BIOSTATISTICS (BIOS)

BIOS 801 BIOSTATISTICS THEORY I 3 Credit Hours
This course is designed to prepare students to have a solid understanding of the probabilistic tools and language (at a rigorous and advanced calculus level) needed as a foundation of biostatistical inference. Major topics to be covered include probability theory, transformations and expectations of random variables, families of distributions, random vectors, sampling distributions, and convergence.
Prerequisite: Calculus I, II and III, or equivalent courses; and instructor permission.
Cross List: CPH 657
Typically Offered: FALL

BIOS 802 BIOSTATISTICS THEORY II 3 Credit Hours
This course is designed to prepare Masters students in Biostatistics to have a solid understanding of biostatistical inference. Major topics to be covered include random samples, data reduction, point estimation, hypothesis testing, interval estimation, and prediction for common parametric models.
Prerequisite: BIOS 801 Biostatistics Theory I, or an equivalent course, and instructor permission.
Cross List: CPH 658.
Typically Offered: SPRING

BIOS 806 BIOSTATISTICS 3 Credit Hours
This course is designed to prepare the graduate student to understand and apply biostatistical methods needed in the design and analysis of biomedical and public health investigations. The major topics to be covered include types of data, descriptive statistics and plots, theoretical distributions, probability, estimation, hypothesis testing, and one-way analysis of variance. A brief introduction to correlation and univariate linear regression will also be given. The course is intended for graduate students and health professionals interested in the design and analysis of biomedical or public health studies; not intended for Ph.D. students enrolled in the Biostatistics Graduate Program.
Cross List: CPH 506.
Typically Offered: FALL/SP/SU

BIOS 808 BIOSTATISTICS II 3 Credit Hours
This course is designed to prepare the student to understand and apply advanced biostatistical methods needed in the design and analysis of biomedical and public health investigations. The major topics to be covered include multiple linear regression, analysis of covariance, logistic regression, survival analysis, and repeated measures analysis.
Prerequisite: BIOS 806 or an equivalent statistics course. The course is intended for graduate students and health professionals interested in the design and analysis of biomedical or public health studies; not intended for Ph.D. students enrolled in the Biostatistics Graduate Program.
Cross List: CPH 650.
Typically Offered: SPRING

BIOS 810 INTRODUCTION TO SAS PROGRAMMING 3 Credit Hours
An introduction to programming for statistical and epidemiologic analysis using the SAS Software System. Students will learn to access data from a variety of sources (e.g. the web, Excel, SPSS, data entry) and create SAS datasets. Data management and data processing skills, including concatenation, merging, and sub-setting data, as well as data restructuring and new variable construction using arrays and SAS functions will be taught. Descriptive analysis and graphical presentation will be covered. Concepts and programming skills needed for the analysis of case-control studies, cohort studies, surveys, and experimental trials will be stressed. Simple procedures for data verification, data encryption, and quality control of data will be discussed. Accessing data and summary statistics on the web will be explored. Through in-class exercises and homework assignments, students will apply basic informatics techniques to vital statistics and public health databases to describe public health characteristics and to evaluate public health programs or policies. Laboratory exercises, homework assignments, and a final project will be used to reinforce the topics covered in class. The course is intended for graduate students and health professionals interested in learning SAS programming and accessing and analyzing public use datasets from the web.
Prerequisite: BIOS 806/CPH 506 or an equivalent course.
Cross List: CPH 651.
Typically Offered: FALL/SPR

BIOS 815 BIOSTATISTICAL COMPUTING 3 Credit Hours
This course is designed for graduate students that are interested in statistical computing. The course will introduce graduate students to the R statistical language, PYTHON and their uses in biostatistical computing. Topics include introductory R, data management and manipulation, loops, vectorizing code, writing functions, coding shiny apps, pipe operators, resampling methods, data simulation and data visualization. In addition, students will be introduced to PYTHON and the R reticulate package for harnessing the power of PYTHON from within R.
Prerequisite: BIOS 806 / CPH 506, BIOS 810 / CPH 651 or Instructor permission
Cross List: CPH 656
Typically Offered: FALL

BIOS 818 BIOSTATISTICAL LINEAR MODELS: METHODS AND APPLICATION 3 Credit Hours
This course is designed to prepare the graduate student to analyze continuous data and interpret results using methods of linear regression and analysis of variance (ANOVA). The major topics to be covered include simple and multiple linear regression model specification and assumptions, specification of covariates, confounding and interactive factors, model building, transformations, ANOVA model specification and assumptions, analysis of covariance (ANCOVA), multiple comparisons and methods of adjustment, fixed and random effect specification, nested and repeated measures designs and models, and diagnostic methods to assess model assumptions. Interpretation of subsequent analysis results will be stressed. Concepts will be explored through critical review of the biomedical and public health literature, class exercises, an exam, and a data analysis project. Statistical analysis software, SAS (SAS Institute Inc., Cary, NC, USA.), will be used to implement analysis methods. The course is intended for graduate students and health professionals who will be actively involved in the analysis and interpretation of biomedical research or public health studies.
Prerequisite: Permission of instructor, calculus (including differential and integral calculus), BIOS 806/CPH 506 or BIOS 816/CPH 516 or an equivalent statistics course, BIOS 810/CPH 651, or equivalent experience with SAS programming.
Cross List: CPH 652.
Typically Offered: FALL

BIOS 823 CATEGORICAL DATA ANALYSIS 3 Credit Hours
Survey of the theory and methods for the analysis of categorical response and count data. The major topics to be covered include proportions and odd ratios, multi-way contingency tables, generalized linear models, logistic regression for binary response, models for multiple response categories, and log-linear models. Interpretation of subsequent analysis results will be stressed.
Prerequisite: BIOS 818/CPH 652 or an equivalent course, CPH 651/ BIOS 810 or equivalent experience with SAS programming, and instructor permission.
Cross List: CPH 653.
Typically Offered: SPRING

BIOS 824 SURVIVAL DATA ANALYSIS 3 Credit Hours
The course teaches the basic methods of statistical survival analysis used in clinical and public health research. The major topics to be covered include the Kaplan-Meier product-limit estimation, log-rank and related tests, and the Cox proportional hazards regression model. Interpretation of subsequent analysis results will be stressed.
Prerequisite: Permission of instructor, calculus (including differential and integral calculus); BIOS 806/CPH 506 or BIOS 816/CPH 516 or an equivalent statistics course; BIOS 810/CPH 651 or equivalent experience with SAS programming.
Cross List: CPH 654.
Typically Offered: FALL

BIOS 825 CORRELATED DATA ANALYSIS 3 Credit Hours
A survey of the theory and methods for analysis of correlated continuous, binary, and count data. Major topics to be covered include linear models for longitudinal continuous data, generalized estimating equations, generalized linear mixed models, impact of missing data, and design of longitudinal and clustered studies. Interpretation of subsequent analysis results will be stressed. Concepts will be explored through critical review of the biomedical and public health literature, class exercises, two exams, and a data analysis project. Computations will be illustrated using SAS statistical software (SAS Institute Inc., Cary, NC, USA.). The course is intended for graduate students and health professionals who will be actively involved in the analysis and interpretation of biomedical research or public health studies.
Prerequisite: Permission of instructor and BIOS 823/CPH 653.
Cross List: CPH 655.
Typically Offered: SPRING

BIOS 826 INTRODUCTION TO CAUSAL INFERENCE FOR DATA SCIENCE 3 Credit Hours
This course is designed to prepare graduate students or professional students to understand the fundamental of causal inference and learned how to apply commonly used techniques for causal inference for both clinical trial and observational studies. Major topics to be covered include defining causal effects, directed acyclic graph, confounding adjustment approaches, and application of machine-learning-based methods for causal inference.
Prerequisite: BIOS 815 and BIOS 818
Cross List: CPH 662
Instructor: Cheng Zheng
Typically Offered: SPRING

BIOS 829 INTRODUCTION TO BIOSTATISTICAL MACHINE LEARNING 3 Credit Hours
This course is designed to prepare graduate students to use modern statistical learning methods for modeling and prediction from data. Major topics to be covered include linear regression, classification (logistic regression, linear and quadratic discriminant analysis, K-Nearest Neighbors), resampling methods (cross-validation, the bootstrap), linear model selection and regularization (subset selection, shrinkage methods, dimension reduction), nonlinear approaches (polynomial regression, splines, Generalized Additive Models), tree-based methods (Classification and Regression Trees, bagging, random forests, boosting), support vector machines, deep learning, unsupervised learning (principal component analysis, clustering). The mathematical level of this course is modest, with only simple matrix operations.
Prerequisite: (i) At least one multivariate statistics course, eg BIOS 808 (CPH 650), BIOS 818 (CPH 652), BIOS 823 (CPH 653), BIOS 824 (CPH 654), BIOS 825 (CPH 655) or equivalent; (ii) BIOS 815 (CPH 656) Biostatistical Computing; or equivalent courses, and (iii) Instructor permission.
Cross List: CPH 659
Instructor: Gleb R. Haynatzki, PhD
Typically Offered: SPRING

BIOS 835 DESIGN OF MEDICAL HEALTH STUDIES 3 Credit Hours
This course is designed to prepare the graduate student to understand and apply principles and methods in the design of biomedical and public health studies, with a particular emphasis on randomized, controlled clinical trials. The major design topics to be covered include sample selection, selecting a comparison group, eliminating bias, need for and processes of randomization, reducing variability, choosing endpoints, intent-to-treat analyses, sample size justification, adherence issues, longitudinal follow-up, interim monitoring, research ethics, and non-inferiority and equivalence hypotheses. Data collection and measurement issues also will be discussed. Communication of design approaches and interpretation of subsequent analysis results also will be stressed. Concepts will be explored through critical review of the biomedical and public health literature, class exercises, and a research proposal. The course is intended for graduate students and health professionals interested in the design of biomedical or public health studies.
Prerequisite: Permission of Instructor, BIOS 806/CPH506 or an equivalent introductory statistics course.
Cross List: CPH 517.
Typically Offered: SPRING

BIOS 896 RESEARCH OTHER THAN THESIS IN BIOSTATISTICS 1-4 Credit Hours
This course is for more advanced students who wish to pursue their research interests in selected areas of Medical Humanities.
Cross List: CPH 677.
Typically Offered: FALL/SP/SU

BIOS 898 SPECIAL TOPICS IN BIOSTATISTICS 1-4 Credit Hours
A course designed for Masters students that focuses on selected topics or problems in Biostatistics.
Cross List: CPH 679.
Typically Offered: FALL/SP/SU

BIOS 899 MASTER'S THESIS 3 Credit Hours
The thesis represents research on a defined problem in biostatistics. The Master's thesis must be a significant piece of biostatistical research that contributes to or clarifies knowledge in the field.
Prerequisite: Completion of sufficient credit hours of required course work such that the student may graduate upon successful defense of their thesis.
Instructor: Christopher S Wichman
Typically Offered: FALL/SP/SU

BIOS 901 ADVANCED BIOSTATISTICS THEORY I 3 Credit Hours
This course is designed to prepare PhD students in Biostatistics to have a solid understanding of statistical theory and its advanced use in developing statistical methods for biomedical studies. Major topics to be covered include Theory of probability and distribution, Statistical inference problems, Asymptotic theory, Maximum likelihood theory I, Maximum likelihood theory II, Maximum likelihood theory III, and EM-algorithm.
Prerequisite: BIOS 802 or an equivalent course, and instructor permission.
Instructor: Ying Zhang, PhD
Typically Offered: FALL
Capacity: 15

BIOS 902 ADVANCED BIOSTATISTICS THEORY II 3 Credit Hours
This course is designed to give a solid understanding of statistical theory and its advanced use in developing statistical methods for biomedical studies. Major topics to be covered include Extended Likelihood Theory, Quasi-Likelihood and Generalized Estimating Equation (GEE), Missing Data Methodology, Group Sequential Methods for Clinical Trials, Bootstrap Methods, Causal Inference, and Lasso Regularization Methods. It is the second part of the advanced biostatistics theory sequence after BIOS 901.
Prerequisite: BIOS 901 Advanced Biostatistics Theory I, and instructor permission.
Instructor: Ying Zhang, PhD
Typically Offered: SPRING
Capacity: 15

BIOS 918 BIOSTATISTICAL LINEAR MODELS: THEORY AND APPLICATIONS 3 Credit Hours
This course on linear models theory includes topics on linear algebra, distribution theory of quadratic forms, full rank linear models, less than full rank models, ANOVA, balanced random mixed models, unbalanced models and estimation of variance components.
Prerequisite: BIOS 818 or an equivalent course, linear algebra, one year of mathematical statistics, and instructor permission.
Typically Offered: FALL

BIOS 921 ADVANCED PROGRAMMING SAS 3 Credit Hours
The objective of this course is to prepare students in advanced SAS programming. The main topics comprise advanced SAS programming techniques, SAS macro programming, using SQL with SAS, and optimizing SAS programs, which are similar to those covered on the SAS Advanced Programmer Exam offered through the SAS Institute, Inc.
Prerequisite: BIOS 810 or equivalent experience with SAS programming, and instructor permission.
Typically Offered: SPRING

BIOS 924 BIOSTATISTICAL THEORY AND MODELS SURVIVAL DATA 3 Credit Hours
The course teaches the statistical theory and models for survival data analysis used in biochemical and public health research. Major topics include parametric, nonparametric, and semiparametric theory and models. The statistical software SAS and R will be used.
Prerequisite: BIOS 824 or an equivalent course, proficiency with the software R and SAS, and instructor permission.
Typically Offered: FALL

BIOS 925 THEORY OF GENERAL LINEAR AND MIXED MODELS IN BIOSTATISTICS 3 Credit Hours
This course focuses on the theory of generalized linear models for both continuous and categorical data. Major topics include generalized linear models, linear mixed models and generalized linear mixed models.
Prerequisite: BIOS 918 or an equivalent course, proficiency with the software R and SAS, and instructor permission.
Typically Offered: SPRING

BIOS 928 BAYESIAN THEORY AND METHODOLOGY IN BIOSTATISTICS 3 Credit Hours
This course is designed to provide graduate students an understanding of advanced theory and applications of Bayesian modeling in public health and biomedical study. The major topics to be covered include Bayesian generalized linear models, Bayesian generalized linear and mixed effects models, Hierarchical Bayesian modeling, Bayesian model selection, and Markov Chain Monte Carlo (MCMC) algorithm, and Bayesian adaptive design.
Prerequisite: BIOS 918 and BIOS 925 or equivalent, and instructor permission.
Instructor: Yeongjin Gwon, PhD.
Typically Offered: FALL
Capacity: 30

BIOS 935 SEMIPARAMETRIC METHODS FOR BIOSTATISTICS 3 Credit Hours
The fundamental theory and application of semi parametric methods in biomedical and public health studies. The major topics include additive semiparametric models, semiparametric mixed models, generalized semiparametric regression models, bivariate smoothing, variance function estimation, Bayesian semiparametric regression and spatially adaptive smoothing.
Prerequisite: BIOS 925 or an equivalent course, proficiency with the software R and SAS, and permission of instructor.
Typically Offered: SPRING

BIOS 938 CAUSAL INFERENCE 3 Credit Hours
This course is designed to prepare graduate students or professional students to rigorously define and estimate causal effects for both clinical trial and observational studies. Major topics to be covered include potential outcome framework, study designs, propensity scores, principal stratification, instrumental variables, graphical models, various structural models, and machine-learning-based causal methods.
Prerequisite: BIOS 802 (concurrent or previously taken) or an equivalent course, or instructor permission
Instructor: Cheng Zheng
Typically Offered: SPRING

BIOS 939 HIGH DIMENSIONAL INFERENCE AND MULTIPLE TESTING 3 Credit Hours
This course is designed to prepare graduate and professional students with strong quantitative skills to rigorously perform statistical inference and hypothesis testing for high-dimensional and/or big data. Major topics to be covered include multiple testing techniques in high dimensional data, high dimensional regression algorithms, variable selection and model selection methods, selective inference after model selection, online and structured testing problems.
Prerequisite: BIOS 802 and BIOS 818 or an equivalent course, and R programming, or instructor permission
Instructor: Ran Dai
Typically Offered: FALL
Capacity: 10

BIOS 941 BIOSTATISTICAL CONSULTANT APPLICATION AND PRACTICE 3 Credit Hours
This course is designed to provide the graduate student with a fundamental understanding and insight into the practice of biostatistical consulting and give students practice in the skills required to become an effective consultant. Major topics include an overview of biostatistical consulting, communication skills, methodological aspects including design and analysis considerations, documentation and preparing reports.
Prerequisite: A minimum of 3 graduate level biostatistics courses, proficiency with a statistical programming package (SAS or R), and instructor permission.
Typically Offered: FALL/SPR

BIOS 970 SEMINAR 1 Credit Hour
Attendance at weekly seminars offered by the department/program, or other activities specific to the degree program (contact the program director for more information).
Typically Offered: FALL/SPR

BIOS 996 DIRECTED READINGS AND RESEARCH 1-9 Credit Hours
This course is specific to doctoral level work in the College of Public Health. Content of this independent study may include research other than dissertation, directed readings, and other study of a doctoral level ¿ all under the supervision of a graduate faculty member.
Prerequisite: Doctoral student status and program permission.
Typically Offered: FALL/SP/SU

BIOS 998 DOCTORAL SPECIAL TOPICS 1-4 Credit Hours
This course is for more advanced students who wish to pursue their research interests in selected areas of Medical Humanities.
Prerequisite: Instructor Permission
Typically Offered: FALL/SP/SU

BIOS 999 DOCTORAL DISSERTATION 1-15 Credit Hours
The dissertation represents original research on a defined problem in biostatistics. The PhD dissertation must be a significant, original piece of biostatistical research that makes a contribution to knowledge in the field.
Prerequisite: Doctoral student status, program permission, instructor permission.
Typically Offered: FALL/SP/SU