PSC 404
Introduction to Statistical Methods

Fall 2000
9:40am-10:55 T/R
Harkness 329

Professor Curtis S. Signorino
325 Harkness Hall
Office Hours: Thursday 2-3:30
sign@troi.cc.rochester.edu
273-4760

TA: Robert Walker
309 Harkness Hall
Office Hours: TBA
Recitation: TBA
wlkr@troi.cc.rochester.edu

PURPOSE: This introductory course in mathematical statistics provides graduate students in the Political Science program with a basic knowledge of probability, statistical inference, and research design. Probability theory is the foundation of this course. It is necessary for characterizing both the data (or sample) and the uncertainty inherent in our inferences. "Statistical" inference is a formal procedure for drawing inferences about a population using only partial information about that population (e.g., a sample of data). The research design specifies how the sample is generated.

Familiarity with each of these three areas is necessary for conducting empirical research and for evaluating the empirical research of others. Individually, each poses potential stumbling blocks for the unwary researcher. If they are not properly addressed, the validity of one's conclusions is threatened. The objective of this course is to help researchers maintain their footing in constructing research designs, analyzing data, or evaluating analyses conducted by others. This course also serves as the foundation for more advanced Political Science graduate courses in statistical methods.

PREREQUISITES: There are no official prerequisites for this course. However, a basic knowledge of calculus — specifically, differentiation and integration — is necessary to understand the material on continuous distributions, multivariate distributions, and functions of random variables. Students not familiar with differentiation and integration should ensure that they learn these techniques on there own or in recitation.

COURSE REQUIREMENTS: There will be weekly homework assignments, a midterm exam, and a final exam. The course grade will be calculated as follows: homework assignments 10%, midterm exam 40%, final exam 50%. I encourage students to work together in groups of two or (at most) three for the homework assignments. In addition to office hours, the TA will hold a weekly recitation. The purpose of the recitation is to cover material not covered in lecture, to go over homework problems, and to review for exams. Students will be responsible for material covered in lecture, recitation, and the required readings.

TEXTS: The required text for this course is

(WMS) Wackerly, Mendenhall, & Scheaffer. *Mathematical Statistics with Applications.* 5th ed.

In general, the course will proceed straight through WMS, with the weeks on research design supplemented by other readings. An optional text is also provided for those who would like a slightly more advanced treatment of the course's topics:

(Degroot)	Degroot. *Probability and Statistics.* 2nd ed.

COURSE SCHEDULE:

Week 1: Course Overview and Introduction to Inference

Topics:	Course overview and business. Probability, statistics, and inference. Characterizing data.
Reading:	WMS Ch 1

Week 2: Introduction to Probability

Topics:	Set notation. Sample points and probabilities of events. Conditional probability and independence. Total probability and Bayes rule.
Reading:	WMS Ch 2, Degroot Ch 1 & 2

Week 3: Discrete Random Variables and Distributions

Topics:	Discrete random variables. Discrete probability distributions. Expectation, variance, and moments. Special discrete distributions. Tchebysheff's Theorem.
Reading:	WMS Ch 3, Degroot Ch 3, 4, & 5

Week 4: Continuous Random Variables and Distributions

Topics:	Continuous random variables. Continuous probability distributions. Expectation, variance, and moments. Special continuous distributions. Revisiting Tchebysheff's Theorem.
Reading:	WMS Ch 4, Degroot Ch 3, 4, & 5

Week 5: Multivariate Distributions

Topics:	Bivariate and multivariate distributions. Marginal and conditional distributions. Independent random variables. Conditional expectation. Covariance and correlation.
Reading:	WMS Ch 5, Degroot Ch 3, 4, & 5

Week 6: Functions of Random Variables

Topics:	Probability distributions of functions of random variables. Expectation and variance.
Reading:	WMS Ch 6, Degroot Ch 3

Week 7: Sampling and Central Limit Theorem

Topics: Sampling distributions related to Normal distribution: Chi-square, t, F. Central limit theorem.

Reading: WMS Ch 7, Degroot Ch 5 & 7

Midterm Exam. Covers Weeks 1–7. Sometime around 10/22

Week 8: Estimation

Topics: Estimators. Bias and mean square error. Goodness of an estimator. Common point estimators. Large-sample and small-sample confidence intervals.

Reading: WMS Ch 8, Degroot Ch 6 & 7

Week 9: Properties of Point Estimators and Methods of Estimation

Topics: Relative efficiency. Consistency. Sufficiency. Rao-Blackwell theorem. Minimum-variance unbiased estimators. Method of Moments. Maximum likelihood estimators and their properties.

Reading: WMS Ch 9, Degroot Ch 6 & 7

Week 10: Hypothesis Testing

Topics: Elements of a statistical test. Type I and II error. Common large-sample tests. Sample size and type II error. Hypothesis testing, confidence intervals, and significance levels. Small-sample hypothesis tests. Power of tests. Neyman-Pearson lemma. Likelihood ratio tests.

Reading: WMS Ch 10, Degroot Ch 8

Week 11: Linear Models

Topics: Least squares. Inferences concerning parameters. Predicting Y.

Reading: WMS Ch 11, Degroot Ch 10

Week 12: Research Design, Part I

Topics: Threats to internal and external validity. Experimental designs.

Reading: WMS Ch 12, C&S pp.1-34

Week 13: Research Design, Part II

Topics: Analysis of variance. Relationship to linear models. Quasi-experimental designs. Non-experimental designs. Case-study research.

Reading: WMS Ch 13, C&S pp.34-71, Degroot Ch 10

Week 14: Analysis of Categorical Data

Topics: Description of data. Chi-square test. Goodness of fit test. Contingency tables. Controlling for intervening variables. Measures of association.

Reading: WMS Ch 14, Degroot Ch 9

Final Exam

(TBA: 12/16–12/22)