Course Catalog

In order to be assured that all prerequisites are met, students must acquire a permission number from the education coordinator prior to enrolling in any Biostatistics course. Courses are not offered every semester.

700 Level
Service courses for graduate students in degree programs other than the MS or PhD programs in Biostatistics.

800 Level
Courses for graduate students in the MS or PhD programs in Biostatistics.

900 Level
Courses for graduate students in the MS or PhD program in Biostatistics.

BIOS 704 Principles of Statistics in Public Health (3)
This is an introductory course concerning the concepts of statistical reasoning and the role of statistical principles as the scientific basis for public health research and practice. Prerequisite: By permission of instructor.

BIOS 714 Fundamentals of Biostatistics I (3)
First-semester course of a two-semester introductory statistics course that provides understanding of the proper application of statistical methods to scientific research with emphasis on the application of statistical methodology to public health practice and research. This course focuses on basic principles of statistical inference with emphasis on one or two sample methods for continuous and categorical data. This course fulfills the core biostatistics requirement. Prerequisite: Calculus or permission of instructor.

BIOS 715 Introduction to Data Management using RedCap and SAS (3)
This course will cover the utilization of RedCap and SAS for data management. Data collection and management using RedCap will be covered. Data cleaning and preparation for analysis will be covered using SAS. Prerequisite: BIOS 704 & BIOS 714 or equivalent or permission of instructor.

BIOS 717 Fundamentals of Biostatistics II (3)
Second level statistics course that provides an understanding of more advanced statistical methods to scientific research with an emphasis on the application of statistical methodology to public health practice, public health research, and clinical research. Special focus will be upon the utilization of regression methodology and computer applications of such methodology. Prerequisite: BIOS 714 or equivalent or permission of instructor.

BIOS 720 Analysis Variance (3)
Methods for designed experiments including one-way analysis of variance (ANOVA), two-way ANOVA, repeated measures ANOVA, and analysis of covariance are emphasized. Post-ANOVA tests, power and testing assumptions required in ANOVA are discussed and applied. Outlier detection using robust estimators also are incorporated. Boxplots, histograms and scatterplots are used to display data. Prerequisite: PRE 710/711 or BIOS 714/717 or equivalent. Preferred: BIOS 715. Knowledge of statistical
software, basic statistical plotting methods, p-values, two-sample t-test and simple linear regression is assumed.

BIOS 725 Applied Nonparametric Statistics (3)
This course will study nonparametric methods in many situations as highlighted by the following topics: Students will learn how nonparametric methods provide exact p-values for tests, exact coverage probabilities for confidence intervals, exact experiment wise error rates for multiple comparison procedures, and exact coverage probabilities for confidence bands. This course will be using EXCEL and SAS to conduct various procedures. **Prerequisite: BIOS 714 or the equivalent or permission of the instructor.**

BIOS 730 Applied Linear Regression (3)
Simple linear regression, multiple regression, logistic regression, nonlinear regression, neural networks, autocorrelation, interactions, and residual diagnostics. Applications of the methods will focus on health related data. **Prerequisite:** 1) BIOS 714 or the equivalent and 2) BIOS 717 or BIOS 720 or permission of the instructor.

BIOS 735 Categorical Data and Survival Analysis (3)
An intermediate level statistics course that provides an understanding of the more advanced statistical methods to scientific research with emphasis on the application of statistical methodology to clinical research, public health practice, public health research and epidemiology. **Prerequisite:** BIOS 714, BIOS 715, and BIOS 717 or permission of the instructor.

BIOS 740 Applied Multivariate Methods (3)
This course is an advanced statistical course for students who have had fundamental biostatistics and linear regression. Topics to be covered include Hotelling’s T-squared test, MANOVA, principal components, factor analysis, discriminant analysis, canonical analysis, and cluster analysis. More advanced topics such as Multidimensional Scaling or Structural Equation Modeling might be introduced if time allows. Computers will be extensively used through the whole course, and students are suggested to be familiar with some statistical software before taking this course. Although students are allowed to use the software they are comfortable with, SAS will be the primary statistical package used to demonstrate examples in this course. **Prerequisite:** BIOS 730 or equivalents or permission of instructor.

BIOS 799 Introduction to Statistical Genomics (3)
This survey course will provide a high level introduction to various statistical and bioinformatics methods involved in the study of biological systems. In particular, this course will provide an overview of the analytical aspects involved in: the study DNA, RNA, and DNA methylation data measured from both microarray and next-generation sequencing (NGS) technologies. This course will be held in a block format with 4 hours of lectures a day for two weeks (one week in June and one week in July), with readings and homework assignments assigned throughout the summer semester. **Prerequisite:** BIOS 714, BIOS 717, and experience with higher level programming language is preferred, or permission of instructor.
BIOS 806 Advanced Special Topics in Biostatistics (3)
This course allows exploration of special topics that are not routinely a part of the Biostatistics PhD curriculum. Prerequisite: Passing grade on the PhD Qualifying exam, or permission of the instructor.

BIOS 810 Clinical Trials (3)
This course introduces issues in the design, organization, implementation, analysis, and assessment of randomized controlled clinical trials. Basic biostatistical concepts and models will be emphasized. Issues of current concerns to trialists will be emphasized. Issues of current concerns to trialists will be explored. Prerequisite: By permission of instructor.

BIOS 820 Statistical Computing/SAS Base L1 (3)
This is a graduate level course preparing a student for the SAS base programming certification exam. We will cover the topics required for a student to pass the SAS base programming certification exam given by SAS. To this end, topics we will study will include, referencing files and setting options, creating list reports, understanding data step processing, creating and managing variables, reading and combining SAS data sets, do loops, arrays, and reading raw data from files. After the completion of the course the student should be able to create SAS programs to read data from external files, manipulate the data into variables to be used in an analysis, generate basic reports showing the results. Prerequisite: By permission of instructor.

BIOS 821 Statistical Computing II (3)
Students will learn to manipulate data, perform matrix operations, generate reports, etc., using Proc SQL and Proc IML. Prerequisite: BIOS 820 or by permission of instructor.

BIOS 823 Introduction to Programming and Applied Statistics in R (3)
This course will provide students with the opportunity to learn advanced statistical programming. The development of new statistical or computational methods often implies the development of programming codes to support its application. Much of this type of development is currently carried out in the R (or S-Plus) language. Indeed much of the recent development of statistical genetics is based on the R programming language and environment. This course provides an introduction to programming in the R language and it's applications to applied statistical problems. Prerequisites: Some previous exposure to computer programming. Some basic statistics at the Applied Regression or Applied Design level and permission of instructor.

BIOS 825 Nonparametric Methods (3)
This course is an introduction to nonparametric statistical methods for data that do not satisfy the normality or other usual distributional assumptions. We will cover most of the popular nonparametric methods used for different scenarios, such as a single sample, two independent or related samples, three or more independent or related samples, goodness-of-fit tests, and measures of association. Power and sample size topics will also be covered. The course will cover the theoretical basis of the methods at an intermediate mathematical level, and will also present applications using real world data and statistical software. Prerequisite: By permission of instructor.
BIOS 830 Experimental Design (3)
The emphasis of this course is on learning the basics of experimental design and the appropriate application and interpretation of statistical analysis of variance techniques. Prerequisite: By permission of instructor; BIOS 820 recommended.

BIOS 833: Sampling Methods (3)
Students will be introduced to the design and analysis techniques when sampling from finite populations using simple, stratified, multistage, systematic, and complex sampling designs. Prerequisite: By permission of instructor.

BIOS 835 Categorical Data Analysis (3)
This course provides an understanding of both the mathematical theory and practical applications for the analysis of data for response measures that are ordinal or nominal categorical variables. This includes univariate analysis, contingency tables, and generalized linear models for categorical response measures. Regression techniques covered for categorical response variables, such as logistic regression and Poisson regression methods, will include those with categorical and/or continuous explanatory variables, both with and without interaction effects. Prerequisite: By permission of instructor; BIOS 820 and 840 are recommended.

BIOS 840 Linear Regression (3)
This course is an introduction to model building using regression techniques. We will cover many of the popular topics in Linear Regression including: simple linear regression, multiple regression, model selection and validation, diagnostics and remedial measures. Throughout the semester, we will be utilizing primarily SAS. Prerequisite: By permission of instructor.

BIOS 845 Survival Analysis (3)
This course provides an understanding of both the mathematical theory and practical applications for the analysis of time to event data with censoring. This includes univariate analysis, group comparisons, and regression techniques for survival analysis. Parametric and semi-parametric regression techniques covered will include those with categorical and/or continuous explanatory variables, both with and without interaction effects. Prerequisite: BIOS 820, 835, 840, and 871, or by permission of instructor.

BIOS 850: Multivariate Statistics (3)
The course will introduce students to a collection of procedures that involve observation and analysis of multiple dependent statistical variables at the same time. Topics include Hotelling’s T-square, principal components analysis, canonical correlation, cluster analysis, multivariate analysis of variance, multivariate repeated measures, and multivariate regression analysis. Prerequisite: BIOS 820, 830 and 840.

BIOS 855 Statistical Methods in Genomics Research (3)
This survey course will provide a high level introduction to various statistical and bioinformatics methods involved in the study of biological systems. In particular, this course will provide an overview of the analytical aspects involved in: the study DNA, RNA, and DNA methylation data measured from both microarray and next-generation sequencing (NGS) technologies. This course will be held in a block format with 4 hours of lectures a day for two weeks (one week in June and one week in July), with
readings and homework assignments assigned throughout the summer semester. During the last week of
the summer semester, students will be required to participate in a group seminar session in which they
will present the results from their assigned genomics projects.  *Perquisite: BIOS 820, BIOS 840, or
experience with higher level programming language is preferred, or permission of instructor.*

**BIOS 871 Mathematical Statistics I (3)**
This course introduces the fundamentals of probability theory, random variables, distribution and density
functions, expectations, transformations of random variables, moment generating functions, convergence
concepts, sampling distributions, and order statistics.  *Prerequisite: By permission of instructor.*

**BIOS 872 Mathematical Statistics II (3)**
This course introduces the fundamentals of statistical estimation and hypothesis testing, including point
and interval estimation, likelihood and sufficiency principles, properties of estimators, loss functions,
Bayesian analysis, and asymptotic convergence.  *Prerequisite: BIOS 871 or by permission of instructor.*

**BIOS 898 Collaborative Research Experience (3)**
This course provides students with experience in collaborative research under the supervision of an
experienced researcher. The student will spend one semester working under an investigator or faculty
member, making independent contributions to a research project.  *Prerequisites: BIOS 820, 830, 835,
840, 871, and 872, or by permission of instructor.*

**BIOS 900 Linear Models (3)**
This course introduces the theory and methods of linear models for data analysis. The course includes
the theory of general linear models including regression models, experimental design models, and
variance component models. Least squares estimation, the Gauss-Markov theorem, and less than full
rank hypotheses will be covered.  *Prerequisites: BIOS 871 and 872 or by permission of instructor; BIOS
820 recommended.*

**BIOS 902 Bayesian Statistics (3)**
This course introduces Bayesian theory and methods for data analysis. The course includes an overview
of the Bayesian approach to statistical inference, performance of Bayesian procedures, Bayesian
computational issues, model criticism, and model selection. Case studies from a variety of fields are
incorporated into the course. Implementation of models using Markov chain Monte Carlo methods is
emphasized.  *Prerequisites: BIOS 871 and 872 or by permission of instructor; BIOS 820 recommended.*

**BIOS 905 Theory of Statistical Inference (3)**
This course covers advanced aspects of statistical inference. It is aimed at preparing Ph.D. Biostatistics
students for the Ph.D. comprehensive exam and will emphasize advanced biostatistical ideas as well as
problem solving techniques.  *Prerequisites: BIOS 871 and 872 or by permission of instructor.*

**BIOS 906 Advanced Special Topics in Biostatistics (3)**
This course allows exploration of special topics that are not routinely a part of the Biostatistics PhD
curriculum.  *Prerequisite: Passing grade on the PhD Qualifying exam, or permission of the instructor.*
BIOS 908 Advanced Clinical Trial Design and Analysis (3)
This course provides an introduction to recent innovations in clinical trial designs and analysis methods. Topics include concepts of controls, blinding, and randomization; common trial designs by phase of clinical development; sample size calculations; interim analysis; and adaptive clinical trials. Traditional frequentist and likelihood approaches to trial design and analysis will be covered in the first half of the course; the Bayesian approach (including adaptive clinical trial designs) will be emphasized in the second half of the course. Prerequisite: BIOS 810, 820, 830, 835, 840, and 845. BIOS 821 recommended.

BIOS 910 Generalized Linear Models (3)
This course is designed for both the applied and theoretical statistician. In this course we will emphasize the theoretical foundations as well as the algorithms used in practice so that students can better utilize GLMs. Prerequisites: BIOS 835, 840 and 900 or by permission of instructor.

BIOS 911 Nonlinear Models (3)
This course will involve both theory and applications of nonlinear models, with emphasis in biological, medical, and pharmaceutical research. Applications to dose-response studies, bioassay studies and clinical pharmacokinetics and pharmacodynamics studies will be discussed. Nonlinear mixed effects models will also be examined, as well as criteria for optimal experimental designs based on mathematical level, and will also present applications using real world data and statistical software. Prerequisite: BIOS 900.

BIOS 915 Longitudinal Data Analysis (3)
This course aims to introduce some background theory and to focus on the most common techniques for analyzing longitudinal data. Prerequisite: BIOS 900. BIOS 820 recommended.

BIOS 920 Latent Variable Analysis (3)
This course is designed to introduce statistical analyses for models involving latent variables with and without measurement/classification errors. Prerequisite: BIOS 850, 900. BIOS 820 recommended.

BIOS 930 Data Mining (3)
Students will be introduced to common steps used in data mining such as accessing and assaying prepared data and pattern discovery, predictive modeling using decision trees, regression, and neural networks, and model assessment methods. Prerequisite: BIOS 820, 821, 850, and 900.

BIOS 999 Biostatistics Doctoral Dissertation (1-6)
Preparation of the doctoral dissertation based upon original research and in partial fulfillment of the requirements for the Ph.D. degree. Credits will be given only after the dissertation has been accepted by the student's dissertation committee. Prerequisite: Successful completion of the Department of Biostatistics Ph.D. Comprehensive Exam and consent of advisor.