

Biostatistics (BIST)

BIST 6510 Probability Sampling 3 Credits

The goal of the course is to convey an understanding of probability and distribution theory. The probability theory is necessary to provide a foundation for statistics. Probability theory: set theory and probability theory, conditional probability and independence, random variables, distribution functions, density and mass functions for continuous and discrete random variables. Transformation and expectations: distributions of functions of a random variable, expected values, moments and moment generating functions. Common families of distributions: discrete and continuous distributions, exponential family, and location-scale family. Multiple random variables: joint and marginal distributions, conditional distributions and independence, covariance and correlation, multivariate distributions, hierarchical models and mixture distributions. Sampling theory: normal theory, limit theorems.

Level: Graduate, Undergraduate

Grading: Main Campus (UGrad, Grad)

Course registration restrictions:

Enrollment is limited to students with a major in Biostatistics, Biostatistics, Biostatistics, Biostatistics, Biostatistics, Biostatistics, Biostatistics, Mathematics and Statistics, Mathematics and Statistics, Mathematics and Statistics or Mathematics and Statistics.

Enrollment limited to students in the MS-BSTE-SM or PHD-BSTE-SM programs.

Enrollment is limited to Graduate level students.

BIST 6511 Statistical Inference 3 Credits

This course will introduce the basics of statistical inference, parameter estimation, and hypothesis testing in preparation for more in depth coverage of specific models in later courses. Inference procedures: point and interval estimation, sufficient statistics, hypothesis testing, methods of constructing test and estimation procedures. Point estimation: criteria for estimators, maximum likelihood estimators, Bayes estimators, mean square error, unbiased estimators, asymptotic variance of estimators. Hypothesis testing: error probabilities, power function, one-sample inference about the mean with known and unknown variance, comparison of two samples, 2x2 contingency tables, shortcuts and non-parametric methods. Modeling and study design: missing data, extreme observations, transformations, factorial experiments, probability sampling, sample size, two-stage sampling, stratified sampling, nonsampling errors.

Level: Graduate, Undergraduate

Grading: Main Campus (UGrad, Grad)

Course registration restrictions:

Enrollment is limited to students with a major in Biostatistics, Biostatistics, Biostatistics, Biostatistics, Biostatistics, Biostatistics, Biostatistics, Mathematics and Statistics, Mathematics and Statistics, Mathematics and Statistics or Mathematics and Statistics.

Enrollment is limited to Graduate level students.

BIST 6512 Categorical Data Analysis 3 Credits

This course covers theory and methods for the analysis of categorical data. The main subject areas are analysis of contingency tables, chi-square and exact tests, logistic models under binomial and multinomial sampling, log-linear models under Poisson sampling and their applications to perform contingency table analysis for nominal and ordinal variables. Methods of maximum likelihood estimation and goodness of fit procedures are discussed. Generalized linear model will be heavily utilized with an emphasis on model building and interpretation. Examples will be illustrated in R. Students are expected to use R or SAS when necessary, for all homework assignments.

Level: Graduate, Undergraduate

Grading: Main Campus (UGrad, Grad)

Course registration restrictions:

Enrollment is limited to students with a major in Biostatistics, Biostatistics, Biostatistics, Biostatistics, Biostatistics, Biostatistics, Biostatistics, Epidemiology, Epidemiology, Epidemiology or Epidemiology.

Enrollment is limited to Graduate level students.

BIST 6513 Survival Analysis 3 Credits

The course will introduce basic concepts in the analysis of survival data. It will be oriented toward application and interpretation of various methodologies. Examples will be drawn mostly from medical and epidemiologic research.

Level: Graduate, Undergraduate

Grading: Main Campus (UGrad, Grad)

Course registration restrictions:

Enrollment is limited to students with a major in Biostatistics, Biostatistics, Biostatistics, Biostatistics, Biostatistics, Biostatistics, Biostatistics, Epidemiology, Epidemiology, Epidemiology or Epidemiology.

Enrollment is limited to Graduate level students.

BIST 6514 Linear Models Multivariate Analysis 3 Credits

This course is an applied course on statistical modeling. The linear models module covers simple linear regression, multiple linear regression, analysis of variance, analysis of covariance, regression diagnostics, and model selection. The multivariate analysis module includes multivariate analysis of variance, principal components analysis, canonical correlation analysis, factor analysis, discriminant analysis, and cluster analysis. Students will learn how to use SAS to perform statistical analyses. Textbook: Applied Linear Statistical Models with Student CD, 5th Edition, by Kutner, Nachtsheim, Neter and Li, McGraw-Hill Higher Education, 2005 ISBN: 9780073108742

Level: Graduate

Grading: Main Campus (UGrad, Grad)

Course registration restrictions:

Enrollment is limited to students with a major in Biostatistics, Biostatistics, Biostatistics, Biostatistics, Biostatistics, Biostatistics, Biostatistics, Epidemiology, Epidemiology, Epidemiology or Epidemiology.

Enrollment is limited to Graduate level students.

BIST 6515 Intro to Statistical Software 2 Credits

BIST 515 is an introductory course to the open-source programming language R and the popular statistical software SAS. Basic syntax and simple applications to Biostatistics and Bioinformatics will be presented.

Level: Graduate, Undergraduate

Grading: Main Campus (UGrad, Grad)

Course registration restrictions:

Enrollment is limited to students with a major in Biostatistics, Biostatistics, Biostatistics, Biostatistics, Biostatistics, Biostatistics or Biostatistics.

Enrollment is limited to Graduate level students.

BIST 6532 Machine Learning for Bioinform 2 Credits

This course is a combination of theories and empirical skills on managing, processing and analyzing high-throughput biomedical data generated from a variety of "Omics" technologies, which spans genomics, transcriptomics, proteomics, and metabolomics. It introduces the students to the conceptual and experimental background, together with specific guidelines for handling raw data. Hand-on skills with R/Bioconductor and other software tools will be covered on popular "Omics" applications, such as microarray gene expression profiling, mass spectrometry-based metabolomics, RNA-seq, pathway analysis, and etc.

Level: Graduate

Grading: Main Campus (UGrad, Grad)

Course registration restrictions:

Enrollment is limited to students with a major in Biostatistics, Biostatistics, Biostatistics, Biostatistics, Biostatistics, Biostatistics, Biostatistics, Epidemiology, Epidemiology, Epidemiology or Epidemiology.

Enrollment is limited to Graduate level students.

BIST 6540 Experimental Design/Clin Trial 3 Credits

The objective of the course is to explain in practical terms the basic principles of clinical trials, with particular emphasis on their scientific rationale, organization and planning, and methodology. Issues discussed include design of randomized and non-randomized trials, size of a clinical trial, monitoring of trial progress, and some basic principles of statistical analysis. The intent is to present the methodology of clinical trials with emphasis on the practical aspects.

Level: Graduate, Undergraduate

Grading: Main Campus (UGrad, Grad)

Course registration restrictions:

Enrollment is limited to Graduate level students.

BIST 6541 Principles of Epidemiology 3 Credits

Epidemiology overview and history; distributions of disease by time, place and person; association and causality; ecological studies; cross-sectional studies and surveys; case-control studies; analysis of case-control studies; types of bias in case-control studies; cohort studies; analysis of cohort studies; bias in cohort studies; population attributable risk; confounding factors; effect modification (interaction); analysis for confounding and interaction; multivariate analysis; sensitivity, specificity and screening; public health practice and prevention; special issues in cancer epidemiology, infectious disease epidemiology and genetic epidemiology. This course includes a discussion session.

Level: Graduate, Undergraduate

Grading: Main Campus (UGrad, Grad)

Course registration restrictions:

Enrollment is limited to Graduate level students.

BIST 6545 Quant Data Analysis Reporting 2 Credits

The goal of this course is to enhance students' skills for identifying appropriate choices of statistical methodologies; and developing statistical approaches to applied research problems and effective communication of the approaches and findings. The course will give students hands on experience in statistical applications. The course will be organized around a series of case studies based on applied problems from different sources with a focus on application of statistical techniques as opposed to the subject matter of the data at hand. Students will formulate statistical approaches to the applied research problems; perform exploratory data analysis, model building and statistical inference; write reports, make oral presentations of results of analyses and interactively discuss analysis aspects of the case studies.

Level: Graduate, Undergraduate

Grading: Main Campus (UGrad, Grad)

Course registration restrictions:

Enrollment is limited to Graduate level students.

BIST 6595 Data Science AI Engineering 3 Credits

As a recent hot topic, big data usually includes data sets with sizes beyond the ability of commonly used software tools to capture, curate, manage, and process data within a tolerable elapsed time, and therefore, specialized and advanced paradigms, architectures, and analytical methodologies are necessary. Biomedical field is one of the most popular areas that generates big data which are typically collected from multiple sources and distributed from multiple sites. Statistical and computational skills are essential to analyze and extract knowledge from massive data. This course is designed for graduate students looking to acquire additional statistical and computational concepts, theories as well as skills beyond other informatics course(s) in the BIST curriculum. The course is divided into 4 modules with each module focusing on a specialized topic in biomedical data science taught by faculty with research interests and expertise in that specific research area. The goal is to introduce students to the use of cutting edge methodologies and tools in biomedical data science that have current broad applications on processing biomedical research and health care data.

Level: Graduate

Prerequisites: (BIST 511 or BIST 6511) and (BIST 512 or BIST 6512) and (BIST 514 or BIST 6514) and (BIST 515 or BIST 6515)

Grading: Main Campus (UGrad, Grad)

Course registration restrictions:

Enrollment is limited to Graduate level students.

BIST 7610 Probability Lrg Sample Theory 3 Credits

This is a course for Ph.D students with advanced knowledge of probability, statistics, and mathematics. The class covers both advanced probability theory and basic theory of stochastic processes to facilitate research of biostatistics and biomedical sciences. For probability theory, the following topics will be taught: measures, integration, probability, large sample theory of random variables. For stochastic processes, an introduction of martingales and point processes with applications to survival analysis will be taught. Text books • A course in Large Sample Theory, Ferguson, T. S., Chapman & Hall/CRC, 1996 • Weak Convergence and Empirical Processes with Applications to Statistics, van der Vaart, A. W. and Wellner, J. A., Springer, 1996 • Probability for Statisticians, Shorack, G. R., Springer, 2000

Level: Graduate

Grading: Main Campus (UGrad, Grad)

Course registration restrictions:

Enrollment is limited to students with a program in Biostatistics, Biostatistics, Biostatistics or Biostatistics.

Enrollment is limited to Graduate level students.

BIST 7615 Advance Statistical Inference 3 Credits

This course takes an advanced approach to statistical inference with emphasis on theory and foundations. Topics covered include UMVUE, variance bounds and information inequalities, U-statistics; Bayes decisions and estimators, invariance, MLE, quasi- and conditional likelihoods, and asymptotic relative efficient estimation; empirical likelihoods, density estimation and semi-parametric methods, M-, L-, R-estimation, jackknife and bootstrap; UMP tests, UMP unbiased and similar tests, UMP invariant tests, likelihood ratio tests, asymptotic tests based on the likelihood, Bayes tests, tests in nonparametric models; asymptotic confidence sets, bootstrap confidence sets and simultaneous confidence intervals.

Level: Graduate

Prerequisites: (BIST 511 or BIST 6511)

Grading: Main Campus (UGrad, Grad)

Course registration restrictions:

Enrollment is limited to students with a program in Biostatistics, Biostatistics, Biostatistics or Biostatistics.

Enrollment is limited to Graduate level students.

Students in a Doctor of Philosophy degree may **not** enroll.

BIST 7620 Generalized Linear Model 3 Credits

The course will cover statistical methods for analyzing non normally distributed data such as proportion, count, and rate data using generalized linear models. The course will cover topics relating to estimation, inference, deviance, diagnosis using both the frequentist and Bayesian framework. The applications include two-way tables; multi-factor, multivariate-responses, variable selection, repeated measurement experiments.

Level: Graduate

Grading: Main Campus (UGrad, Grad)

Course registration restrictions:

Enrollment is limited to students with a program in Biostatistics, Biostatistics, Biostatistics or Biostatistics.

Enrollment is limited to Graduate level students.

BIST 7625 Statistical Computing 3 Credits

This course will cover a wide range of topics that are likely to be of use to a graduate student or researcher who needs to use and develop statistical methods. We will concentrate on optimization, ideas from numerical linear algebra, numerical integration and Monte Carlo Methods in R and C. It is a survey of special topics that you will find useful as you pursue PhD degrees in our Department. These include interfacing R and C, exploring methods of computational statistics, and developing strategies for tackling computational problems in statistics.

Level: Graduate

Grading: Main Campus (UGrad, Grad)

Course registration restrictions:

Enrollment limited to students in the PHD-BSTE or PHD-BSTE-SM programs.

Enrollment is limited to Graduate level students.

BIST 7630 Bayesian Inference 3 Credits

This course examines essential aspects of the Bayesian approach. It includes Bayes theorem, decision theory, likelihood principles, exchangeability, de Finetti's theorem, selection of prior distributions (conjugate, non-conjugate, reference), single-parameter models (binomial, poisson, normal), multi-parameter models (normal, multinomial, linear regression, general linear model, hierarchical regression), inference (exact, normal approximations, non-normal iterative approximations), computation (Monte Carlo, convergence diagnostics), and model diagnostics (Bayes factors, posterior predictive checks) as well as the Bayesian approaches to a variety of Biostatistics models using the inverse Bayes theorem related non-iterative sampling and MCMC.

Level: Graduate

Grading: Main Campus (UGrad, Grad)

Course registration restrictions:

Enrollment limited to students in the PHD-BSTE program.

Enrollment is limited to Graduate level students.

BIST 7635 Longitudinal Data Analysis 3 Credits

This course intends to cover the major parametric and nonparametric models, estimation methods and inferences for the analysis of longitudinal or clustered data, i.e., repeated measurements data. The main topics include most of the well-known parametric, semiparametric and nonparametric regression models and their corresponding estimation and inference procedures. The regression models include the parametric marginal models, the linear and generalized linear mixed-effects models, the partially linear semiparametric models, and the structured nonparametric regression models. The estimation and inferences include the likelihood-based procedures, the kernel and basis approximation based nonparametric smoothing methods, the resampling subject bootstrap, and the asymptotically approximated inferences for longitudinal data. The practical aspects of the course will focus on the different longitudinal/clustered data structures, model construction and interpretations, computationally feasible estimation and inference methods, and applications to real longitudinal studies. Theoretical justifications of the estimation and inference methods will be outlined to show the unique techniques of asymptotic developments for repeated measurements data. But the detailed theoretical derivations will be assigned as reading materials. Students are expected to analyze some real datasets from biomedical studies using different models, conduct sensitivity studies and interpret the results. The main objective of the course is for students to build a solid background of the regression methods for longitudinal/clustered data and be able to apply these tools in practice. The R packages for longitudinal data and smoothing methods will be used throughout the course.

Level: Graduate

Grading: Main Campus (UGrad, Grad)

Course registration restrictions:

Enrollment limited to students in the PHD-BSTE program.

Enrollment is limited to Graduate level students.

BIST 7640 Causal Inference 3 Credits

This course introduces concepts and methods for causal inference including potential outcomes, directed acyclic graphs, confounding, selection bias, propensity score methods, inverse probability weighting of marginal structural models, parametric g-formula, g-estimation of structural nested models, mediation analysis, methods to handle unmeasured confounding, and methods to deal with time-dependent confounding.

Level: Graduate

Grading: Main Campus (UGrad, Grad)

Course registration restrictions:

Enrollment limited to students in the PHD-BSTE or PHD-BSTE-SM programs.

Enrollment is limited to Graduate level students.

BIST 7645 Advanced Survival Analysis 3 Credits

The course will provide the statistical models and methods and their recent advancement in the analysis of survival data. It will be oriented toward application and interpretation of various methodologies. It includes counting processes and asymptotic theory, rank regression and the accelerated failure time model, competing risks and multistate models, correlation analysis and multivariate survival data, analysis of interval-censored failure time data, Bayesian methods, joint modeling of longitudinal data and survival data analysis.

Level: Graduate

Grading: Main Campus (UGrad, Grad)

Course registration restrictions:

Enrollment limited to students in the PHD-BSTE or PHD-BSTE-SM programs.

Enrollment is limited to Graduate level students.

BIST 7650 Semiparametric Inference 3 Credits

This course study essential aspects of parametric, semiparametric and nonparametric inferences. It includes optimality of Euclidean parameter estimation, basic properties of maximum likelihood estimate, convolution theorem, profile likelihood, Edgeworth expansion, Delta method, M-estimator, empirical process theory, weak convergence in functional space, convergence rate of general estimator, semiparametric/nonparametric efficiency, functional Delta method, density estimation, nonparametric regression (kernel method, basis method, spline method, reproducing kernel Hilbert space method), U-statistic, nonparametric maximum likelihood estimation, empirical likelihood, relative efficiency of nonparametric tests.

Level: Graduate

Grading: Main Campus (UGrad, Grad)

Course registration restrictions:

Enrollment limited to students in the PHD-BSTE or PHD-BSTE-SM programs.

Enrollment is limited to Graduate level students.

BIST 7655 Stat. Genetics Genomics 3 Credits

This is a course for both master and Ph.D students in epidemiology, statistics, medical genetics and molecular biology. It introduces probabilistic and statistical methods in analyzing genetic data arising from human and animal studies, gene mapping, molecular genetics, and DNA sequencing. Topics include basic concepts in human genetics, sampling design in human genetics, gene frequency estimation, Hardy-Weinberg equilibrium, linkage disequilibrium, association and transmission disequilibrium test studies, linkage and pedigree analysis, classical segregation analysis and ascertainment, polygenic models, complex segregation analysis, and DNA sequence data analysis.

Level: Graduate

Prerequisites: (BIST 510 or BIST 6510) and (BIST 511 or BIST 6511)

Grading: Main Campus (UGrad, Grad)

Course registration restrictions:

Enrollment is limited to students with a program in Biostatistics, Biostatistics, Biostatistics or Biostatistics.

Enrollment is limited to Graduate level students.

BIST 7660 Deep LearningArtificial Intel 3 Credits

This course is a resource intended to help Biostatistics PhD students better understand the field of machine learning in general and deep learning in particular. In this course, we study the theory of deep learning, namely of modern, multi-layered neural networks trained on big data.

Level: Graduate

Grading: Main Campus (UGrad, Grad)

Course registration restrictions:

Enrollment is limited to students with a major in Biostatistics, Biostatistics, Biostatistics or Biostatistics.

Enrollment is limited to Graduate level students.

BIST 7665 Stats Ethics Communication 1 Credit

This course offers instruction on ethical principles of statistical research and collaborative work, and effective communication in collaboration and consulting. The goals are achieved by studying better communication practices and learning the ethical side of statistical consulting and collaboration in depth. The learning process comprises class lectures, discussions, and reading assignments.

Level: Graduate

Grading: Main Campus (UGrad, Grad)

Course registration restrictions:

Students in the PHD-BSTE program may **not** enroll.

Enrollment is limited to Graduate level students.

BIST 7817 Special Topics: 1 Credit

This course is designed to enrich students' background by exposing them to advanced methodologies, cutting-edge techniques, and other material not generally covered in regular curriculum. Examples include (but not limited to): adaptive design of clinical trials, Bayesian analysis, spline regression, meta-analysis. Students will be involved in both theory and hands-on exercises. Prerequisites: BIST 510, 511, 515 or Instructor's permission.

Level: Graduate

Grading: Main Campus (UGrad, Grad)

Course registration restrictions:

Enrollment is limited to Graduate level students.

BIST 7818 Special Topics II 1 Credit

Statistical analysis of data sets with missing values. Pros and cons of standard methods such as complete-case analysis, imputation. Likelihood-based inference for common statistical problems when data are missing, including regression, repeated-measures analysis, contingency table analysis. Selection and pattern-mixture models for nonrandom nonresponse. We will review computational tools include the EM algorithm and extensions, the Gibbs' sampler and multiple imputation.

Level: Graduate

Prerequisites: (BIST 817 or BIST 7817)

Grading: Main Campus (UGrad, Grad)

Course registration restrictions:

Enrollment is limited to Graduate level students.

BIST 7940 Research Practicum I 1 Credit

Students will be involved in a research project under the supervision of a faculty member. While the consulting class will expose them to short-term projects, the practicum will provide them with an opportunity to implement a combination of the skills they have acquired and to extend them in a limited context. This practical experience should span 3-4 months. The project will be written up as a Master's paper including the following sections: background to the problem, experimental design, description of the data, analytical methods, results, and interpretation of the latter. This paper will be defended orally, after no fewer than two faculty members (the advisor and one other) have read it and deemed it ready for presentation.

Level: Graduate

Grading: Main Campus (UGrad, Grad)

Course registration restrictions:

Enrollment is limited to Graduate level students.

BIST 7941 Research Practicum II 1 Credit

Students will be involved in a research project under the supervision of a faculty member. While the consulting class will expose them to short-term projects, the practicum will provide them with an opportunity to implement a combination of the skills they have acquired and to extend them in a limited context. This practical experience should span 3-4 months. The project will be written up as a Master's paper including the following sections: background to the problem, experimental design, description of the data, analytical methods, results, and interpretation of the latter. This paper will be defended orally, after no fewer than two faculty members (the advisor and one other) have read it and deemed it ready for presentation.

Level: Graduate, Undergraduate

Grading: Main Campus (UGrad, Grad)

Course registration restrictions:

Enrollment is limited to Graduate level students.

BIST 9994 Continuous Registration

Level: Graduate, Undergraduate

Grading: No Grade

Course registration restrictions:

Enrollment is limited to Graduate level students.

BIST 9999 Thesis Research

Thesis Research

Level: Graduate

Grading: No Grade

Course registration restrictions:

Enrollment is limited to Graduate level students.

BIST 7942 BIST Independent Study 1-4 Credits

This course requires department permission.

Level: Graduate

Grading: Main Campus (UGrad, Grad)

Course registration restrictions:

Enrollment is limited to Graduate level students.

BIST 7950 BIST Internship 0.25 Credits

Level: Graduate

Grading: Main Campus (UGrad, Grad)

Course registration restrictions:

Enrollment is limited to Graduate level students.

BIST 9001 Tutorial: Biostatistics 1-3 Credits

Level: Graduate, Undergraduate

Grading: Main Campus (UGrad, Grad)

Course registration restrictions:

Enrollment is limited to Graduate level students.

BIST 9991 Continuous Registration

Level: Graduate, Undergraduate

Grading: No Grade

Course registration restrictions:

Enrollment is limited to Graduate level students.

BIST 9992 Continuous Registration

Level: Graduate, Undergraduate

Grading: No Grade

Course registration restrictions:

Enrollment is limited to Graduate level students.

BIST 9993 Continuous Registration

Level: Graduate, Undergraduate

Grading: No Grade

Course registration restrictions:

Enrollment is limited to Graduate level students.