Political Science 60833 **David Nickerson**
Math for Political Scientists **Decio 413**
Monday and Wednesdays, 11:45 – 1:00pm **Phone: 631-7016**
Edward J. DeBartolo Hall, Room 108 **Email: dnickers@nd.edu**

The primary purpose of this course is to teach you a foreign language: Math. You came to graduate school to study politics, but it turns out that math is mighty useful for learning about politics. Theoretical models of conflicts, legislative bargaining, or voter decisions make use of calculus regularly. Any analysis of multiple countries or people will rely heavily on calculus and matrix algebra. Probability infuses all reasoning about stochastic and idiosyncratic phenomena. Thus, you will be better prepared to conduct your own research and critically consume the research of others if you have an understanding of basic mathematical concepts.

This course will focus on probability, matrix algebra, and calculus. Taking introductory undergraduate courses in those topics (a worthwhile but time consuming enterprise) would take up five semesters of work. The goal of *Math for Political Scientists* is **not** to condense five semesters into one super-intense semester. Such a course would be as edifying and enriching as a motorcycle ride through an art gallery. Our more modest goal is to learn the basic tools from each topic that you will encounter most frequently in the course of your future work. These skills are not difficult and require only sincere effort on your part and repeated exposure. Like all foreign languages, mathematics requires routine practice. Simple pattern recognition will go a long way to demystifying the quantitative and formal sections of articles that most people skip over.

You will not master the skills presented in this course the first time you encounter them. My experience is that students (and professors) have to encounter a concept three times before they really understand the logic behind a technique. You should evaluate your progress during the course by gauging whether you understand more math than you did at the beginning of the course. The true test of the course is whether your understanding of future training and substantive courses improves as a result of this math course. My ultimate goal is to train you for a career in political science; not simply to ensure you memorize a handful of formulas for tests.

Goals The overarching purpose of this course is to prepare students to take future courses in formal and quantitative methods. By the end of the course, you should be able to:

1) Understand simple probabilities;
2) Take derivatives and integrate to find maxima and minima;
3) Perform basic matrix manipulations and read the algebra;
4) Correctly apply rules of logarithms and exponents;
5) Gain greater fluency in writing mathematical writing;
6) Begin to understand the logic of mathematical reasoning.

Measurement Your understanding of the course material is a latent trait that is not easily measured. I'll rely upon three imperfect measures of your performance in the classroom:

1) **Participation**: Attendance and asking questions. The material in the course builds upon itself. If you do not understand one section, the next section will be an even greater struggle. Thus, attendance is *strongly* encouraged. Similarly, if you have a question about the material, be sure to speak up in class. In general, it is best to clear up questions as they arise.

2) **Problem sets**: Problem sets will be due each week. You are *encouraged* to work in groups. Collaboration is an important part of academic inquiry and I see no reason to artificially impose solitude. While you should take advantage of your colleagues as an important resource, you will be required to type up the answers to the problem sets on your own. [Note: Typing mathematical notation can be painful, but will be required on all problem sets and exams. Good practice for the future.]
3) **Final exam**: The final exam will be take home and open book. Cramming will not help you, so it is important that you stay on top of the material.

Grading If you put forth can honest effort in this course, your final grade in the class will be an "A". Ability in quantitative methods varies and not everyone will be able to "master" the material. If you need a particular methodological skill to conduct your work, I do not want grades to dissuade someone from taking a course that can help them. You will receive feedback along the way on problem sets and know how you are doing in the class, but the final grade submitted in the books will be uninformative. My goal is to give you the skills to conduct your own research, not weed people out of the program or send signals about hiring. [Of course, if you blow off the course, failure is always an option.]

Office Hours Monday and Thursday 2:00 – 3:30 (or by appointment)

Texts Sadly, there is no perfect text for our purposes. Jeff Gill's *Essential Mathematics for Political and Social Research* is a worthy attempt, but covers topics quickly. The first two years we offered the course, we opted for Simon and Blume's *Mathematics for Economists*, which is admirably clear and covered most of the required topics. *Mathematics for Economists* has many virtues (it covers all the topics we need and it is fairly clear), but students found the treatment of the material somewhat abrupt and the examples frustrating (they are all taken from micro and macro economics, which are less helpful when you know neither micro nor macro economics). The suggestion of several participants was that we assign a different undergraduate textbook for each topic. To keep costs down, I have assigned the four books below (which are all available as free pdfs).

Hammack's *The Book of Proof* : This book is very clear and covers many useful topics.

Beezer's *A First Course in Linear Algebra*: This book is clear, rigorous and thorough. Don't be put off by the length. One can get through it quickly.

Strang's *Calculus*: A classic text that happens to be free. The book is rigorous, but built on many years of experience teaching so it should be accessible.

Grinstead & Snell's *Introduction to Probability* (G&S): Probability books are often written to be far more technical than our purposes require. G&S is very good, but not quite perfect for our needs. However, it builds on itself very well and should be accessible.

Supplemental texts

Velleman;s *How to Prove It*: An exceptionally lucid accounting of formal mathematical logic.

DeGroot and Schervish's *Probability and Statistics*: A classic and thorough treatment of probability, but not for the faint of heart.

Rice's *Mathematical Statistics and Data Analysis*: Geared towards engineers, but is a very clear and systematic algebraic treatment of statistics.

Freedman, Pisani, and Purves' *Statistics*: One of the most elegant, non-technical, and clear sighted treatments of introductory statistics.

Schedule The schedule below represents my best guess as to the speed the course will proceed. Since the material is cumulative and builds upon itself, we will make sure that the class has a good grasp of prior material before moving on. It is possible that some sections may progress faster, while others may take longer than anticipated. Students are asked to be flexible and offer consistent feedback.

Date	Topic	Reading
Aug. 24th	Set Theory and Probability	DeGroot and Schervish: Chapters 1 and 2 Hammack: Chapter 1
Aug. 29th		
Aug. 31st	Cancelled for APSA	
Sep. 5th	Cancelled for APSA / Labor Day	
Sep. 7th	Single variable calculus, exponentials, and logarithms	Strang: Chapters 2 - 4
Sep. 12th		
Sep. 14th		
Sep. 19th		Strang: Chapters 5 - 6
Sep. 21st		
Sep. 26th	Proofs	Hammack: Chapters 4, 5, and 6
Sep. 28th		
Oct. 3rd	Matrix Algebra	Beezer: Chapters SLE and V
Oct. 5th		
Oct. 10th		Beezer: Chapters M and VS
Oct. 12th		
Oct. 17th	FALL BREAK	
Oct. 19th		
Oct. 24th	Matrix Algebra	Beezer: Chapters D and LT
Oct. 26th		
Oct. 31st	Probability	G&S: Chapters 1 – 2
Nov. 2nd		
Nov. 7th		G&S: Chapters 3 – 4
Nov. 9th		
Nov. 14th		G&S: Chapters 5 - 7
Nov. 16th		
Nov. 21st		G&S: Chapters 8 and 9
Nov. 23rd	THANKSGIVING BREAK	
Nov. 28th	Multivariate calculus	Strang: Chapters 13 and 14
Nov. 30th		
Dec. 5th		Strang: Chapter 11 (plus 8.4, 8.5 and 10.4)
Dec. 7th		