Prerequisite:** A ST 565 and A ST 507.
**Learning Outcomes**

1. Explore time series datasets for autocorrelation, cross-correlation, and stationarity
2. Select appropriate models for analyzing and forecasting time series data
3. Identify regular patterns and frequencies in time series data
4. Fit time series models using statistical software
5. Understand mathematical theory underlying time series models

**A ST 665. Bayesian Theory**
**3 Credits (3)**
Provides an overview of theory underlying Bayesian inference. Topics include Likelihood and Sufficiency Principles, concepts from decision theory, construction of prior distributions, Bayesian point estimation, tests and confidence regions.
**Prerequisite:** A ST 565 and A ST 566.
**Learning Outcomes**

1. Understand the theoretical justification for using Bayesian methods as a means of statistical inference
2. Apply decision-theoretic principles to evaluate estimators under different loss functions
3. Develop prior distributions using the concepts of entropy, conjugacy, and non-informativeness
4. Derive basic point estimators using Bayesian principles
5. Understand testing and confidence region methods used for Bayesian inference

**A ST 700. Doctoral Dissertation**
**1-15 Credits (1-15)**
Dissertation for the Applied Statistics doctoral program. Students must have advancement to candidacy in order to enroll in this course. May be repeated up to 36 credits.
**Learning Outcomes**

1. Make substantive progress towards completing a dissertation that fulfills the requirements for the Applied Statistics doctoral degree.