

# Statistics and Data Science, M.S.

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FOX SCHOOL OF BUSINESS AND MANAGEMENT (<https://www.fox.temple.edu>)

Learn more about the Master of Science in Statistics and Data Science (<https://www.temple.edu/academics/degree-programs/statistics-and-data-science-ms-bu-sdsc-ms>).

## About the Program

The Department of Statistical Science offers the Statistics and Data Science M.S. degree program to allow students to acquire in-depth knowledge of statistics. The program prepares “super analysts” who have stronger and deeper predictive analytics skills. Students learn to:

- Understand descriptive, predictive, and prescriptive analytics; recognize when each is appropriate; and understand the fundamental methods and techniques used in each.
- Understand the applications, assumptions, and limitations of data science models and techniques.
- Develop expertise in the use and application of cutting-edge analytical tools and software.
- Obtain information and insight from highly complex, large datasets.
- Effectively communicate insights and results of analyses in managerially relevant terms.

**Time Limit for Degree Completion:** 3 years

**Campus Location:** Main and Center City, with some courses offered online

**Full-Time/Part-Time Status:** The degree program can be completed on a full- or part-time basis.

**Job Prospects:** Graduates of the master's program are trained to serve as professional statisticians in industry, research organizations, or government.

**Non-Matriculated Student Policy:** Students with an undergraduate GPA of 3.0 or above may take classes on a non-matriculated status. Non-matriculated students can take a maximum of 9 credits.

**Financing Opportunities:** Assistantships are typically reserved for those engaged in doctoral study.

## Admission Requirements and Deadlines

### Application Deadline:

*Fall:*

- December 15 – Early Decision Deadline and International Deadline
- March 1 – Scholarship Deadline
- June 30 – Final Deadline

Applications are reviewed as they are received and can sometimes be considered after the deadline.

International students who miss the December 15 deadline are required to submit to Temple University an evaluation of their transcript(s) by an approved educational evaluation firm.

APPLY ONLINE (<https://fox.secure.force.com/SiteLogin>) to this Fox graduate program at <https://fox.secure.force.com/SiteLogin/>.

### Letters of Reference:

*Number Required:* 2

*From Whom:* Professional references from an immediate supervisor, current or past, are preferred. Academic references are acceptable.

**Coursework Required for Admission Consideration:** Students must have completed a minimum of two semesters of university-level Calculus or its equivalent. Adequate preparation in Linear Algebra and in Programming are also required. Prerequisites include:

Code	Title	Credit Hours
CIS 5011	Programming and Data Structure (or equivalent)	3
MATH 5001	Linear Algebra (or equivalent)	3

**Bachelor's Degree in Discipline/Related Discipline:** A baccalaureate degree is required, although it need not be in a business discipline.

**Statement of Goals:** In 500 words or less, describe your goals and motivations for pursuing the master's degree in Statistics and Data Science.

**Standardized Test Scores:**

GRE/GMAT: Required. Quantitative and verbal scores on the GRE should be in the 50th percentile or above. Scores under 500 on the GMAT are not considered for the M.S. program.

Applicants who earned their baccalaureate degree from an institution where the language of instruction was other than English, with the exception of those who subsequently earned a master's degree at a U.S. institution, must report scores for a standardized test of English that meet these minimums:

- TOEFL iBT: 88
- IELTS Academic: 6.5
- PTE Academic: 60

Any student admitted with a TOEFL score below 100 iBT must pass an English skills course during the first term of enrollment at Temple University.

**Resume:** Current resume required.

**Transfer Credit:** Upper-level graduate credits from an accredited graduate program, but not previously applied to a conferred degree, may be transferred into the M.S. program. The credits must be part of the required degree program at Temple University. To be transferred, the grade must be a "B" or better. The Admissions Committee makes recommendations with regard to transfer credits to the Director of the Graduate Program in Statistical Science. The maximum number of credits a student may transfer is 6.

## Program Requirements

**General Program Requirements:**

*Number of Credits Required Beyond the Baccalaureate:* 30

*Required Courses:*

Code	Title	Credit Hours
<b>Core Courses</b>		
STAT 5602	Visualization: The Art of Numbers and the Psychology of Persuasion	3
STAT 8003	Statistical Methods I	3
STAT 8102	Statistical Methods III	3
STAT 8109	Applied Statistics and Data Science	3
STAT 8121	Statistical Computing	3
STAT 8207	Design and Analysis of Complex Experiments	3
STAT 8515	Data Wrangling and Curation	3
<b>Electives</b> <sup>1</sup>		6
Select two of the following:		
AS 5102	Actuarial Modeling I	
AS 5103	Actuarial Modeling II	
AS 5104	Actuarial Modeling III	
AS 5105	Actuarial Economics	
CIS 5523	Knowledge Discovery and Data Mining	
CIS 5525	Neural Computation	
CIS 5526	Machine Learning	
CIS 5538	Text Mining and Language Processing	
GUS 5162	Advanced Statistics for Urban Applications	
GUS 8066	Application Development for Geographic Information Systems	
STAT 8004	Statistical Methods II	
STAT 8111	Survey Techniques for Business Applications	
STAT 8115	Nonparametric Methods	
STAT 8116	Categorical Data Analysis	
STAT 8123	Time Series Analysis and Forecasting	
STAT 8982	Independent Study	

**Capstone Course**

STAT 5651	Capstone in Analytics	3
Total Credit Hours		30

<sup>1</sup> Other electives may be selected with the approval of the Academic Director.

**Culminating Event:** Satisfactory completion of coursework is required to earn the degree.

## Contacts

### Program Web Address:

<https://www.temple.edu/academics/degree-programs/statistics-and-data-science-ms-bu-sdsc-ms>

### Department Information:

Fox School of Business and Management  
 329 Speakman Hall  
 1810 N. 13th Street  
 Philadelphia, PA 19122  
 foxinfo@temple.edu  
 215-204-5890  
 215-204-7678  
 Fax: 215-204-1632

### Submission Address for Application Materials:

<https://fox.secure.force.com/SiteLogin/>

### Department Contacts:

*Graduate Program Director:*

Zhigen Zhao  
 1810 Liacouras Walk, Room 390  
 zhaozhg@temple.edu  
 215-204-6208

## Courses

### STAT 5001. Quantitative Methods for Business. 1 to 3 Credit Hour.

This course is designed to introduce you to contemporary elementary applied statistics and to provide you with an appreciation for the uses of statistics in business, economics, everyday life, as well as hands-on capabilities needed in your later coursework and professional employment.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**College Restrictions:** Must be enrolled in one of the following Colleges: Business & Mngmnt, Fox School.

**Repeatability:** This course may not be repeated for additional credits.

### STAT 5002. Introduction to Biostatistics. 3 Credit Hours.

Topics cover statistical methods and concepts with special emphasis on applications in health and biological sciences.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may not be repeated for additional credits.

### STAT 5170. Special Topics. 1 to 6 Credit Hour.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may be repeated for additional credit.

### STAT 5182. Independent Study. 1 to 6 Credit Hour.

Special study in a particular aspect of statistics under the direct supervision of an appropriate graduate faculty member. No more than six semester hours of independent study may be counted toward degree requirements.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may be repeated for additional credit.

**STAT 5190. Special Topics - Stat. 1 to 6 Credit Hour.**

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may be repeated for additional credit.

**STAT 5282. Independent Study. 1 to 3 Credit Hour.**

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may be repeated for additional credit.

**Pre-requisites:**

STAT 5001|Minimum Grade of B-|May not be taken concurrently.

**STAT 5602. Visualization: The Art of Numbers and the Psychology of Persuasion. 3 Credit Hours.**

Organizations are collecting an unprecedented volume of data, and analysts are producing information from data using analytics and models. None of the information that is extracted from the data is usable unless it can be effectively communicated. In this course, we will begin with the fundamental questions of communication: Who is the audience? What is the information? What is the goal? Using these questions to focus our thoughts, we will explore the techniques that allow you to select appropriate information and to craft a narrative that clearly and effectively communicates this information using visual elements. Producing good visual displays is a combination of art and science and compromise between function and form. We will discuss how humans process and encode visual and textual information in relation to selecting an appropriate visual display, and we will cover topics including: exploratory data analyses, charts, tables, graphics, static and dynamic displays, effective presentations, multimedia content, animation, and dashboard design. Examples and cases will be used from a variety of industries.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**College Restrictions:** Must be enrolled in one of the following Colleges: Business & Mngmnt, Fox School.

**Repeatability:** This course may not be repeated for additional credits.

**STAT 5603. Statistical Learning and Data Mining. 3 Credit Hours.**

This course is designed to change the way you think about data. Numerous firms have demonstrated that the ability to reliably extract managerially-relevant information from data is a potent and enduring source of competitive advantage, a realization that transforms data into an asset that can be a primary source of competitive advantage. Competition is pushing organizations to "mine" (or extract) these insights faster, with greater reliability, and in ways that maximize the probability of implementation. In this course we will explore how statistical learning and data mining techniques can be used to improve decision-making and profitability. The course will provide an overview of the fundamental principles and techniques of data mining, and we will use real-world examples, cases, and "hands-on" techniques to demonstrate data-mining techniques in context, to develop your analytic thinking, and to develop your model building acumen.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**College Restrictions:** Must be enrolled in one of the following Colleges: Business & Mngmnt, Fox School.

**Repeatability:** This course may not be repeated for additional credits.

**Pre-requisites:**

STAT 5001|Minimum Grade of B-|May be taken concurrently

OR (MIS 5301|Minimum Grade of B-|May be taken concurrently

AND STAT 5301|Minimum Grade of B-|May be taken concurrently)

OR (MIS 5401|Minimum Grade of B-|May be taken concurrently

AND STAT 5401|Minimum Grade of B-|May be taken concurrently)

**STAT 5604. Experiments: Knowledge by Design. 3 Credit Hours.**

How do we know which policies, strategies, and decisions work, which should be continued, and which should be changed? Organizations frequently implement strategies and changes, only to find that they fail to produce their intended effects. Thus, there is a gap between what "sounded good" and what was "right." Ultimately, the gold standard for assessing what is "right" is a controlled experiment, which is the least utilized technique in the corporate arsenal. Experiments provide a structured way to construct a feedback loop that allows us to identify errors in our beliefs and to ascertain the real drivers of outcomes. In this course, we will explore how to use this "test and learn" paradigm to answer questions such as how advertising should be designed and targeted, what types of promotions are most effective, what products should be offered, how employees should be compensated, which sales channels should be emphasized, how webpages should be designed, and more. Experiments are an ideal way to understand how to implement a "test and learn" approach to management and to separate the "signal" from the "noise."

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**College Restrictions:** Must be enrolled in one of the following Colleges: Business & Mngmnt, Fox School.

**Repeatability:** This course may not be repeated for additional credits.

**Pre-requisites:**

STAT 5001|Minimum Grade of B-|May be taken concurrently  
OR (MIS 5301|Minimum Grade of B-|May be taken concurrently  
AND STAT 5301|Minimum Grade of B-|May be taken concurrently)  
OR (MIS 5401|Minimum Grade of B-|May be taken concurrently  
AND STAT 5401|Minimum Grade of B-|May be taken concurrently)

**STAT 5605. Decision Models: From Data to Decisions. 3 Credit Hours.**

Good analysts know that predictions are always uncertain. However, merely expressing uncertainty is not sufficient for decision making. In addition, we need to combine the results of uncertain inputs into a more general model, account for the relative severity of negative outcomes, and choose a strategy that best achieves our goals (e.g. highest expected value, most robust, least chance of losing, etc.). We also need to communicate the process and conclusions to constituents and to decision-makers. This course focuses on techniques for combining uncertain inputs into a decision model that can be used to characterize likely and unlikely outcomes, to quantify risk, and to identify inputs to a decision that are "high leverage" (i.e., outcomes are very sensitive to those inputs). In addition, you will learn how to build a decision model, how to make better decisions in the presence of uncertainty, and how to deal with multi-stage decisions.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**College Restrictions:** Must be enrolled in one of the following Colleges: Business & Mngmnt, Fox School.

**Repeatability:** This course may not be repeated for additional credits.

**Pre-requisites:**

STAT 5001|Minimum Grade of B-|May be taken concurrently  
OR (MIS 5301|Minimum Grade of B-|May be taken concurrently  
AND STAT 5301|Minimum Grade of B-|May be taken concurrently)  
OR (MIS 5401|Minimum Grade of B-|May be taken concurrently  
AND STAT 5401|Minimum Grade of B-|May be taken concurrently)

**STAT 5606. Data: Care, Feeding, and Cleaning. 3 Credit Hours.**

Data is ubiquitous. Real data is also "dirty." Analysis of unclean data can significantly distort the results of analyses, and it can reduce or eliminate the benefits of an information-driven strategy. Thus, the first step in generating good information from data is to "clean" the data. Substantial research has been done on procedures to automatically or semi-automatically identify--and, when possible, correct--errors in large datasets. Even after data have been "scrubbed" the datasets are frequently not in the correct configuration for analysis. Data combination and manipulation involves techniques for merging and summarizing datasets, extracting subsets of data, and transforming variables within the datasets. In this course we explore tools and techniques for cleaning raw data (fixing errors, identifying outliers, etc.), extracting subsets or samples of data, merging and combining datasets, summarizing disaggregate data, and manipulating and transforming individual variables within the datasets. We will also discuss good procedures for ensuring data quality and reliability in data collection. In addition, we will discuss techniques to identify issues in data collection and how to clean the data.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**College Restrictions:** Must be enrolled in one of the following Colleges: Business & Mngmnt, Fox School.

**Repeatability:** This course may not be repeated for additional credits.

**Pre-requisites:**

STAT 5001|Minimum Grade of B-|May be taken concurrently  
 OR (MIS 5301|Minimum Grade of B-|May be taken concurrently  
 AND STAT 5301|Minimum Grade of B-|May be taken concurrently)  
 OR (MIS 5401|Minimum Grade of B-|May be taken concurrently  
 AND STAT 5401|Minimum Grade of B-|May be taken concurrently)

**STAT 5607. Advanced Business Analytics. 3 Credit Hours.**

This course builds upon the foundation in Business Analytics. In previous courses, we saw that data by itself is useless, and that it must be transformed into information in order to have value to decision makers. This course will extend your understanding of the art and science of extracting information from data into increasingly complex and "real world" data. Specifically, we will cover extensions to regression, logistic regression, hierarchical modeling, model selection, and other topics spanning the process of building and evaluating models. In addition, we will practice drawing intuition and insight from models and effectively communicating that insight in a format that can help decision-makers to make better decisions.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**College Restrictions:** Must be enrolled in one of the following Colleges: Business & Mngmnt, Fox School.

**Repeatability:** This course may not be repeated for additional credits.

**Pre-requisites:**

STAT 5001|Minimum Grade of B-|May be taken concurrently  
 OR (MIS 5301|Minimum Grade of B-|May be taken concurrently  
 AND STAT 5301|Minimum Grade of B-|May be taken concurrently)  
 OR (MIS 5401|Minimum Grade of B-|May be taken concurrently  
 AND STAT 5401|Minimum Grade of B-|May be taken concurrently)

**STAT 5611. Business Analytics II. 1.5 Credit Hour.**

Organizations are drowning in a sea of data. However, data by itself is useless. To have value, it must be transformed into information that can be used to make decisions. It has been shown by myriad companies that one path to success in the business arena is through superior use of information - information about customers, markets, and operations. This course extends the material presented in Business Analytics I, continuing the development of the art and science of extracting information from data. The emphasis is on using extracted information to improve business decisions. It also delves into the presentation of quantitative data using state of the art tools and techniques.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**College Restrictions:** Must be enrolled in one of the following Colleges: Business & Mngmnt, Fox School.

**Repeatability:** This course may not be repeated for additional credits.

**Pre-requisites:**

(MIS 5301|Minimum Grade of B-|May not be taken concurrently  
 AND STAT 5301|Minimum Grade of B-|May not be taken concurrently)  
 OR (MIS 5401|Minimum Grade of B-|May not be taken concurrently  
 AND STAT 5401|Minimum Grade of B-|May not be taken concurrently)  
 OR STAT 5001|Minimum Grade of B-|May not be taken concurrently.

**STAT 5651. Capstone in Analytics. 3 Credit Hours.**

The capstone in analytics is the culmination of analytics-focused coursework. You will work with real data from "live" clients. Some of you will work on projects at companies for which you are interning. Others will work with MBA teams as part of our Fox Management Consulting program, providing analytics support for a live client. Others will work on primarily analytics focused projects.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may not be repeated for additional credits.

**STAT 5801. Statistical Analysis for Management. 3 Credit Hours.**

In this course, you'll learn how to use statistics to help solve business problems throughout an enterprise. You'll examine case examples of statistical analysis in areas such as marketing, finance and management. You'll learn descriptive and inferential techniques such as regression analysis and how to analyze data and reach decisions, using statistical computer software and Excel.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may not be repeated for additional credits.

**STAT 5802. Quantitative Techniques for Management. 3 Credit Hours.**

In this course you'll apply advanced quantitative techniques for managerial decision-making such as forecasting, linear programming, simulation, decision analysis, Markov chains and game theory. You'll use customized software and Excel to analyze these models extensively and apply them to decisions regarding resource allocation and other managerial problems.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may not be repeated for additional credits.

**STAT 5890. Special Topics. 1 to 6 Credit Hour.**

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may be repeated for additional credit.

**STAT 8001. Probability and Statistics Theory I. 3 Credit Hours.**

Topics include basic probability theory and combinatorial problems, generating functions, random variables, probability distributions, law of large numbers, and limit theorems.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may not be repeated for additional credits.

**STAT 8002. Probability and Statistics Theory II. 3 Credit Hours.**

A comprehensive development of the theory of statistics, including standard distributions, sampling distributions, general theory of estimation, testing of hypotheses, statistical decision theory, order statistics, linear statistical estimation.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may not be repeated for additional credits.

**Pre-requisites:**

(STAT 8001|Minimum Grade of B-|May not be taken concurrently  
AND STAT 8002|Minimum Grade of B-|May not be taken concurrently)

**STAT 8003. Statistical Methods I. 3 Credit Hours.**

Introduction to applied statistics. Topics include data management, probability distributions, parameter estimation, hypothesis testing, sampling methodologies, graphical display, analysis of variance, and simple and multiple regression. Use of R, S-Plus and SAS statistical software.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may not be repeated for additional credits.

**Pre-requisites:**

MATH 2031|Minimum Grade of B-|May not be taken concurrently.

**STAT 8004. Statistical Methods II. 3 Credit Hours.**

Design of experiments, analysis of discrete data, introduction to nonparametric methods, logistic regression, ARIMA time series analysis, bootstrapping, jackknife, robustness, and selected topics in multivariate analysis. Use of R, S-Plus and SAS statistical software.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may not be repeated for additional credits.

**Pre-requisites:**

STAT 8003|Minimum Grade of B-|May not be taken concurrently.

**STAT 8031. Probability and Large Sample Theory. 3 Credit Hours.**

An advanced level theoretical course covering measure theoretic probability, some probability inequalities, statistical independence, strong and weak laws of large numbers, convergence in distribution, variance stabilizing transformations, characteristic functions and central limit theorem.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may not be repeated for additional credits.

**Pre-requisites:**

STAT 8001|Minimum Grade of B|May not be taken concurrently.

**STAT 8101. Stochastic Processes. 3 Credit Hours.**

This is a first course in stochastic processes, with an emphasis on continuous-time models that support applications in financial mathematics and derivative evaluation. The course covers: fundamentals of probability, limit theorems, conditional expectation, change of measures, Markov chains, random walks, martingales, Brownian motion, the Ito integral, stochastic differential equations, the Black-Scholes model and its use in evaluating a variety of financial derivatives.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may not be repeated for additional credits.

**Pre-requisites:**

MATH 1031|Minimum Grade of B-|May not be taken concurrently  
OR MATH 1931|Minimum Grade of B-|May not be taken concurrently  
OR MATH 1041|Minimum Grade of B-|May not be taken concurrently  
OR MATH 1941|Minimum Grade of B-|May not be taken concurrently  
OR MATH 1038|Minimum Grade of B-|May not be taken concurrently  
OR MATH 1042|Minimum Grade of B-|May not be taken concurrently  
OR MATH 1942|Minimum Grade of B-|May not be taken concurrently.

**STAT 8102. Statistical Methods III. 3 Credit Hours.**

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may not be repeated for additional credits.

**Pre-requisites:**

STAT 8004|Minimum Grade of B-|May not be taken concurrently.

**STAT 8103. Sampling Theory. 3 Credit Hours.**

Theory and application of sampling from finite populations. Topics include random, stratified, cluster, and systematic sampling; estimation of means and variances; optimal allocation of resources; problems of nonsampling errors; and ratio and regression estimation.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may not be repeated for additional credits.

**Pre-requisites:**

STAT 8003|Minimum Grade of B-|May not be taken concurrently.



**STAT 8104. Mathematics for Stat. 3 Credit Hours.**

Vector spaces; linear independence of vectors and basis; matrices and algebraic operations on matrices; determinants; rank of a matrix; inverse of nonsingular matrices; linear equations and their solutions; generalized inverse of a matrix; eigen values and vectors of matrices; diagonalization theorems; quadratic forms and their reduction to sum of squares; Jacobians.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may not be repeated for additional credits.

**Pre-requisites:**

MATH 2101|Minimum Grade of B-|May not be taken concurrently

OR MATH 2103|Minimum Grade of B-|May not be taken concurrently.

**STAT 8105. Univariate Time Series Analysis. 3 Credit Hours.**

Theory and application of univariate time series analysis. Includes both time domain and frequency domain methods. Considers stationary and nonstationary linear processes, time series model building, forecasting, unit root test, intervention models and outlier detection, spectral theory of stationary processes, spectral windows, and estimation of spectrum.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may not be repeated for additional credits.

**Pre-requisites:**

STAT 8002|Minimum Grade of B-|May not be taken concurrently.

**STAT 8106. Linear Models I. 3 Credit Hours.**

Covers the basic theory and practice of generalized linear models (GLM), such as the logistic, Poisson and gamma regression, as well as models for multilevel or longitudinal Gaussian responses, such as the hierarchical linear model and linear mixed model. The students will need to work with R and SAS throughout the semester.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may not be repeated for additional credits.

**Pre-requisites:**

(STAT 8002|Minimum Grade of B-|May not be taken concurrently)

AND (STAT 8004|Minimum Grade of B-|May not be taken concurrently)

AND (STAT 8104|Minimum Grade of B-|May not be taken concurrently)

**STAT 8107. Design of Experiments I. 3 Credit Hours.**

Principles of experimental designs, completely randomized designs, multiple comparisons, randomized block design, latin square design, missing value problems, analysis of covariance, and factorial experiments.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may not be repeated for additional credits.

**Pre-requisites:**

STAT 8004|Minimum Grade of B-|May not be taken concurrently.

**STAT 8108. Applied Multivariate Analysis I. 3 Credit Hours.**

Multivariate normal distribution; marginal and conditional distributions; estimation of population mean vector and dispersion matrix; correlation, partial correlation, and multiple correlation coefficients; Hotelling's T<sup>2</sup>; MANOVA; discriminant function; repeated measurements analysis; principal components and canonical correlation; factor analysis; and multidimensional scaling.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may not be repeated for additional credits.

**Pre-requisites:**

(STAT 8004|Minimum Grade of B-|May not be taken concurrently)

AND (STAT 8104|Minimum Grade of B-|May not be taken concurrently)

**STAT 8109. Applied Statistics and Data Science. 3 Credit Hours.**

PART I: Elements of a scientific problem, including estimands, the role of statistical models, the language of statistical modeling, notions of likelihood, finite vs infinite populations, and types of analysis. PART II: Elements of statistical modeling, including transformation theorems, sufficiency, 1-parameter and multi-parameter models, multivariate Normal models, Dirichlet-multinomial models, hierarchical models, generalized linear models, mixture models, text analysis, social network analysis. PART III: Concepts and algorithms for estimation and inference, including information, statistical efficiency, asymptotic approximations, maximum likelihood estimators, method of moments estimators, Bayesian estimators, empirical Bayes vs full Bayes estimation strategies, expectation-maximization algorithm, Monte Carlo approximations, Gibbs samplers, Metropolis-Hastings samplers, prior and posterior predictive checks, and Bayesian vs. frequentist coverage. Data Science visitors: The course will feature a series of short talks and Q&A sessions with prominent data scientists spanning academia, government, and the Tech industry.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may not be repeated for additional credits.

**Pre-requisites:**

STAT 5001|Minimum Grade of B-|May not be taken concurrently.

**STAT 8111. Survey Techniques for Business Applications. 3 Credit Hours.**

Application oriented. A course dealing with statistical and nonstatistical aspects of organizing a sample survey. Included are discussions of objectives, measurement, sample selection, pilot testing, data collection, data editing, summarization and interpretation of results in addition to describing the various sampling schemes. Students may be required to plan and execute a survey.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may not be repeated for additional credits.

**Pre-requisites:**

STAT 5001|Minimum Grade of B-|May not be taken concurrently.

**STAT 8112. Statistical Methods for Business Research I. 3 Credit Hours.**

Part I of a doctoral level, one-year sequence of courses for the PhD students in Business Administration program. The course covers a variety of statistical methods useful in business research, such as: multiple regression analysis, ANOVA, linear models, analysis of covariance, logistic regression, principal component analysis, exploratory factor analysis and canonical correlation analysis. Emphases are placed on rationales, assumptions, techniques, and interpretation of results from computer packages. Relevant mathematical results will be presented, but proofs or abstract arguments shall be avoided. The lectures cover computer usages, such as R and/or SAS, and the students are expected to work with SAS (or equivalent packages) throughout the semester.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may not be repeated for additional credits.

**Pre-requisites:**

STAT 2101|Minimum Grade of B-|May not be taken concurrently  
OR STAT 2901|Minimum Grade of B-|May not be taken concurrently  
OR STAT 2103|Minimum Grade of B-|May not be taken concurrently  
OR STAT 2903|Minimum Grade of B-|May not be taken concurrently  
OR MATH 2031|Minimum Grade of B-|May not be taken concurrently  
OR MATH 3032|Minimum Grade of B-|May not be taken concurrently.

**STAT 8113. Statistical Methods for Business Research II. 3 Credit Hours.**

Part II of a doctoral level, one-year sequence of courses for the PhD students in Business Administration program. Topics covered in this course are: discriminant analysis, confirmatory factor analysis and structural equations modeling, time-series intervention analysis, survival (event history) analysis, MANOVA, multivariate profile analysis, hierarchical linear models (HLM), linear mixed models (LMM) for multilevel data.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may not be repeated for additional credits.

**Pre-requisites:**

STAT 8112|Minimum Grade of B-|May not be taken concurrently.

**STAT 8114. Survival Analysis I. 3 Credit Hours.**

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may not be repeated for additional credits.

**STAT 8115. Nonparametric Methods. 3 Credit Hours.**

A thorough course in nonparametric statistics. Estimation and testing of hypothesis when the function form of the population distribution function is not completely specified.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may not be repeated for additional credits.

**Pre-requisites:**

STAT 8002|Minimum Grade of B-|May not be taken concurrently.

**STAT 8116. Categorical Data Analysis. 3 Credit Hours.**

Sampling models and analyses for discrete data: Fisher's exact test; Logistic regression; ROC analysis; Log-linear models and Poisson regression; Conditional logistic regression; Cochran-Mantel-Haenszel test; Measures of agreement between observers; Quasi-independence; Multinomial logit models; Proportional odds model; Association models; generalized estimating equations (GEE); generalized linear mixed model (GLIMMIX); GSK models; Composite link functions. The students will need to work with R and SAS throughout the semester.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may not be repeated for additional credits.

**Pre-requisites:**

STAT 8002|Minimum Grade of B-|May not be taken concurrently.

**STAT 8117. Clinical Trials. 3 Credit Hours.**

Introduction to the special problems associated with medical trials on humans. Topics include randomization, sample-size determination, methods for early trial termination, and tests for superiority, equivalence, and non-inferiority. Also discussed are choice of endpoints, control, side effects, use of historical data, meta-analysis and ethics of experimentation on humans.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may not be repeated for additional credits.

**Pre-requisites:**

STAT 8002|Minimum Grade of B-|May not be taken concurrently

OR STAT 8004|Minimum Grade of B-|May not be taken concurrently.

**STAT 8121. Statistical Computing. 3 Credit Hours.**

Use of computers in the solution of statistical problems. Topics include: floating point architecture, random number generation, design of statistical software, computational linear algebra, numerical integration, optimization methods.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may not be repeated for additional credits.

**Pre-requisites:**

STAT 8004|Minimum Grade of B-|May not be taken concurrently.

**STAT 8122. Advanced SAS Programming. 3 Credit Hours.**

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may not be repeated for additional credits.

**Pre-requisites:**

(MATH 1042|Minimum Grade of B-|May not be taken concurrently

OR MATH 1942|Minimum Grade of B-|May not be taken concurrently)

AND (STAT 8001|Minimum Grade of B-|May not be taken concurrently)

AND (STAT 8002|Minimum Grade of B-|May not be taken concurrently)

**STAT 8123. Time Series Analysis and Forecasting. 3 Credit Hours.**

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may not be repeated for additional credits.

**Pre-requisites:**

(STAT 8002|Minimum Grade of B-|May not be taken concurrently  
OR STAT 8101|Minimum Grade of B-|May not be taken concurrently)  
AND (ECON 8009|Minimum Grade of B-|May not be taken concurrently  
OR MATH 3032|Minimum Grade of B-|May not be taken concurrently)

**STAT 8207. Design and Analysis of Complex Experiments. 3 Credit Hours.**

Experimentation has become a strategic foundation for modern corporations. This course focuses on strategies for designing, executing, and analyzing experiments on large populations, as well as dealing with large collections of concurrent experiments. We will consider settings where units of analysis may be assigned treatment in multiple experiments that are running concurrently. The course is largely based on critical reading of recent articles and technical reports. The emphasis will be on the design of complex field experiments that produce actionable results, and in working with experimentation platforms at large IT companies.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may not be repeated for additional credits.

**Pre-requisites:**

(STAT 8303|Minimum Grade of B-|May not be taken concurrently)  
AND (STAT 8109|Minimum Grade of B-|May not be taken concurrently)

**STAT 8515. Data Wrangling and Curation. 3 Credit Hours.**

This course will explore advanced tools and techniques for cleaning "raw" data. Real data is ubiquitous, but it is almost always "dirty". Analysis of "dirty" data can significantly distort results, which can reduce or eliminate the benefits from an analytic solution. The first step in extracting actionable information from data is to "clean" the data, and this process frequently occupies the majority of the analysis time. In this course, we will provide an in-depth look at the techniques that can be used to identify and deal with problematic data. Even after data have been "scrubbed", datasets are frequently not in the correct configuration for analysis, and we will explore techniques for merging and summarizing datasets, extracting subsets of data, and transforming variables. We will also discuss procedures for ensuring data quality and reliability in data collection.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may not be repeated for additional credits.

**Pre-requisites:**

STAT 8003|Minimum Grade of B|May be taken concurrently.

**STAT 8982. Independent Study. 1 to 3 Credit Hour.**

Special study in statistics theory and methods under the supervision of a graduate faculty member.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may be repeated for additional credit.

**STAT 9001. Advanced Statistical Inference I. 3 Credit Hours.**

Background: Matrix Theory Estimation: Sufficiency, Completeness, UMVU Estimation, Information Inequality, Invariance Principle, Bayes Estimation, Admissibility, Maximum Likelihood Estimation, Large Sample Properties of Estimators.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may not be repeated for additional credits.

**Pre-requisites:**

(MATH 1042|Minimum Grade of B-|May not be taken concurrently  
OR MATH 1942|Minimum Grade of B-|May not be taken concurrently)  
AND (STAT 8001|Minimum Grade of B-|May not be taken concurrently)  
AND (STAT 8002|Minimum Grade of B-|May not be taken concurrently)

**STAT 9002. Advanced Statistical Inference II. 3 Credit Hours.**

Testing of Hypotheses: Neyman-Pearson Fundamental Lemma; Uniformly Most Powerful Tests, Confidence Intervals, Likelihood Ratio Tests; Asymptotic Tests, Multiple Hypotheses Testing.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may not be repeated for additional credits.

**STAT 9090. Special Topics. 1 to 6 Credit Hour.**

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**College Restrictions:** Must be enrolled in one of the following Colleges: Business & Mngmnt, Fox School.

**Repeatability:** This course may be repeated for additional credit.

**STAT 9101. Multivariate Time Series Analysis. 3 Credit Hours.**

Theory and application of multiple time series analysis and special topics. Covers transfer function models, time series regression with autocorrelated errors, ARCH and GARCH models, vector time series models, cointegration, state space models, long memory processes and nonlinear processes, time series aggregation and disaggregation.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may not be repeated for additional credits.

**Pre-requisites:**

STAT 8105|Minimum Grade of B-|May not be taken concurrently.

**STAT 9103. Stat Lrng & Data Mining. 3 Credit Hours.**

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may not be repeated for additional credits.

**Pre-requisites:**

(STAT 8001|Minimum Grade of B-|May not be taken concurrently)

AND (STAT 8002|Minimum Grade of B-|May not be taken concurrently)

AND (STAT 8003|Minimum Grade of B-|May not be taken concurrently)

AND (STAT 8004|Minimum Grade of B-|May not be taken concurrently)

**STAT 9106. Linear Models II. 3 Credit Hours.**

Continuation of Stat 8106, covers the theory and practice of analyzing multivariate repeated/correlated non-Gaussian responses, with or without missing observations. Missing at random (MAR) models; informative missingness; EM algorithm; multiple imputations; quasi-likelihood estimation; generalized estimating equations (GEE); transition models; Gibbs sampling; Markov Chain Monte-Carlo (MCMC) technique. The students will need to work with R, SAS and WinBugs throughout the semester.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may not be repeated for additional credits.

**Pre-requisites:**

STAT 8106|Minimum Grade of B-|May not be taken concurrently.

**STAT 9107. Design of Experiments II. 3 Credit Hours.**

Covers symmetric and asymmetrical factorial experiments, fractional replication, split plot design, balanced and partially balanced incomplete block designs without and with recovery of interblock information and lattice designs.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may not be repeated for additional credits.

**Pre-requisites:**

STAT 8107|Minimum Grade of B-|May not be taken concurrently.

**STAT 9108. Multivariate Analysis II. 3 Credit Hours.**

A study of specialized topics in multivariate analysis.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may not be repeated for additional credits.

**Pre-requisites:**

(STAT 8002|Minimum Grade of B-|May not be taken concurrently)  
AND (STAT 8108|Minimum Grade of B-|May not be taken concurrently)

**STAT 9114. Survival Analysis II. 3 Credit Hours.**

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may not be repeated for additional credits.

**Pre-requisites:**

STAT 8114|Minimum Grade of B-|May not be taken concurrently.

**STAT 9116. Statistical Genetics: An Advanced Graduate Course. 3 Credit Hours.**

An advanced level graduate course in statistical genetics covering the basic concepts of allele, gene, genotype, phenotype, Hardy-Weinberg equilibrium, linkage analysis, QTL mapping using marker analysis, functional mapping for longitudinal traits, analysis of ultra-high dimensional data, genome-wide association studies.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may not be repeated for additional credits.

**Pre-requisites:**

(STAT 8001|Minimum Grade of B|May not be taken concurrently)  
AND (STAT 8002|Minimum Grade of B|May not be taken concurrently)  
AND (STAT 8003|Minimum Grade of B|May not be taken concurrently)  
AND (STAT 8004|Minimum Grade of B|May not be taken concurrently)

**STAT 9180. Seminar in New Topics in Statistics. 3 Credit Hours.**

Special topics in Statistics.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may be repeated for additional credit.

**STAT 9183. Directed Study in Statistics. 1 to 6 Credit Hour.**

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may be repeated for additional credit.

**STAT 9190. Seminar in New Topics in Statistics. 3 Credit Hours.**

Special topics in Statistics.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may be repeated for additional credit.

**STAT 9994. Preliminary Examination Preparation. 1 Credit Hour.**

Preparation for preliminary examinations.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may be repeated for additional credit.

**STAT 9998. Pre-Dissertation Research. 1 Credit Hour.**

Proposal design. Registration required until approved proposal is on file at the Graduate School.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Repeatability:** This course may be repeated for additional credit.

**STAT 9999. Dissertation Research. 1 to 12 Credit Hour.**

For students elevated to candidacy and doing their dissertation research. Registration required until successful defense and graduation.

**Level Registration Restrictions:** Must be enrolled in one of the following Levels: Graduate.

**Student Attribute Restrictions:** Must be enrolled in one of the following Student Attributes: Dissertation Writing Student.

**Repeatability:** This course may be repeated for additional credit.