**PhD Advanced Research Methods and Statistics course options**

2016-17 Handbook requirement: Students must complete a minimum of two research methods/statistics courses (3-4 units each), drawn from the following two groupings. One course must be taken from Group A and one from Group B. At least one course must be at the graduate (200) level.

2017-18 and 1018-19 proposed Handbook requirement (pending GS approval): Students must complete a minimum of three research methods/statistics courses (3-4 units each), drawn from the following three groupings. At least one course must be taken from Group A **AND** at least one from Group B. The remaining course may be taken from Group A, B, or C. In addition, at least **two courses** must be at the graduate (200) level.

**A. ANOVA, Regression, and Multivariate Analysis (for example, EDU 204A, 204B; EPI 204, 208; POL 212,213; PSC 204A, 204B; SOC 206; STA 106, 130A, B, 131A, B)**

**EDU 204A Quantitative methods in Educational Research: Experimental Designs; prereq: introductory stats or consent of instructor**

Methods for analysis of correlational data in educational research. Topics include multiple correlation and regression, discriminant analysis, logistic regression, and canonical correlation. Emphasis on conceptual understanding of the techniques and use of statistical software.

**EDU 204B**: **Quantitative methods in Educational Research: Analysis of Correlational Designs, prereq: introductory stats or consent of instructor**

Methods for analysis of experimental data in educational research. Topics include ANOVA, fixed v. random effects models, repeated measures ANOVA, analysis of co-variance, MANOVA, chi square tests, small sample solutions to t and ANOVA.

**EPI 204:** **Quantitative Epidemiology III: Statistical Models; prereq: EPI 203or STA 130B or 131B or 133)**

A basic course in Epidemiology (EPI 205 or equivalent); consent of instructor. Introduces statistical models, methods, and data analysis in the areas of generalized linear model and survival analysis methodology.

**EPI 208: Analysis and Interpretation of Epidemiologic Data; prereq: EPI 204 (can be concurrent)**

An entry level skill in standard statistical software (eg. SPSS, BMDP, SAS, Stata, MinTab, S-Plus). Application of theory and concepts of statistics and epidemiology to analysis and interpretation of data typically found in veterinary and human epidemiologic research.

**POL 212:** **Quantitative Analysis in Political Science; prereq: POL 211**

Introductory statistics course with an emphasis on applications in political science. Topics include descriptive statistics for samples, probability and probability distributions, hypothesis testing, ANOVA, bivariate regression, and introduction to multiple regression.

**POL 213:** **Quantitative Analysis in Political Science II; prereq: POL 211 and 212**

More advanced topics in the use of statistical methods, with emphasis on political applications. Topics include: properties of least squares estimates, problems in multiple regression, and advanced topics (probit analysis, simultaneous models, time-series analysis, etc.).

**PSC 204A:** **Statistical Analysis of Psych Experiments; prereq: STA 102 or consent of instructor**

Probability theory, sampling distributions, statistical inference, and hypothesis testing using standard parametric and correlational approaches. Analysis of variance, factorial and repeated measures, and tests of trends.

**PSC 204B:** **Causal Model Correlational Data; prereq: PSC 204A or consent of instructor**

Examination of how to make causal inferences from correlational data in the behavioral sciences. Emphasis is on testing rival causal models using correlations among observed variables. Beginning with multiple regression analysis, discussion advances to path analysis and related techniques.

**SOC 206: Quantitative Analysis in Sociology prereq: SOC 106**

Survey of the statistical models and methods that serve as a foundation for quantitative research in sociology, with an emphasis on multivariate regression analysis, as well as measurement theory and time series analysis. (S/U grading only.)

**STA 106: Applied Statistical Methods: Analysis of Variance; prereq: STA 13 or 32 or 100**

Basics of experimental design. One-way and two-way fixed effects analysis of variance models. Randomized complete and incomplete block design. Multiple comparisons procedures. One-way random effects model.

**STA 130A**: **Mathematical Statistics: Brief Course; prereq: MAT 16C or 17C or 21C**

Basic probability, densities and distributions, mean, variance, covariance, Chebyshev's inequality, some special distributions, sampling distributions, central limit theorem and law of large numbers, point estimation, some methods of estimation, interval estimation, confidence intervals for certain quantities, computing sample sizes.

**STA 130B**: **Mathematical Statistics: Brief Course; prereq: STA 130A or 131A or MAT 135A**

This course is a continuation of STA 130A.  It is designed to continue the integration of theory and applications, and to cover hypothesis testing, and several kinds of statistical methodology. Transformed random variables, large sample properties of estimates. Basic ideas of hypotheses testing, likelihood ratio tests, goodness-of- fit tests. General linear model, least squares estimates, Gauss-Markov theorem. Analysis of variance, F-test. Regression and correlation, multiple regression.

**STA 131A: Introduction to probability Theory; prereq: MAT 21B and 21C; MAT22A**

Fundamental concepts of probability theory, discrete and continuous random variables, standard distributions, moments and moment-generating functions, laws of large numbers and the central limit theorem.

**STA 131B: Introduction to Mathematical Statistics: prereq: STA 131A or MAT 135A**

Sampling, methods of estimation, bias-variance decomposition, sampling distributions, Fisher information, confidence intervals, and some elements of hypothesis testing.

**B. Special Quantitative Topics in Research Methods, Statistics, and Mathematical Modeling (for example, BST 222, 223, 224, 225, 226, 252; EDU 203, 236; EPI 207, 222; ESP 228; HDE 205, 298; PSC 204D, 205A,B,C,D,G; STA 137, 138, 141, 144, 145, 233, 237A,B, 240A,B, 241, 250, 251). Courses may have prerequisites or require consent of instructor. Consult with instructor before enrolling.**

**BST 222: Biostatistics: Survival Analysis; prereq: STA 131C**

Incomplete data; life tables; nonparametric methods; parametric methods; accelerated failure time models; proportional hazards models; partial likelihood; advanced topics.

**BST 223: Biostatistics: Generalized Linear Models; prereq: STA 131C**

Likelihood and linear regression; generalized linear model; Binomial regression; case-control studies; dose-response and bioassay; Poisson regression; Gamma regression; quasi-likelihood models; estimating equations; multivariate GLMs.

**BST 224: Analysis of Longitudinal Data; prereq: BST 222 or 223, or STA 222 or 223 or 232B**

Standard and advanced methodology, theory, algorithms, and applications relevant for analysis of repeated measurements and longitudinal data in biostatistical and statistical settings. (Same course as STA 224.)

**BST 225**: **Clinical Trials; prereq: BST 223 or STA 223**

Basic statistical principles of clinical designs, including bias, randomization, blocking, and masking. Practical applications of widely-used designs, including dose-finding, comparative and cluster randomization designs. Advanced statistical procedures for analysis of data collected in clinical trials. (Same course as STA 225.)

**BST 226: Statistical Methods for Bioinformatics; prereq: BST 131C**

Data analysis experience recommended. Standard and advanced statistical methodology, theory, algorithms, and applications relevant to the analysis of -omics data. (Same course as STA 226.)

**BST 252**: **Advanced Topics in Biostatistics; prereq: BST 222; BST 223**

Biostatistical methods and models selected from the following: genetics, bioinformatics and genomics; longitudinal or functional data; clinical trials and experimental design; analysis of environmental data; dose-response, nutrition and toxicology; survival analysis; observational studies and epidemiology; computer-intensive or Bayesian methods in biostatistics.

**EDU 203 Educational Test and Evaluation**

Introduces the theoretical assumptions underlying traditional test construction, as well as the basic statistical principles involved in the design, evaluation, and interpretation of standardized tests. Also introduces the debates surrounding the uses of different kinds of tests and evaluation tools.

**EDU 236 Application of Hierarchical Linear Models in Education Research; prereq: EDU 204A or equivalent**

Application of hierarchical linear models in education research across multiple areas, such as policy, curriculum, and assessment. Develop working knowledge of hierarchical linear modeling and an understanding of its use in existing research as well as student's work.

**EPI 207 Advanced Epidemiologic Methodology; prereq: EPI 206 or consent of instructor**

In-depth integration of advanced epidemiological concepts. Theory, methods, and applications for observational studies including random and systematic error, confounding, counterfactuals, causal inference, effect modification, internal and external validity, estimability, and interpretation of effect measures, and advanced study designs.

**EPI 222 Epidemiological Modeling ; prereq MPM 405**

Techniques of model building and simulation of infectious diseases will be explored. Epidemiologic modeling philosophy, construction and validation will be emphasized.

**EPI 270 Research Methods in Occupational Epidemiology; prereq: EPI 205A or MPM 205; MPM 202 or STA 102**

Methods used in epidemiologic research on occupational hazards. Topics include design and analysis of cohort and case-control studies, sample size, measuring dose, choosing a control group, validation of employment and health data, interpreting negative studies, and analysis software.

**ESP 228 Advanced Simulation Modeling; prereq: STA 108; ESP 128 and 128L**

Advanced techniques in simulation modeling; optimization and simulation, dynamic parameter estimation, linear models, error propagation, and sensitivity testing. Latter half of course will introduce model evaluation in ecological and social system models.

**HDE 205 Longitudinal Data; prereq: PSC204B or equivalent**

Introduction to longitudinal data manipulation, organization, description, and modeling in the multilevel modeling and structural equation modeling frameworks.

**HDE 298 Intensive Longitudinal Data; prereq: HDE 205, PSC 205G or equivalent**

This course is an introduction to statistical models for the analysis of intensive longitudinal data (ILD), which are repeated measures collected intensively from individuals within a relatively short period of time. Students should gain abilities related to data manipulation, organization, description, and modeling, interpretation of results, and presentation and critique of empirical research. Topics include models in the multilevel modeling, time series analysis, and structural equation modeling frameworks. Students are expected to have prior knowledge of descriptive statistics, correlation, and multiple regression.

**PSC 204D Advanced Statistical Inference from Psychological Experiments; prereq: PSC 204A or equivalent**

Advanced topics in statistical inference, which may include probability theory, sampling distributions, statistical inference and hypothesis testing, nonparametric statistics, Bayesian approaches, and advanced issues in analysis of variance

**PSC 205A Applied Multivariate Analysis of Psychological Data; prereq: 204A, B and D; or consent of instructor**

Review of the major methods of multivariate data analysis for psychological data. Students will program statistical routines using a linear algebra-based computing language. Topics will include multivariate analysis of variance. discriminant analysis, canonical analysis factor analysis, and component analysis.

**PSC 205B Factor Analysis; prereq: PSC 204A and B or equivalent; or consent of instructor**

Theory and methods of factor analysis, including exploratory factor analysis, confirmatory factor analysis, and principal component analysis

**PSC 205C Structural Equation Modeling; prereq: PSC 204A and B or consent of instructor**

Theory and methods of structural equation modeling, including path analysis, confirmatory factor analysis, multiple-group modeling and latent growth curve modeling

**PSC 205D Multilevel Models; prereq: PSC 204A or consent of instructor**

Introduction to statistical techniques for the analysis of normal, hierarchically structured data, such as cross-sectional clustered data or repeated-measures data. Topics include hierarchical linear models, latent growth curve models, and how these methods handle unbalanced and/or missing data

**PSC 205G Applied Longitudinal Data Analysis; prereq: PSC 204A**

Modeling and understanding of intraindividual change and interindividual differences in change. Reviews conventional methods and introduces contemporary techniques for modeling intraindividual change.

**STA 137 Applied Time Series Analysis; prereq STA 108 or consent of instructor**

Time series relationships; univariate time series models: trend, seasonality, correlated errors; regression with correlated errors; autoregressive models; autoregressive moving average models; spectral analysis: cyclical behavior and periodicity, measures of periodicity, periodogram; linear filtering; prediction of ti**m**e series; transfer function models.

**STA 138 Analysis of Categorical Data; prereq STA 130B or 131B; STA 106 or 108**

Varieties of categorical data, cross-classifications, contingency tables, tests for independence. Multidimensional tables and log-linear models, maximum likelihood estimation; tests of goodness-of-fit. Logit models, linear logistic models. Analysis of incomplete tables. Packaged computer programs, analysis of real data.

**STA 141A Fundamentals of Statistical Data Science;** **prereq STA 108 or 106; STA 32 or STA 100 or STA 13 or STA 13Y**

Introduction to computing for data analysis and visualization, and simulation, using a high-level language (e.g., R). Computational reasoning, computationally intensive statistical methods, reading tabular and non-standard data.

**STA 144 Sampling Theory of Survey; prereq STA 130B or 131B; STA 106 or 108**

Simple random, stratified random, cluster, and systematic sampling plans; mean, proportion, total, ratio, and regression estimators for these plans; sample survey design, absolute and relative error, sample size selection, strata construction; sampling and nonsampling sources of error.

**STA 145 Bayesian Statistical Inference; prereq STA 130B or 131B**

Subjective probability, Bayes Theorem, conjugate priors, non-informative priors, estimation, testing, prediction, empirical Bayes methods, properties of Bayesian procedures, comparisons with classical procedures, approximation techniques, Gibbs sampling, hierarchical Bayesian analysis, applications, computer implemented data analysis.

**STA 233 Design Experiments; prereq: STA 131C**

Topics from balanced and partially balanced incomplete block designs, fractional factorials, and response surfaces.

**STA 237A Time Series Analysis; prereq: STA 131B or equivalent**

Advanced topics in time series analysis and applications. Models for experimental data, measures of dependence, large-sample theory, statistical estimation and inference. Univariate and multivariate spectral analysis, regression, ARIMA models, state-space models, Kalman filtering.

**STA 237B Time Series Analysis; prereq: STA 131B or equivalent; STA 237A**

Advanced topics in time series analysis and applications. Models for experimental data, measures of dependence, large-sample theory, statistical estimation and inference. Univariate and multivariate spectral analysis, regression, ARIMA models, state-space models, Kalman filtering.

**STA 240A Nonparametric Inference; prereq:** **STA 231C; STA 235A, STA 235B, STA 235C recommended**

Comprehensive treatment of nonparametric statistical inference, including the most basic materials from classical nonparametrics, robustness, nonparametric estimation of a distribution function from incomplete data, curve estimation, and theory of resampling methodology.

**STA 240B Nonparametric Inference; prereq:** **STA 231C; STA 235A, STA 235B, STA 235C recommended**

Comprehensive treatment of nonparametric statistical inference, including the most basic materials from classical nonparametrics, robustness, nonparametric estimation of a distribution function from incomplete data, curve estimation, and theory of resampling methodology.

**STA 250 Topics in Applied and Computational Statistics; prereq: STA 131A; STA 232A recommended**

Resampling, nonparametric and semiparametric methods, incomplete data analysis, diagnostics, multivariate and time series analysis, applied Bayesian methods, sequential analysis and quality control, categorical data analysis, spatial and image analysis, computational biology, functional data analysis, models for correlated data, learning theory.

**STA 251 Topics in Statistical Methods and Models; prereq: STA 231B or the equivalent**

Topics may include Bayesian analysis, nonparametric and semiparametric regression, sequential analysis, bootstrap, statistical methods in high dimensions, reliability, spatial processes, inference for stochastic process, stochastic methods in finance, empirical processes, change-point problems, asymptotics for parametric, nonparametric and semiparametric models, nonlinear time series, robustness.

**C. Qualitative/Mixed Methods; Specialized Methods for Data (i.e. Accelerometry, Dietary Assessment, Neuroimaging, Geospatial). Courses may have prerequisites or require consent of instructor. Consult with instructor before enrolling. (for example EDU 205A,B, 238; EPI 223, 224; GGG201A, 201B, 201D; NPB 245; NUT 254; PSC 207, 210). Courses may have prerequisites or require consent of instructor. Consult with instructor before enrolling.**

**CRD 298: Spatial Methods in Community Research**

This course introduces students to the important theoretical roles that space and place have in community research. The course will also have a large analytical component, exposing students to the acquisition, management, examination, and modelling of spatial data for understanding communities. The course will focus on applications in the social sciences and public health, including demography, epidemiology, sociology, criminology, human geography, public policy, education, and others.

**EDU205A Ethnographic Research in School Settings I: Current Theory and Practice**

Emphasis on the organizational structure of institutions, and the analysis of face-to-face interaction. Will explore the relationship between field-based research and theory development on the acquisition of knowledge in specific social and cultural contexts.

**EDU205B Ethnographic Research in School Settings II: Field Based Research Projects; prereq: EDU 205A**

Student research projects in specific schools with cooperative critical analysis of the design, data collection, and inferencing by researchers.

**EDU 238 Participatory Action Research**

Principles and strategies of PAR and related methodologies that emphasize collaborating with those affected by the issue being researched in order to educate, take action or effect social change. Conduct interviews with potential collaborators, case analyses and research proposals.

**EPI 223** **Spatial Epidemiology; prereq: EPI 205A or MPM205**

Geographic Information Systems (GIS) and spatial statistics. Students are expected to complete a term project based on their graduate research

**EPI 224 Health and Ecological Risk Analysis**

Methodological approach to risk analysis for human and animal-related health and ecological issues. Basic principles of risk analysis, including perception, communication, assessment and management. Emphasis on the assessment of risk

**GGG 201A Advanced Genetic Analysis; prereq: BIS 101; STA 100**

Fundamentals of genetic analysis and chromosome structure using model organisms including mutation, transmission, complementation, suppression, and enhancement as well as epigenetic phenomena at the whole organism and molecular levels.

**GGG 201B Genomics; prereq: GGG201A; GGG 201C; or equivalents that provide a basic understanding of genetics and molecular biology; priority given to Genetics Grad Group students**

Prokaryotic and eukaryotic genomes. Experimental strategies and analytical challenges of modern genomics research and the theory and mechanics of data analysis. Structural, functional, and comparative genomics. Related issues in bioinformatics

**GGG 201D Quantitative and Population Genetics; prereq: GGG 201A**

Basic concepts of quantitative and population genetics including gene and genotypic frequencies, multiple factor hypothesis, phenotypic and genotypic values, heritability, selection, genetic variation, the detection of quantitative trait loci and evolution in populations. Experimental and analytical methods.

**NPB 245 Computational Models of Cellular Signaling; prereq: consent of instructor**

Computational and mathematical techniques in modeling of regulatory and signaling phenomena in neurobiology and cell physiology, focusing on linear and nonlinear ordinary differential equation models. Applications include ion channel kinetics, electrical activity, signal transduction, calcium oscillations, and simple neural circuits.

**NUT 254 Applications of Systems Analysis in Nutrition; prereq: NUT 202**

Quantitative aspects of digestion and metabolism; principles of systems analysis. Evolution of models of energy metabolism as applied in current feeding systems. Critical evaluations of mechanistic models used analytically in support of nutritional research

**PSC 207 Survey and Questionnaire Research Methods; no prereqs**

Survey and questionnaire research methods with emphasis on how to ask questions. Cognitive, motivational, and social processes that influence how respondents answer questions; sampling techniques; internet resources; practical aspects of fielding survey and questionnaire research.

**PSC 210 Fundamentals of Cognitive Neuroimaging**

Introduction to empirical foundations and methodology of neuroimaging, emphasizing pragmatics of functional magnetic resonance imaging (fMRI) to study cognition. Topics include MR physics, the relationship between neural activity and the BOLD response, experimental design, and analysis of fMRI data.

**MS students: may take any of the above approved courses or one of the courses below to fulfill their stats requirement**

**PSC 103A Statistical Analysis of Psychological Data; prereq: PSC 001 or PSC 001Y; PSC 041; STA 013 or 013Y or 102 (MS program only)**

Design and statistical analysis of psychological investigations and the interpretation of quantitative data in psychology.

**PSC 103B Statistical Analysis of Psychological Data; prereq: PSC 103A; STA 013 or 013Y or 102 (MS program only)**

Probability theory, sampling distributions, statistical inference, and hypothesis testing using standard parametric and correlational approaches. Simple regression analysis, multiple regression analysis, non-parametric statistics, introduction to multivariate statistics, with applications in psychology