GSPH Course Descriptions
December 03, 2018

BIOST 2000 TEACHING PRACTICUM **Credit(s): 03.0**

THIS COURSE WILL PROVIDE DOCTORAL STUDENTS WITH AN OPPORTUNITY TO OBTAIN TEACHING EXPERIENCE. THIS COURSE IS INTENDED FOR DOCTORAL STUDENTS DURING THEIR DISSERTATION STAGE. TEACHING EXPERIENCE WILL ENHANCE THE PROFESSIONAL GROWTH OF STUDENTS. STUDENTS WILL FURTHER DEVELOP ORAL AND WRITTEN COMMUNICATION SKILLS AND AN ART FOR EXPLAINING MATERIAL, WHICH IS AN INTEGRAL PART OF A BIOSTATISTICIAN'S CAREER.

BIOST 2011 PRINCIPLS STATISTICAL REASNING - RECITATION **Credit(s): 00.0**

CLASSROOM INSTRUCTION USUALLY ASSOCIATED WITH A LECTURE WHICH FACILITATES INTERACTION BETWEEN THE STUDENT AND THE INSTRUCTOR.

RECITATON for BIOST 2011 effective 2016, Term 2171.
(When enrolling in BIOST 2011 you will also enroll in one of the required Recitations)

BIOST 2011 PRINCIPLS STATISTICAL REASNING **Credit(s): 03.0**

ACQUAINTS STUDENTS WITH THE CONCEPTS OF STATISTICAL REASONING AS APPLIED TO THE STUDY OF PUBLIC HEALTH PROBLEMS. STUDENTS LEARN THE GENERAL PRINCIPLES OF STATISTICAL ANALYSIS AND ACQUIRE THE ABILITY TO UTILIZE A STATISTICAL SOFTWARE PACKAGE (MINITAB) AS A TOOL TO FACILITATE THE PROCESSING, EDITING, STORING, DISPLAYING, ANALYSIS AND INTERPRETATION OF HEALTH RESEARCH RELATED DATA.
[Effective 2016, Term 2161: When enrolling in BIOST 2011 you will also enroll in one of the required Recitations.]

BIOST 2015 ELEMENTS STATISTICAL LEARNING **Credit(s): 03.0**

THE PURPOSE OF THE COURSE IS TO PRESENT IN THOROUGH FASHION THE MATERIAL IN AN OUTSTANDING BOOK, ELEMENTS OF STATISTICAL LEARNING BY HASTIE, TIBSHIRANI, AND FRIEDMAN. THIS RIGOROUS AND CLEARLY WRITTEN BOOK PLACES "STATISTICAL LEARNING" OR "DATA MINING" TECHNIQUES IN THE PROPER CONTEXT WITH REGARD TO THEIR ORIGINS IN SIMPLE CLASSICAL METHOS LIKE LINEAR REGRESSION, TO CLARIFY THE STRENGTHS AND WEAKNESSES FROM THEORETICAL AND PRACTICAL SIDES. "SUPERVISED LEARNING" TECHNIQUES STUDIED INCLUDE USING REGULARIZATION AND BAYESIAN METHOS, KERNEL METHODS, BASIS FUNCTION METHODS, NEURAL NETOWRKS, SUPPORT VECETOR MACHINES, ADDITIVE TREES, BOOSTING BOOTSTRAP-BASED METHODS. UNSUPERVISED LEARNING TECHNIQUES STUDIED INCLUDE CLUSTER ANALYSIS, SELF-ORGANIZING MAPS, INDEPENDENT COMPONENT ANALYSIS AND PROJECTION PURSUIT.

BIOST 2016 SAMPLING DESIGN AND ANALYSIS **Credit(s): 02.0**

Prerequisite(s): BIOST 2011 or BIOST 2039 or BIOST 2041

This is an applied statistical methods course designed to provide students with a working knowledge of introductory and intermediate-level sample designs and associated methods of statistical analysis along with a basic understanding of the theoretical underpinnings. Emphasis is placed on sampling human populations in large communities. Students will also learn statistical software used in survey data analysis, including sample selection and survey procedures in the STATA software package. Lecture topics include: simple probability samples, stratified sampling, ratio and regression estimation, cluster sampling, sampling with unequal probabilities, variance estimation and weighting in complex surveys, two-phase sampling, estimating population size and estimation of rare populations and small areas. The course will consist of one weekly 2-hour lecture and one class devoted to student presentations related to a term project assigned at midterm.

[Rev spring 2019, term 2194: Pre-reqs--BIOST 2011 or BIOST 2039 or 2041 (2039 replaces 2093).]

[Revised fall 2018, term 2191; description; credit decrease; description.]

BIOST 2021 SPECIAL STUDIES **Credit(s): 01.0 to 15.0**

QUALIFIED STUDENTS MAY UNDERTAKE ADVANCED WORK OR RESEARCH WITH THE APPROVAL AND UNDER THE GUIDANCE OF A MEMBER OF THE STAFF.

BIOST 2025 BIOSTATISTICS SEMINAR **Credit(s): 01.0**

BIOMETRY SEMINARS INTRODUCE THE STUDENTS TO CURRENT HEALTH PROBLEMS INVOLVING THE APPLICATION AND DEVELOPMENT OF BIOSTATISTICS METHODS AND THEORY.

BIOST 2039 BIOSTATISTICAL METHODS **Credit(s): 03.0**

This course is an introductory biostatistics methods course for biostatistics graduate students, other quantitative public health students, and health career professionals who will make use of statistical methods in research projects, interpreting literature and possibly develop new biostatistical methods in the future. This class is intended for students needing a more research-oriented approach than that provided in BIOST 2011 and an approach with a greater emphasis on mathematical foundation than provided in BIOST 2041. Students in BIOST 2039 are expected to have a working knowledge of calculus, including multivariable differentiation and integration. Topics covered in this course include exploratory and descriptive analyses, probability, estimation and hypothesis testing. One and two sample problems will be considered for both continuous and discrete variables. ANOVA, regression, correlation and nonparametric methods will be discussed. R will be used extensively for data analysis.

[New course for fall 2018, term 2191.]

BIOST 2040 ELEMENTS OF STOCHASTIC PROCESSES **Credit(s): 03.0**

Prerequisite(s): College Calculus and BIOST 2043

COVERS GENERATING FUNCTIONS AND CONVOLUTIONS OF RANDOM VARIABLES, THE POISSON AND COMPOUND POISSON DISTRIBUTIONS, BRANCHING PROCESSES, RANDOM WALK, AND THE GAMBLER'S RUIN PROBLEM, MARKOV CHAINS, AND SIMPLE BIRTH AND DEATH PROCESSES.

BIOST 2041 INTRO TO STATISTICAL METHODS 1 **Credit(s): 03.0**

DISCUSSES TECHNIQUES FOR THE APPLICATION OF STATISTICAL THEORY TO ACTUAL DATA. TOPICS INCLUDE PROBABILITY THEORY, ESTIMATION OF PARAMETERS, AND TESTS OF HYPOTHESIS FOR BOTH THE DISCRETE AND CONTINUOUS CASE.

(Effective fall 2015, term 2161: When enrolling in BIOST 2041 you will also enroll in a required Recitation.)

BIOST 2041 INTRO TO STATISTICAL METHODS 1 - RECITATION **Credit(s): 00.0**

CLASSROOM INSTRUCTION USUALLY ASSOCIATED WITH A LECTURE WHICH FACILITATES INTERACTION BETWEEN THE STUDENT AND THE INSTRUCTOR.

[RECITATION for BIOST 2041, effective fall 2015, term 2161:
You will also enroll in the required Recitation.)

BIOST 2043 INTRO TO STATISTICAL THEORY 1 **Credit(s): 03.0**

Prerequisite(s): College Calculus

COVERS JOINT, MARGINAL, AND CONDITIONAL PROBABILITIES; DISTRIBUTIONS OF RANDOM VARIABLES AND FUNCTIONS OF RANDOM VARIABLES; EXPECTATIONS OF RANDOM VARIABLES AND MOMENT GENERATING FUNCTIONS; LAW OF LARGE NUMBERS; CENTRAL LIMIT THEOREM.

BIOST 2044 INTRO TO STATISTICAL THEORY 2 **Credit(s): 03.0**

Prerequisite(s): BIOST 2043

COVERS ELEMENTS OF STATISTICAL INFERENCE; SAMPLING DISTRIBUTIONS OF ESTIMATORS; RAO-CRAMER'S INEQUALITY; PROBLEMS OF TESTING STATISTICAL HYPOTHESES; NEYMAN-PEARSON LEMMA; LIKELIHOOD RATIO TESTS.

BIOST 2049 APPLIED REGRESSION ANALYSIS **Credit(s): 03.0**

Prerequisite(s): BIOST 2039 or 2041

This is an introductory course in statistical modelling intended for Masters or PhD students in biostatistics or other disciplines who have already had basic training in statistical methods. The course focuses on all types of regression methods with the following learning objectives:

•To fit and interpret linear regression models with multiple continuous and/or categorical predictors
•To fit and interpret generalized linear models (GLMs) with emphasis on logistic and Poisson regression.
•To justify and apply standard modelling procedures using data, including model interpretation and assessment of model adequacy.
•To analyze data sets taken from the fields of medicine and public health.
•To develop oral and written communication skills through the description of analytic strategies and the summarization and interpretation of results.

[Effective Spring term 2194: Co-req of BIOST 2042 removed--Pre-reqs BIOST 2039 or BIOST 2041.
Also revised course description.]

BIOST 2050 LONG AND CLUSTERED DATA ANALYS **Credit(s): 02.0**

Prerequisite(s): BIOST 2049

This introductory course in statistical modeling is intended for MS students in biostatistics and PhD students in biostatistics or epidemiology in their second year of graduate work. This course may be thought of as the third methods course in Biostatistics following BIOST 2041/2048 and BIOST 2049. The course focuses on regression methods for the analysis of longitudinal or more generally clustered data with emphasis on generalized estimating equation. The course objectives are to introduce generalized estimating equations (GEEs), mixed models, and generalized linear mixed models from an applied perspective to analyze longitudinal and clustered data, to understand the justification and applicability of standard procedures to standard problems, including model interpretation and assessment of model adequacy.

[New course for fall 2018, term 2191.]

BIOST 2051 STATISTICAL ESTIMATION THEORY **Credit(s): 03.0**

Prerequisite(s): BIOST 2039 and BIOST 2044

FISHER'S INFORMATION; RAO-CRAMER INEQUALITY AND SUFFICIENT STATISTICS; BHATTACHARYYA BOUNDS; RAO-BLACKWELL THEOREM; METHODS OF MOMENTS; THE METHOD OF MAXIMUM LIKELIHOOD; NEWTON-RAPHSON METHOD AND RAO'S SCORING FOR PARAMETERS; ESTIMATION OF SEVERAL PARAMETERS; ORDER STATISTICS AND LIFE-TESTING PROBLEMS; ESTIMATION WITH CENSORED DATA AND SURVIVAL ANALYSIS.

(Eff spring 2019, term 2194: Pre-reqs BIOST 2039(replaces 2042) and BIOST 2044.]

BIOST 2052 MULTIVARIATE ANALYSIS **Credit(s): 03.0**

Prerequisite(s): BIOST 2044

MULTIVARIATE NORMAL DISTRIBUTION, ESTIMATION OF THE MEAN VECTOR AND COVARIANCE MATRIX, DISTRIBUTIONS AND USES OF SIMPLE, PARTIAL AND MULTIPLE CONCLATION CORRELATION COEFFICIENTS, THE GENERALIZED T2 STATISTIC, THE DISTRIBUTION OF THE SAMPLE GENERALIZED VARIANCE, MULTIVARIATE ANALYSIS OF VARIANCE AND THE MULTIVARIATE BEHRENS-FISHER PROBLEM. MULTIVARIATE METHODS ARE APPLIED TO REPEATED MEASURES ANALYSIS, FACTOR ANALYSIS, AND DISCRIMINANT ANALYSIS. THE BEGINNING OF THE COURSE EMPHASIZES THEORY. LATER APPLICATIONS AND COMPUTATIONAL METHODS ARE EMPHASIZED. LECTURES ARE OF CURRENT AND CLASSICAL LITERATURE. Prerequisite: Biost 2044 or permission of instructor.

BIOST 2054 SURVIVAL ANALYSIS **Credit(s): 03.0**

Prerequisite(s): BIOST 2039 and BIOST 2044

INTRODUCES THE STUDENT TO THE DESIGN CONSIDERATIONS AND STATISTICAL ANALYSIS OF CLINICAL TRIALS. COVERS THE THEORETICAL ASPECTS OF VARIOUS MODELS IN RELIABILITY THEORY AND THE PROPORTIONAL HAZARDS MODEL, AS WELL AS THE MORE APPLIED PROBLEMS OF INTERPRETING SPECIFIC DATA SETS AND DESIGNING LARGE-SCALE TRIALS.

[Effective Spring term 2194: Pre-reqs BIOST 2039(replaces 2042) and 2044.]

BIOST 2055 INTROD GNOMC ANAL 1: APPLCS **Credit(s): 03.0**

Prerequisite(s): BIOST 2039

THIS 3-CREDIT COURSE IS A GRADUATE LEVEL INTRODUCTION AND OVERVIEW OF MODERN HIGH-THROUGHPUT GENOMIC DATA ANALYSIS. IT IS DESIGNED FOR GRADUATE STUDENTS IN BIOSTATISTICS AND HUMAN GENETICS WHO ARE INTERESTED IN THE TECHNOLOGY AND ELEMENTARY DATA MINING OF HIGH-THROUGHPUT GENOMIC DATA (INCLUDING BUT NOT LIMITED TO CLASSICAL EXPRESSION ARRAYS, VARIOUS ARRAY-BASED APPLICATIONS, NEXT-GENERATION SEQUENCING AND PROTEOMICS). THE COURSE IS ALSO HELPFUL FOR BIOLOGY STUDENTS WITH BASIC QUANTITATIVE TRAINING (E.G. TWO ELEMENTARY STATISTICS COURSES AND R PROGRAMMING) WHO HAVE INTERESTS IN UNDERSTANDING THE INTUITION AND LOGIC UNDERLYING THE DATA ANALYSIS METHODS. R IS THE MAJOR LANGUAGE USED IN THE COURSE.

[Eff spring 2019, term 2194: Pre-req BIOST 2039(replaces 2042).]

BIOST 2056 INTRO TO DIAG TEST EVAL & ROC **Credit(s): 03.0**

Prerequisite(s): BIOST 2039 and BIOST 2044

THE COURSE OFFERS AN INTRODUCTION TO CONCEPTS AND APPROACHES FOR STATISTICAL ASSESSMENT OF DIAGNOSTIC SYSTEMS AND ROC ANALYSIS. THE COVERED MATERIAL INCLUDES DIFFERENT MEASURES OF DIAGNOSTIC ACCURACY, ASPECTS OF THE DESIGN OF ACCURACY STUDIES, STATISTICAL ESTIMATION AND HYPOTHESIS TESTING, SAMPLE SIZE CALCULATION AND SOME ADVANCED TOPICS. GENERAL PREREQUISITES INCLUDE KNOWLEDGE OF BASIC STATISTICAL CONCEPTS AND APPROACHES RELATED TO ESTIMATION AND HYPOTHESIS TESTING; SOME KNOWLEDGE OF REGRESSION MODELING AND SAS IS DESIRABLE.

[Eff spring 2019, term 2194: Pre-reqs BIOST 2039 and 2044.]
(replacing pre-reqs BIOST 2041, 2042, 2043, 2044.]

BIOST 2058 SCIENTFC COMMUNICATION SKILLS **Credit(s): 02.0**

THIS COURSE IS MEANT TO HELP STUDENTS DEVELOP ORAL, VISUAL AND WRITTEN SCIENTIFIC COMMUNICATION SKILLS AND TO FAMILIARIZE STUDENTS WITH RESEARCH RESOURCES. STUDENTS MAY USE THEIR OWN RESEARCH TOPIC, INCLUDING WORK ON A THESIS OR DISSERTATION, OR HELP WILL BE PROVIDED IN SELECTING ONE.

BIOST 2059 CONSTRNTD STATCL INFRN APPLCS **Credit(s): 02.0**

Prerequisite(s): BIOST 2044 and BIOST 2049

This is an applied biostatistics course for biostatistics graduate students, other quantitative public health students, and health career professionals who will make use of statistical methods in research projects and possibly develop new biostatistical methods in the future. While this course is intended to be an application oriented course motivated by real scientific problems, it will rely on some statistical theory. Students are expected to have basic understanding of statistical theory at the level of BIOST 2044 (Introduction to Statistical Theory 2) and have applied analysis skills at the level of BIOST 2049 (Applied Regression Analysis). Additionally, students are expected to have working knowledge of the programming language R. Topics covered in this course include: (a) Brief review of some important concepts from BIOST 2043, BIOST 2044 and BIOST 2049, such as parametric and nonparametric estimation and testing of hypotheses, linear fixed and mixed effects models, best linear unbiased predictor (BLUP) and generalized linear models. (b) Some real world motivating examples of various types of constraints on parameter spaces. Reasons for constrained inference. (c) Estimation of parameters and testing of hypotheses under inequality constraints in a variety of settings - challenges and solutions. Various estimation and testing procedures such as Pool Adjacent Violators Algorithm (PAVA), Restricted Maximum Likelihood Estimation (RMLE), Isotonic Regression, Likelihood Ratio Test (LRT), Williams' test, Dunnett's test, Jonckheere-Terpstra test. Substantial reduction in samples sizes and gain in power when using constrained inference based methods in comparison to standard methods. (e) Resampling methods for constrained inference, why they fail for confidence intervals but are suitable for some testing problems. (f) Nonparametric problems - various notions of orderings of random variables, univariate and multivariate analysis. (g) Applications in clinical trials, toxicology, high dimensional gene expression studies, microbiome, cell-cycle and circadian clock.

[New course spring 2019, term 2194.]

BIOST 2061 LIKELIHOOD THEORY & APPLICATN **Credit(s): 02.0**

Prerequisite(s): BIOST 2044

THE PURPOSE OF THIS COURSE IS TO INTRODUCE THE STUDENT TO MODERN LIKELIHOOD THEORY AND ITS APPLICATIONS. THE COURSE WILL COVER MAXIMUM LIKELIHOOD THEORY, PROFILE LIKELIHOOD THEORY, PSEUDO LIKELIHOOD THEORY AND GENERALIZED ESTIMATING EQUATIONS. THE COURSE IS TAUGHT AT A DOCTORAL LEVEL AND MUCH OF THE THEORY IS ILLUSTRATED THROUGH APPLICATIONS.

BIOST 2062 CLINICAL TRIALS: METHDS & PRACT **Credit(s): 03.0**

Prerequisite(s): BIOST 2039 and BIOST 2093

COURSE CONSISTS OF TWO WEEKLY LECTURES, POSTED ON THE WEB IN ADVANCE, AND TWO IN-CLASS SESSIONS WHICH CONSIST OF QUESTIONS AND ANSWERS RELATED TO THE WEB-BASED INFORMATION, PROBLEM-SOLVING, OR DISCUSSION OF CASE STUDIES. IT COVERS FUNDAMENTAL CONCEPTS IN THE DESIGN AND CONDUCT OF MODERN CLINICAL TRIALS. TOPICS INCLUDE: EXPERIMENTAL DESIGNS FOR SAFETY AND EFFICACY TRIALS, QUANTITATIVE METHODS FOR DESIGN, INTERIM MONITORING, AND ANALYSIS OF RANDOMIZED COMPARATIVE CLINICAL TRIALS INCLUDING CROSSOVER, FACTORIAL AND EQUIVALENCE DESIGNS. ETHICAL, ORGANIZATIONAL, AND PRACTICAL CONSIDERATIONS OF DESIGN AND CONDUCT OF SINGLE AND MULTICENTER STUDIES ARE INTEGRATED IN LECTURES AND CASE STUDIES. THE COURSE ALSO COVERS INTERNATIONAL GUIDELINES ON STATISTICAL CONSIDERATIONS FOR DRUG DEVELOPMENT, GUIDELINES ADOPTED FOR PUBLICATION OF TRIALS IN MAJOR MEDICAL JOURNALS, AND RECOMMENDED APPROACHES FOR META-ANALYSES.

[Effective Spring term 2194: Pre-requisite of BIOST 2039(replaces 2042) and BIOST 2093.]

BIOST 2063 BAYESIAN DATA SCIENCE **Credit(s): 03.0**

Prerequisite(s): (BIOST 2039 or BIOST 2041) and BIOST 2049

This is a course in Bayesian methods for applied statistics and data science whose broad goal is to provide students with the skills needed to be able to select, conduct, report and interpret appropriate Bayesian analyses for a wide variety of applied problems. General topics covered include Bayesian concepts of statistical inference, Markov chain Monte Carlo and other computational methods, linear, hierarchical and generalized linear models, model selection and diagnostics, and Bayesian learning. The course explores the use of the popular and free software packages R, JAGS and Stan for conducting Bayesian analyses.

[Effective spring 2019, term 2194: title, course description, pre-req changes.]
[Pre-reqs 2039(replaces 2042) or 2041 and 2049--removing 2044.]

BIOST 2065 ANALYSIS OF INCOMPLETE DATA **Credit(s): 03.0**

Prerequisite(s): BIOST 2049 and BIOST 2051 and BIOST 2061

THIS COURSE WILL PRESENT MISSING DATA PROBLEMS IN STATISTICS AND DISCUSS NAÏVE METHODS SUCH AS COMPLETE CASE ANALYSIS, AVAILABLE CASE ANALYSIS AND IMPUTATION; STANDARD LIKELIHOOD-BASED METHODS, THEORY AND APPLICATION OF MULTIPLE IMPUTATION, DATA AUGMENTATION, GIBBS SAMPLER, AND SOME RECENTLY DEVELOPED METHODOLOGIES IN THE MISSING DATA LITERATURE AND RELATED FIELDS.

BIOST 2066 APLD SURVIVAL ANAL METHS & PRA **Credit(s): 02.0**

Prerequisite(s): BIOST 2049

THIS COURSE COVERS FUNDAMENTAL CONCEPTS AND METHODS IMPORTANT FOR ANALYSIS OF DATASETS WHERE THE OUTOME IS THE TIME TO AN EVENT OF INTEREST, SUCH AS DEATH, DISEASE OCCURRENCE OR DISEASE PROGRESSION. TOPICS INCLUDE: BASIC METHODS FOR SUMMARIZING AND PRESENTING TIME-TO-EVENT DATA IN TABULAR FORM AND GRAPHICALLY AS LIFE TABLES, NON-PARAMETRIC STATISTICAL TECHNIQUES FOR TESTING HYPOTHESES COMPARING LIFE TABLES FOR TWO OR MORE GROUPS; APPROACHES TO FITTING THE SEMI-PARAMETRIC COX PROPORTIONAL HAZARD MODEL AND OTHER COMMONLY USED PARAMETRIC MODELS THAT INCORPORATE STUDY COVARIABLES, METHODS FOR ASSESSING GOODNESS-OF-FIT OF THE MODELS, AND SAMPLE SIZE CONSIDERATIONS. IN ADDITION TO DIDACTIC LECTURES, THERE ARE GROUP PROJECTS THAT INVOLVE ANALYSIS OF DATASETS AND PRESENTATION OF ANALYTIC REPORTS IN THE CLASSROOM.

[Revised fall 2018, term 2191; credit decrease.]

BIOST 2077 SPECIAL TOPICS **Credit(s): 03.0**

INTRODUCES THE STUDENT TO SPECIALIZED TOPICS IN BIOSTATISTICS THAT ARE NOT COVERED IN THE FORMAL CURRICULUM.

BIOST 2078 HIGH-DIM DATA WITH OMICS APPL **Credit(s): 02.0**

Prerequisite(s): BIOST 2039 and BIOST 2043

This 2-credit course is a graduate level course to introduce theories and algorithms for statistical analysis of high-throughput genomic data. Emphases will be given to high-dimensional data analysis and theories behind the commonly used methods. This course is designed for graduate students who already have sufficient statistical background, have basic knowledge of various high-throughput genomic experiments (e.g. already finished BIOST 2055 or MSCBIO 2070) and wish to learn advanced statistical theories for bioinformatics and genomics research. Students are expected to have programming experiences in R (e.g. BIOST 2094) or in other low-level languages such as C, C++, Java and Fortran. The course will meet four hours per week for half a semester.

[Eff spring 2019, term 2194: Pre-reqs BIOST 2039(replaces 2041) and 2043.]

[Revised course spring 2018, term 2184; title, credit, description.]

BIOST 2081 MATHEMATICAL METHODS FOR STAT **Credit(s): 03.0**

DIFFERENTIATION AND INTEGRATION OF FUNCTIONS OF SEVERAL VARIABLES. INFINITE SEQUENCES AND SERIES. FUNDAMENTALS OF MATRIX ALGEBRA. CLASS EXAMPLES AND HOMEWORK PROBLEMS WILL EMPHASIZE APPLICATIONS TO PROBABILITY AND STATISTICS.

(Enrollment requirement: Biostatistics (PhD; MPH; MS) effective fall 2015, term 2161.)

BIOST 2083 LINEAR MODELS **Credit(s): 03.0**

Prerequisite(s): BIOST 2044

ACQUAINTS STUDENTS WITH LINEAR MODEL TECHNIQUES FOR ANALYZING BOTH BALANCED AND UNBALANCED DATA. THE TOPICS COVERED INCLUDE GENERALIZED INVERSES, ORTHOGONAL CONTRASTS WITH UNBALANCED DATA, AND ANALYSIS OF COVARIANCE. ANALYSIS WITH COMPUTER PACKAGED PROGRAMS IS DISCUSSED.

BIOST 2086 APPLIED MIXED MODELS ANALYSIS **Credit(s): 03.0**

Prerequisite(s): BIOST 2083

MIXED MODEL ANALYSIS PROVIDES A NEW APPROACH TO MODELING WHICH ALLOWS ONE TO RELAX THE USUAL INDEPENDENCE ASSUMPTIONS AND TAKE INTO ACCOUNT COMPLICATED DATA STRUCTURES. THIS COURSES WILL CONSIDER ALL TYPES OF MIXED MODELS INTO A GENERAL FRAMEWORK AND CONSIDER THE PRACTICAL IMPLICATIONS OF THEIR USE. TOPICS WILL INCLUDE: NORMAL MIXED MODELS, GENERALIZED MIXED MODELS, AND MIXED MODELS FOR CATEGORICAL DATA, REPEATED MEASURES DATA ANALYSIS AND CROSS-OVER TRIALS WITH MIXED MODELS. SOFTWARE FOR FITTING MIXED MODELS WILL BE DISCUSSED.

BIOST 2087 BIOST CONSULTING PRACTICUM **Credit(s): 01.0**

PROVIDES ADVANCED STUDENTS (SECOND-YEAR MASTERS AND DOCTORAL) WITH EXPOSURE AND PRACTICAL EXPERIENCE IN CONSULTING ON THE BIOSTATISTICAL ASPECTS OF RESEARCH PROBLEMS ARISING IN THE BIOMEDICAL OR OTHER ALLIED FIELDS. STUDENTS INITIALLY UNDER THE SUPERVISION OF A FACULTY MEMBER PARTICIPATE IN DISCUSSIONS WITH INVESTIGATORS LEADING TO THE DESIGN AND/OR ANALYSIS OF A CURRENT RESEARCH PROBLEM.

BIOST 2087 BIOST CONSULTING PRACTICUM - LAB **Credit(s): 00.0**

LABORATORY

BIOST 2093 SAS DATA MANAGEMENT & ANALYSIS **Credit(s): 02.0**

Prerequisite(s): BIOST 2039

THE GOAL OF THIS COURSE IS TO PROVIDE STUDENTS WITH AN UNDERSTANDING OF THE SAS PROGRAM ENVIRONMENT AS WELL AS THE SKILLS NEEDED TO USE SAS AS A TOOL TO CONDUCT RESEARCH, PREPARE DATA, AND PERFORM ANALYSES. UPON COMPLETION OF THE COURSE THE STUDENT WILL HAVE AN UNDERSTANDING OF SAS AT THE INTERMEDIATE LEVEL. THE COURSE COVERS THE UTILITY OF SAS AS A DATA MANAGEMENT, DATA MANIPULATION, AND DATA ANALYSIS TOOL. THE FOCUS WILL NOT BE STATISTICAL ANALYSIS, BUT RATHER HOW TO USE SAS AS A PROGRAMMING TOOL. EMPHASIS WILL BE PLACED ON PROGRAM CODE WRITING. CONCEPTS WILL BE ILLUSTRATED WITH NUMEROUS EXAMPLES FROM BASIC DESCRIPTIVE ANALYSIS.
(Note: Students should have a basic understanding of the PC computer environment with some exposure to the Windows operating system.)

[Effective Spring term 2194: Co-req of BIOST 2039(replaces 2041).]

BIOST 2094 ADVANCED R COMPUTING **Credit(s): 02.0**

Prerequisite(s): BIOST 2039 and BIOST 2043

An advanced statistical computing course using R designed for graduate level biostatistics students with programming experience in R or other low-level languages such as C, C++, Java, and/or Fortran. Experience in SAS and/or Stata does not qualify. The course will cover topics, including but not limited to, R in modeling and optimization, advanced R graphics, functional programming, object-oriented field guide, efficient computing in R, GUI for R-shiny, embedding C/C++, R package/documentation, Julia, Github etc. The course will also include real life application for students to practice the programming techniques learned in class.

[Eff spring 2019, term 2194; Pre-reqs BIOST 2039(replacing 2041) and BIOST 2043.]

[Revised course: for biost students; title, course description, pre-reqs changed, effective 4/30/17.]

[Effective Spring term 2194: Pre-req changed from BIOST 2041 to BIOST 2039; pre-req BIOST 2043 remains unchanged.]

BIOST 2096 NUMERICAL METHODS IN BIOSTATISTICS **Credit(s): 03.0**

Prerequisite(s): BIOST 2044 and BIOST 2049

THE PURPOSE IS TO FAMILIARIZE STUDENTS WITH A BROADER RANGE OF NUMERICAL METHODS WHICH ARE USEFUL IN BIOSTATISTICAL RESEARCH. SELECTED COMPUTATIONAL TECHNIQUES USED IN STATISTICAL RESEARCH WILL BE COVERED. SOME BACKGROUND WILL BE PROVIDED TO FACILITATE UNDERSTANDING OF A FEW NUMERICAL ALGORITHMS WIDELY USED IN STATISTICS. THE FOLLOWING ARE COVERED: RECURRENCE RELATIONS, POWER SERIES AND ASYMPTOTIC EXPANSIONS, GENERATING PSEUDO-RANDOM DEVIATES, BASIC SIMULATION METHODOLOGY, SOLUTIONS OF NONLINEAR EQUATIONS, NEWTON'S METHOD, VECTOR AND MATRIX NORMS, LINEAR REGRESSION AND MATRIX INVERSION.

BIOST 3010 RESEARCH AND DISSERTATION PHD **Credit(s): 01.0 to 15.0**

DISSERTATION CREDITS FOR QUALIFIED DOCTORAL STUDENTS IN THE DEPARTMENT OF BIOSTATISTICS.

FTDR 3999 FULL-TIME DISSERTATION RESEARCH **Credit(s): 00.0**

DOCTORAL CANDIDATES WHO HAVE COMPLETED ALL CREDIT REQUIREMENTS FOR THE DEGREE, INCLUDING ANY MINIMUM DISSERTATION REQUIREMENTS, AND ARE WORKING FULL-TIME ON THEIR DISSERTATIONS MAY REGISTER FOR THIS COURSE. WHILE THE COURSE CARRIES NO CREDITS AND NO GRADE, STUDENTS WHO ENROLL IN "FULL-TIME DISSERTATION STUDY" ARE CONSIDERED BY THE UNIVERSITY TO HAVE FULL-TIME REGISTRATION STATUS.
