

## Quantitative and methods courses outside of the School of Public Health

This document lists quantitative and methods courses offered by other departments that may be relevant to epidemiology doctoral students. Courses are listed alphabetically by department name.

Please note that this is as a work in progress. Courses may be infrequently offered. Course content may have changed. Visit department web sites to verify timing, content, and prerequisites. Send additions and corrections to this list (as well as comments on any of the classes) to the Epidemiology Student Services Coordinator.

Other resources for courses NOT on this list include:

Biostatistics Department in the School of Public Health (<http://www.sph.umich.edu/biostat/>)

Center for the Study of Complex Systems (<http://www.cscs.umich.edu/education/grad/courses.html>)

Center for Statistical Consultation and Research (<http://www.umich.edu/~cscar>)

Epidemiology Graduate Summer Session (<http://www.sph.umich.edu/epid/GSS/>)

ICPSR Summer Program (<http://www.icpsr.umich.edu/icpsrweb/sumprog/>)

### BIOLOGICAL ANTHROPOLOGY (College of Literature, Science, & Arts)

#### **ANTHRBIO561: Quantitative Field Methods**

This course teaches students how to do quantitative fieldwork in Anthropology. Topics include: sample selection, hypothesis testing, strong inference, research instruments, interview and measurement techniques, behavioral observation, statistical analysis, demographic censuses, collection of biomedical specimens, map making, fieldwork ethics, and human subjects compliance. The goal is to equip students with a set of tools with which to strive for excellence in research. This course is aimed at students of all subfields and theoretical orientations.

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### ECOLOGY AND EVOLUTIONARY BIOLOGY (College of Literature, Science, & Arts)

#### **EEB401: Interrogating data with models**

Ecologists are frequently taught statistical recipes that can be used to analyze data, e.g., correlation, regression, analysis of variance. These classical methods have been designed with analytical tractability foremost in mind. The assumptions on which they depend are such that they typically afford only an oblique perspective on the specific ecological questions we wish to answer. This is a pity, since hard-won data are effectively squandered when we can ask only crude questions of them. Advances in computational power over the last decades have brought more complex statistical procedures within the realm of the possible such that it is now possible to design statistical tests that directly answer the ecological questions we ask. This is evident from the fact that the ecological literature now abounds with references to likelihood, Bayesian inference, and information-based model selection. In this course, students will have an opportunity to apply these approaches to questions they themselves find interesting. We will study a number of examples in which we have to (1) refine scientific questions into statistical questions by means of mathematical models and (2) put these models to the test by bringing them into risky contact with data. Course work will consist of readings from several texts (see below) and from the primary literature, a number of computer labs, and a project. It is hoped that advanced graduate students will take this opportunity to view their data in new ways through the use of models.

Prerequisites: A burning scientific question, willingness to engage with others in thinking about ecological questions, willingness to think and talk about the philosophy of science, some numerical or statistical computing experience, candidate standing, calculus.

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## **ECONOMICS (College of Literature, Science, & Arts)**

### **ECON671: Econometric Analysis I (Cross-listed with Stats 505)**

This course is the first in a two-course block that forms the basic required sequence in econometrics for all doctoral students. Their purpose is to provide Ph.D. students with the training needed to do the basic quantitative analysis generally understood to be part of the background of all modern economists. This includes: the theory and practice of testing hypotheses, statistical estimation theory, the basic statistical theory underlying the linear model, an introduction to econometric methods, and the nature of the difficulties which arise in applying statistical procedures to economic research problems.

Prerequisite: Graduate standing and permission of instructor.

### **ECON672: Econometric Analysis II**

This course is the second in a two-course block that forms the basic required sequence in econometrics for all doctoral students. Their purpose is to provide Ph.D. students with the training needed to do the basic quantitative analysis generally understood to be part of the background of all modern economists. This includes: the theory and practice of testing hypotheses, statistical estimation theory, the basic statistical theory underlying the linear model, an introduction to econometric methods, and the nature of the difficulties which arise in applying statistical procedures to economic research problems.

Prerequisite: Demonstrated competence in the material covered in Econ 600 and 671.

### **ECON675: Applied Microeconometrics**

The purposes of the course are (1) to discuss types of microeconomic models likely to be useful in dissertation (and subsequent) research and (2) to provide some supervised experience in applied econometric research. The course's topics vary from year to year, but they typically include models for discrete and limited dependent variables and methods for analysis of longitudinal data.

Prerequisites: Econ 671 and 672.

### **ECON676: Applied Macroeconometrics**

The aim of this course is to equip students with a working knowledge of important econometric techniques used in monetary economics, financial economics, international economics, and econometric theory. The centerpiece of this course is the vector autoregressive model. The course is divided into six parts: (1) a review of the foundations of time series econometrics; (2) detrending methods; restricted and unrestricted estimation of stationary vector autoregressive and moving-average models; asymptotic, bootstrap and Bayesian inference; model selection and specification tests, forecasting; exogeneity and Granger causality; tests of forecast encompassing and tests of equal forecast accuracy; impulse response analysis, variance decompositions and historical decompositions; (3) estimation and inference in the presence of trends, structural change and unit roots in univariate models; (4) spurious regressions, unbalanced regressions and cointegration; (5) identification problems and the relationship between structural and reduced form models; and (6) estimation and inference for structural dynamic macroeconomic models and their relationship to vector autoregressive models.

Prerequisite: Econ 671 and 672; Graduate Standing

### **ECON677: Analysis of Time Series (Cross-listed with Stats 531)**

Introduction to modern time series models and methods including identification and estimation of univariate and multivariate autoregressive moving average models for discrete time covariance stationary processes, spectrum estimation and inference, and state space methods.

Prerequisite: Stats 426

**ECON678: Econometric Theory**

A course in econometric theory stressing the statistical foundation of the general linear model and the asymptotic distribution theory of nonlinear models. The course involves a development of the required theory in mathematical statistics and derivations and proofs of the main results associated with statistical inference in econometric models. Asymptotic distribution theory is studied in some detail.

Prerequisites: Econ 600, 671 and 672 or their equivalents.

**ECON679: Econometric Theory II (Cross-listed with Stats 576)**

This course continues from Econ 678. Includes a thorough treatment of statistical problems in econometrics, cross section data, times series data, panel data, development of simultaneous equation techniques, generalized method of moments, and formulation and estimation of special models. Selected current research topics depend on time and interest.

Prerequisite: Econ 678/Stats 575

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**POLITICAL SCIENCE (College of Literature, Science, & Arts)****PS599: Statistical Methods in Political Research**

A first course in statistics for students with little or no previous exposure to the subject. Topics include probability theory, discrete and continuous sampling distributions, sampling theory, properties of estimators, confidence intervals, hypothesis testing, and nonparametric statistics. Some familiarity with calculus is helpful but not absolutely required. Often, a brief introduction to the ideas of differential and integral calculus is provided in the course. Although the emphasis is on application, sufficient emphasis is placed on statistical theory so that students doing well in PS 599 will be prepared to pursue advanced course work in econometrics.

**PS680: Problems in Behavioral Research Methods**

This course is intended primarily as an introduction to study design, data collection, and measurement. Beginning with problem formulation, design strategies, indicator construction, validity threats, and sampling, the course moves on to take up in detail a variety of approaches as exemplified by such topics as field studies, experiments, survey methodology, aggregate data utilization, contextual studies, cross-sample linkages, longitudinal studies, and cross-cultural approaches. Emphasis is placed on eclecticism and on recognizing the interplay between theoretical and substantive questions, on the one hand, and research methods, on the other. Little or no attention is given to analysis as such. Participants in the course ordinarily make several presentations during the term and play prominent roles in the conduct of the class.

**PS699: Statistical Methods in Political Research II**

A second course in statistics and data analysis and assumes PS 599, or equivalent, as a prerequisite. The course is intended to be an introduction to methods of analysis subsumed under the General Linear Model, including analysis of variance and covariance, simple and multiple regression, and correlation. Certain aspects of these topics are presented most efficiently through the use of matrix algebra; A brief introduction to matrix algebra is included.

**PS787: Multivariate Analysis**

This is an extension of PS 699. Topics covered include Generalized Least Squares; the identification and estimation of simultaneous equation models; principal components, discriminant and factor analysis; models for limited dependent variables; and the general analysis of covariance structures (LISREL). Computer exercises are used extensively to illustrate the range of topics.

**PS789: Techniques of Causal Inference.**

No description available.

**PS790: Techniques of Dimensional Analysis**

This course is an introduction to the statistical analysis of time series in political science. Topics will include elementary stochastic difference equations, ARIMA modeling and intervention analysis, rational expectations, causality testing, unit root testing, co-integration, and error-correction models.

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**PYSCHOLOGY (College of Literature, Science, & Arts)****PSYCH613: Advanced Statistical Methods, I**

This is a two-term course (with Psych 614 in the Winter term). Psych 613 is a prerequisite for Psych 614. Students will gain experience by analyzing data and gain an appreciation for the rationale underlying the standard statistical procedures used in psychological research. The course consists of four hours of lecture; additional review sections will also be available. Topics covered throughout the year include analysis of variance, regression, factor analysis, multidimensional scaling, and clustering.

**PSYCH614: Advanced Statistical Methods, II**

This course is a continuation of PSYCH 613. Topics covered in this course include multidimensional scaling, cluster analysis, principal components, factor analysis, multivariate analysis of variance and canonical correlation. A brief introduction to reliability theory, structural equations modeling and hierarchical linear modeling will also be provided.

**PSYCH687: Methods of Survey Sampling (Cross-listed with SOC612, SURVMETH612)**

Methods of Survey Sampling/Applied Sampling is an applied statistical methods course, but differs from most statistics courses. It is concerned almost exclusively with the design of data collection. Little of the analysis of collected data will be discussed in the course. The course will concentrate on problems of applying sampling methods to human populations, since survey practices are more widely used in that area, and since sampling human populations poses a number of particular problems not found in sampling of other types of units. The principles of sample selection, though, can be applied to many other types of populations. The course is presented at a moderately advanced statistical level. While we will not develop the mathematical aspects of sampling theory, statistical notation and outlines of some algebraic proofs will be given. A sound background in applied statistics is necessary, since a few algebraic derivations will be presented. Little emphasis will be placed on the derivations. Nonetheless, a thorough understanding of the notation and results will be needed.

**PSYCH808-004: Special Seminar: Building and Testing Structural Equation Models in Social Sciences**

This course will cover the conceptual and technical issues of Structural Equation Modeling (SEM). Following the presentation of major conceptual issues, eight basic structural models will be described in detail. The models vary from simple to more complex ones. They also cover a wide range of situations including longitudinal and mediational analyses, comparisons between groups, and analyses that include data from different sources such as from parents, teachers, supervisors, co-workers. The description and discussion of the models will provide students with the knowledge and skills to apply SEM techniques using EQS software for analyzing, evaluating and reporting results produced by this analytic method. This knowledge is easily transferable to the use of LISREL or AMOS software. The course will also include three sessions in the computer lab to complete six short assignments. Course work will require the students to construct and test a structural model using their own data or data from available data sets and produce a research paper reporting the analyses and results.

**PSYCH817: Interdisciplinary Seminar in Quantitative Social Science Methodology (Cross-listed with EDUC817, SOC810, STATS817)**

This seminar will meet to consider methodological issues that arise in research in the social sciences. Themes for each meeting will arise from ongoing research projects at the University of Michigan. Visiting researchers provide a brief account of their aims and data before defining the methodological challenges for which they desire discussion.

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**SOCIOLOGY (College of Literature, Science, & Arts)**

**SOC510: Statistics**

This course is the first of a two-semester sequence required of all sociology department graduate students. It consists of two weekly class sessions plus a lab-discussion. In the first semester we cover basic concepts of probability, sampling distributions, confidence intervals, and statistical inference. The lab sessions will be used to discuss problems encountered in the lectures and written assignments and to develop statistical computing skills. The course assumes no prior knowledge of statistics and no mathematical knowledge beyond high school algebra. Please note that this is not a course in statistical theory, but rather one on the applied use of statistical methods for the analysis of social science data. As such, it will explore many topics but not deal with any of them in great depth. Those who are contemplating more advanced work involving statistical methods should consider taking other courses that do delve more deeply into statistical theory.

**SOC610: Statistical Methods**

Continuing from SOC 510, SOC 610 is the second course in the statistics sequence required for a doctoral degree in sociology. The course begins with linear algebra and reviews linear regression in matrices. At the core of the course are linear regression and its applications in social science research. A few special topics cover path analysis, the analysis of longitudinal data, and logit analysis for binary dependent variables. Students are required to conduct statistical analyses of real data sets using STATA. Evaluation is based on six exercises, two exams, and a final project.

Prerequisites: Soc 510 or equivalent.

**SOC543: Quantitative Methods I**

This course teaches relatively advanced statistical methods. In the current incarnation, this course focuses on statistical methods for analyzing categorical data, with an emphasis on practical applications rather than statistical theories. It covers three classes of statistical models: loglinear models for count data, logit/probit models for discrete dependent variables, and hazards models for studying transitions with longitudinal data.

Prerequisites: Soc 510, Soc 610

**SOC 710: Research Seminar: Causal Inference in the Social Sciences (Cross-listed with STATS 617, SOC 810, EDUC 817, PSYCH 817, STATS 817)**

In this course we explore and critique methods for conducting causal inference in the social sciences. These methods will be drawn from a wide variety of disciplines, including economics, sociology, statistics, education, psychology, and epidemiology. Particular attention will be paid to causal inference from observational research designs. This course is part of the Michigan Quantitative Methodology Program. It provides an interdisciplinary forum for researchers and graduate students in several related disciplines at Michigan to be engaged in discussing cutting-edge issues in social science methodology. The first four weeks of the course consist of faculty lectures. The remaining nine weeks will involve group presentations by students. The number of group presentations depends on the course enrollment. Unregistered auditors who are grad students or postdocs are welcome, but are expected to fully participate in the course, including group presentations.

**SOC717: Methods and Theory of Sample Design (Cross-listed with BIOSTAT617, STATS580, SURVMETH617)**

Methods and Theory of Sample Design is concerned with the theory underlying the methods of survey sampling widely used in practice. It covers the basic techniques of simple random sampling, stratification, systematic sampling, cluster and multi-stage sampling, and probability proportional to size sampling. It also examines methods of variance estimation for complex sample designs, including the Taylor series expansion method, balanced repeated replications, and jackknife methods. It will cover several specialized topics, including stratification and subclasses, multi-phase or double sampling, ratio estimation, selection with unequal probabilities without replacement, non-response adjustments, imputation, and small area estimation. The course will examine both the practical applications of the sampling techniques presented as well as the theory supporting the methods.

Prerequisites: Three or more courses in statistics and preferably a course in methods of survey sampling.

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**STATISTICS (College of Literature, Science, & Arts)**

**STAT403: Introduction to Quantitative Research Methods**

This course introduces methods for planning, executing, and evaluating research studies based on experiments, surveys, and observational datasets. In addition to learning a toolset of methods, students will read and report on recent research papers to learn how study design and data analysis are handled in different fields.

**STAT413: The General Linear Model and Its Applications**

Introduces students to the general linear model and its assumptions, and covers such topics as the geometry of the model, projections, least squares estimation, residuals, normal distribution theory results, inference on parameters, diagnostic tools, and applications in analysis of variance, design, and time series.

Prerequisites: Stat 350 and Math 217; prior or concurrent enrollment in Stat/Math 425. Non-Stat majors who have not taken Math 217 should elect Stat 401.

**STAT414: Topics in Applied Statistics**

Topics in applied statistics, including random and mixed effects ANOVA models, analysis of covariance and repeated measures designs, ridge regression, splines, logit-probit analysis, log-linear models, topics in multivariate analysis (MANOVA), discriminate analysis, profile analysis, topics in time series analysis, and basics of survival analysis.

Prerequisites: Stat 413 and permission of instructor.

**STAT449: Topics in Biostatistics (Cross-listed with Biostat 449)**

Introduction to biostatistical topics: clinical trials, cohort and case-control studies; experimental versus observational data; issues of causation, randomization, placebos; case control studies; survival analysis; diagnostic testing; image analysis of PET and MRI scans; statistical genetics; longitudinal studies; missing data.

Prerequisites: Stat 401 or permission of instructor

**STAT500: Applied Statistics I**

Linear models; definitions, fitting, identifiability, collinearity, Gauss-Markov theorem, variable selection, transformation, diagnostics, outliers and influential observations. ANOVA and ANCOVA. Common designs. Applications and real data analysis are stressed, with students using the computer to perform statistical analyses.

Prerequisites: Math 417 and Stat 350 or 426

**STAT501: Applied Statistics II**

Generalized linear models including logistic regression, Poisson regression, contingency tables. Random effects and repeated measures. Modern regression techniques. Regression and classification trees. Neural networks.

Prerequisites: Stat 500

**STAT617: Advanced Topic in Quantitative Methodology**

This course explores and critiques advanced methods for conducting quantitative research in the social sciences. A special topic is chosen for a particular semester, with relevant methods drawn from a wide variety of disciplines, including economics, education, epidemiology, psychology, sociology, and statistics. Particular attention is paid to quasi- experimental and observational research design.

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**SURVMETHODOLOGY (College of Literature, Science, & Arts)****SURVMETH612 See PSYCH687****SURVMETH613: Analysis of Complex Sample Survey Data**

This introductory course on the analysis of data from complex sample designs covers the development and handling of selection and other compensatory weights; methods for handling missing data; the effect of stratification and clustering on estimation and inference; alternative variance estimation procedures; methods for incorporating weights, stratification, clustering, and imputed values in estimation and inference procedures for complex sample survey data; and generalized design effects and variance functions.

Prerequisites: SurvMeth 612

**SURVMETH673: Survey Practicum: Data Analysis**

This course is the second in the series of courses comprising the survey research practicum. The course focuses on lectures and readings on the following issues: data cleaning and file preparation; classification systems and recodes; descriptive statistics and hypothesis testing; sums of squares and the analysis of variance; data reduction through factor and/or cluster analysis and the development of indices; cross-classification of categorical data and the measurement of association; multivariate linear regression tools; dummy-variable regression and multiple classification analysis; the logic of causal analysis and multiple dependent variables; multiple indicators, measurement errors and statistical analysis; report writing, graphics and presentation of data.

Prerequisites: SurvMeth 672

**SURVMETH685: Statistical Methods I**

This is the first in a two term sequence in applied statistical methods covering topics such as regression, analysis of variance, categorical data, and survival analysis.

Prerequisites: Completion of a two course sequence in probability and statistics or equivalent.

**SURVMETH686: Statistical Methods II**

This builds on the introduction to linear models and data analysis provided in Statistical Methods I. Topics include: Multivariate analysis techniques (Hotelling's T-square, Principal Components, Factor Analysis, Profile Analysis, MANOVA); Categorical Data Analysis (contingency tables, measurement of association, log-linear

models for counts, logistics and polytomous regression, GEE); and lifetime Data Analysis (Kaplan-Meier plots, logrank test, Cox regression).

**SURVMETH895.002: Regression Models in Complex Sample Design Settings**

This course examines a range of statistical regression analysis techniques for modeling survey data, and presents methods to compensate for design features for complex sample survey data. Course topics include likelihood estimation and testing; application of likelihood methods to linear and generalized linear models, including logistic, probit, generalized (multinomial) logit, Poisson, and negative binomial models; time-to-event (survival analysis) models; regression models for longitudinal data; and propensity score and Bayesian regression modeling. In general the course will proceed by considering the particular regression model in the simple random sample setting, and then considering the effect of accounting for the complex sample survey design (stratification, clustering, and weighting) on the inference. Issues such as model misspecification and ignorable vs. non-ignorable sampling in the context of regression modeling will be addressed. In general a design-based approach will be considered, although the application of fully Bayesian regression models in the complex sample design setting will be considered at the end of the course.

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**ROSS SCHOOL OF BUSINESS**

**BA 870 Research Methods in the Behavioral & Social Sciences (Cross-listed with SOCADMIN 870)**

This course is designed to provide conceptual and operational skills needed to do and interpret basic and applied research in the behavioral, managerial, and social sciences. Particular focus will be on structural equation models (known also by such names as causal models, path analysis, analysis of covariance structures, simultaneous equation models with latent variables) with an aim to addressing measurement and hypothesis testing issues, as well as exploring the broader philosophical foundations and implications of the methods. We will cover such topics as reliability, validity, explanation, prediction, control, and understanding of individual, group, and organizational phenomena. Considerable emphasis will be placed on examination of assumptions, measurement, theory specification, theory operationalization, estimation of parameters, hypothesis testing, and interpretation of findings. In addition, such topics as questionnaire design, formative versus reflective indicators, confirmatory factor analysis, high order factor models, cross-sectional and longitudinal designs, recursive and non recursive models, survey and experimental research, multiple group analyses, and the role of cross-cultural inquiry will be considered.

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**SCHOOL OF EDUCATION**

**EDUC796: Advanced Quantitative Methods for Non-Experimental Research**

A field-based advanced-level course in research methods that focuses on non-experimental research. The course will emphasize the combination of proper methodology with theoretical considerations to be addressed and characteristics of the data. Application to current educational questions will be emphasized. Several advanced statistical methods, with the appropriate software, will be covered. Recommended for doctoral students specializing in research, measurement, and evaluation.

Prerequisites: EDUC 794 and EDUC 795 or equivalent

**EDUC797: Advanced Quantitative Methods for Experimental Research**

Advanced-level course in research methods, focuses on experimental research. Emphasis on studies for which random assignment to groups is possible. Course emphasizes combination of proper methodology with theoretical considerations. Concentration on experimental design of studies, including randomized block designs, factorial designs, multiple treatment levels, and hierarchical designs. Issues in sampling (simple random, stratified, cluster, etc.) are also treated in some detail, as well as selection of appropriate comparison groups. Application to current educational questions will be emphasized.

Prerequisites: EDUC 794 and EDUC 795 or permission of instructor.

**EDUC890: Multi-level Analysis of Survey Data**

The major phenomenon of interest in educational research is the learning of individual students. Because learning (a) implies change over time, and (b) occurs in organizational settings, two troublesome methodological problems persist in the social sciences: how to measure change and how to accommodate the grouped nature of the phenomenon (also referred to as the unit of analysis problem). In a sense, the problems share a common cause, since traditional statistical techniques are inadequate to model the hierarchical nature of both phenomena. This advanced course in quantitative methods introduces students to the analytic situations in which multilevel methods are ideal, trains students in the use of the statistical program Hierarchical Linear Models (HLM), and provides experience in multilevel analysis. Students must possess skill in multivariate data analysis

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**SCHOOL OF NATURAL RESOURCES AND ENVIRONMENT****NRE501: Analysis and Modeling of Ecological Data**

This course will consist on an overview of standard and innovative techniques in ecological data analysis and modeling. Topics will include: linear regression, mixed effects models (fixed and random effects), maximum likelihood, general linear models and general additive models, survival analysis, time series, spatial analysis and Bayesian and hierarchical Bayesian approaches. The course will be a combination of lectures and computer labs, for which we will be using two open source programs, R and OpenBUGS (see list of references). This course is designed for students to work on their own data, or simulated data, related to their research projects or scientific interests. While reviewing the major statistical techniques, students will work on their projects and will be presenting their work to the class along the semester, these presentations will consist on: initial exploratory data analysis, selection of statistical analysis or modeling approach, implementation, and results.

Prerequisites: Students are expected to have a (undergrad) background in calculus, algebra, and statistics. Students will need their own laptops for the R and OpenBUGS lab.

**NRE 569: Introduction to Geostatistics**

Geostatistics provides a set of statistical tools for incorporation the spatial and temporal coordinates of observations in data processing. This course will introduce the main geostatistical tools for description and modeling of spatial variability, and interpolation of environmental attributes (e.g., pollutant concentrations) at unsampled locations. Important topics such as sampling design or the incorporation of different types of information (continuous categorical) in prediction will also be addressed. Homework will consist of small problems to get familiar with the theoretical part of the class, and assignments dealing with the analysis and interpretation of various data sets (soil, water pollution, remote sensing) using the geostatistical software GSLIB. moreover, each student will be asked to read a scientific publication in the field of applied geostatistics and asked to give a short presentation at the end of the term. emphasizing the objectives, methodology, and main findings (merits, drawbacks) of the paper. This course is a prerequisite to a more advanced course CEE 625 on the geostatistical modeling of uncertainty through stochastic simulation and its incorporation of decision making.

Prerequisites: An undergraduate class in statistics and probability, eg. NRE 438

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## FORD SCHOOL OF PUBLIC POLICY

### **PUBPOL 567: Practicum in Data Analysis Using Stata**

This course will provide students with a practical hands-on instruction in the analysis of survey data using the statistical package Stata. Students will learn how to investigate a variety of public policy issues using data from the U.S. as well as several developing countries

### **PUBPOL 571: Applied Econometrics**

This course is an introduction to econometric methods and their use in policy analysis. Most of the course focuses on multiple regression analysis, beginning with ordinary least squares estimation, and then considers the implications and treatment of serial correlation, heteroskedasticity, specification error, and measurement error. The course also provides an introduction to simultaneous equations models, time series analysis, models for binary dependent variables, and methods for longitudinal analysis.