Politics 502: Math for Political Science

Fall 2006

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Office Hours Thursday, 4:20–6

Class Meeting Time Monday and Wednesday, 10:00–11:20

Classroom

Catalog Description This course presents basic mathematical concepts that are essential for formal and quantitative analysis in political science research. It prepares students for advanced courses offered in the department (e.g. POL 572–573, 575–576). The topics include logic, real analysis optimization, vector spaces, and probability. Some applications to political science will be introduced. Students are assumed to have familiarity with calculus and matrix algebra.

Assessment There will be regular problem sets (30% of the grade), a midterm (30% of the grade), and a final (40% of the grade). The final will occur during exam week in January. I am open to the idea of making these take-home exams, if that's what the class would prefer.

I encourage you to form study groups and to discuss the homework problems, but everyone must write their own solutions to turn in. To get the most out of the homework, follow the following procedure: First, try to solve *all* of the problems yourself. Then get together with your group to discuss the problems and their solutions. Finally, go off on your own and write up the solutions. If you take notes during your group meeting, try to look at them as little as possible when you write up your solutions.

Reading Since the course has to cover so much ground, and no book has the perfect combination of topics and presentation several sources will be used. First, it is worth considering a few reference/background texts for students not entirely comfortable with algebra, calculus and linear algebra. First Alpha C. Chiang's *Fundamental Methods of Mathematical Economics 3ed* is an excellent reference for calculus and linear algebra. We will review some topics from his treatment, but I recommend having a copy handy. Michael Spivak's *The Hitchikers Guide* *to Calculus* is also nice to have. A more rudimentary but handy source is Lang's *Basic Math*. None of these books is required.

The lectures will be based on several sources:

- Krantz *Real Analysis and Foundations 2ed*, chs. 1–3, 4–8, 13
- Sundaram *A First Course in Optimization Theory*
- Amemiya *Introduction to Statistics and Econometrics* chs 1-6
- Luenberger *Optimization by Vector Space Methrods* chs 2-4
- McCarty and Meirowitz *Political Game Theory* chs. 2-3, 12
- Ashworth *Math for Political Science*

The recommended books as well as Krantz, Sundaram, Amemiya and Luenberger are available in the bookstore. If you are considering a subset of the texts, Luenberger is the one to skip.

Outline

1. Foundations (Krantz 1-2; Amemiya 2,3; MM 12.1-12.3)

   We begin with the basic building blocks of mathematics: sets, elements, numbers, functions, and relations. As applications, we will look at choice theory and probability theory.

2. Sequences and Limits (Krantz 3; Amemiya 6; MM 12.3)

   We will study some of the fundamental properties of real numbers, including sequences and convergence. As an application, we will look at the law of large numbers and Condorcet's theory of majority rule.

3. Point Set Topology (Krantz 5-6; MM 12.4-12.6)

   A return to points, sets and functions with emphasis on open sets, compact sets, and continuity of functions. This will lead to a discussion of optimization and fixed point theorems. The former is the basis for choice theory and the latter is fundamental to the idea of equilibrium. We will consider some examples from the theory of games.

4. Vector Spaces (Luenberger 2-4; Sundaram appendix C; Krantz 13)

   We treat a large and useful class of multidimensional spaces. Operators and norms are covered. Applications include the geometry of linear regression.

5. Linear Algebra (Sundaram 1.3)

   We focus on linear operators on finite dimensional spaces. Matrices are used to solve systems of linear equations. A few examples from the study of stochastic processes are considered.

6. Differentiation and Optimization (Krantz 7,13; Sundaram 2-6; MM 12.7)

   We present a formal treatment of the derivative and study its use in the optimization of functions of several variables with inequality and equality constraints. Comparative statics of solutions to optimization problems will also be covered. Applications to decision theory and comparative statics of equilibria will be included.

7. Integration and Expectation (Krantz 8; Amemiya 3,4; MM 12.7)

   We present a formal treatment of the integral and study its use in probability theory.