Mathematical Tools for Political Scientists (POLS 508)

Fall 2017
Location: Tarbutton Hall 120
Hours: Fridays 10:00am-1:00pm

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Description

This course provides a rigorous introduction to the mathematical tools that are needed to conduct quantitative and formal theoretical research in political science. The main topics covered are: calculus in the real line and multivariate calculus, elementary linear and matrix algebra, and an introduction to probability theory. Familiarity with these topics is essential for students who wish to become empirical researchers or formal modelers. This course is a prerequisite for all other coursework in methods and formal theory. Knowledge of algebra, equation solving and graphs is expected.

Course Structure

Before each session, I will distribute class notes with the material that will be covered. You should prepare for class reading these notes carefully. Although reading the notes and attending the lectures is important, learning mathematical material requires constant practice solving problems. Because of this, I will assign weekly problems sets. There will also be two in-class midterms and one final.

Grading

- 20% Homework assignments
- 40% Midterms (20% each).
- 40% Cumulative Final.

Recommended Textbooks

There is no single textbook that covers all the class material at this level. Because of this, the class notes will be your main reference. However, I strongly encourage you to consult at least one of the following textbooks. This will allow you to see additional examples, and to deepen your understanding of the material. The list includes textbooks written for undergraduate students (U) as well as more advanced references (A).

- Cupilary, Antonella. *The Nuts and Bolds of Proofs.* Elsevier. (U)
- Casella, George and Roger L. Berger. *Statistical Inference.* Duxbury, Thompson Learning. (A)
- De la Fuente, Angel. *Mathematical Methods and Models for Economists.* Cambridge University Press. (A)
- Lay, David C. , Steven R. Lay and Judy McDonald. *Linear Algebra and Its Applications.* 5th edition, Pearson. (U)
- Roberts, Charles E. *Introduction to Mathematical Proofs: A Transition.* CRC Press. (U)
- Simon, Carl P. and Lawrence Blume. *Mathematics for Economists.* Norton and Company. (U)
- Stewart, James. *Calculus* 7th edition. Cengage Learning. (U)
- Sundaram, Rangarajan K. A First Course in Optimization Theory. Cambridge University Press. (A)
- Wackerly, Dennis D., Mendenhall William and Richard L. Scheaffer. *Mathematical Statistics with Applications.* Brooks/Cole Cengage Learning. (U)

Outline

The schedule may change as the semester unfolds.

1. Sets and Functions (August 25 - September 8) (Cupilary Ch. 2 and 4.1-4.2; De la Fuente Ch. 1.1, 1.2, and 1.4; Roberts Ch. 3 and 5; Sundaram Appendix A)
   (a) Basic Set Theory
   (b) Methods of Proof
   (c) Functions
2. Differential Calculus (September 15 - October 6) (Simon and Blume Ch. 2.1-2.6, 3.1-3.5, 4, and 5.1-5.5; Stewart Ch. 1.5-1.8, 2.2-2.3, 2.5, 3.1-3.5, 3.8, and 6.1-6.8)
   (a) Limits and Continuity
   (b) Derivatives
   (c) Inverse Functions
   (d) The Newton's Method
   (e) Mean Value Theorem and Curve Sketching
3. Midterm 1 (October 13)
4. Integral Calculus (October 20) (Stewart Ch. 3.9, 4.2-4.5, and 7.1)

(a) Antiderivatives

(b) The Definite Integral

(c) Substitution Rule and Integration by Parts

5. Linear Algebra (October 20 - October 27) (Lay, Lay and Mcdonald Ch. 1.1, 1.4, 1.7, 2.1-2.3, 3.1-3.2, and 5.1-5.2; Simon and Blume Ch. 6.1, 8.1-8.2, 9.1, and 11.1; Sundaram Ch. 1.3 and 1.5.1-1.5.2)

   (a) Matrix Algebra

   (b) Systems of Linear Equations

   (c) Vectors

   (d) Linear Independence

   (e) Eigenvalues and Eigenvectors

6. Multivariate Calculus (November 03 - November 10) (Stewart Ch. 14.1-14.3, and 14.5-14.7; De la Fuente Ch. 4.1-4.3; Sundaram Ch. 1.2, 1.4, and 1.6)

   (a) Sequences

   (b) Functions of Several Variables

   (c) Limits and Continuity

   (d) Directional Derivative and Gradient

   (e) Implicit Functions

7. Introduction to Probability (November 18 - December 1) (Wackerly, Mendenhall and Scheaffer Ch. 2-4; Casella and Berger Ch. 1,2.1-2.3, and 3.1-3.3)

   (a) Axioms of Probability

   (b) Independence and Conditional Probability

   (c) Random Variables and Distribution Functions

   (d) Moments