Fundamentals of Political Research—Mathematics

David A. Siegel

Course information:
Course Number: POS5744
Time: T,R 12:30 - 1:45 pm
Place: Bellamy Building 113
Course website: Blackboard

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Course Description

This course is designed to introduce and/or review the mathematical tools underlying most work in quantitative political science, including both statistical and formal modeling techniques. Topics to be covered include: (i) calculus, (ii) probability, (iii) linear algebra, and (iv) multivariable calculus and optimization. The course is intended to prepare students for later methods classes, provide students with a basic understanding of a variety of mathematical skills, and explore the importance of these skills in the context of social science research. Upon successful completion of the course students will be able to:

- apply basic mathematical operations,
- understand when and why certain mathematical operations are required by social scientists,
- recognize and hopefully avoid the various pitfalls of faulty application of mathematics, and
- attain basic mathematical literacy with respect to research published in the discipline.

Course Format

There is no way to learn mathematics without actually practicing mathematics, and the class structure reflects this. Every Thursday new material will be presented in a lecture format, though questions and active participation are strongly encouraged. I will also assign problem sets most weeks that do not precede an exam. Every Tuesday other than exam weeks we will discuss the problem sets. This discussion is designed to challenge: students will present their solutions, or work through the problems on the board should they not have solved them. Students will also be expected to show that they have at least put serious effort into all problems, though the sets themselves will not be graded for accuracy. There will be three exams during the semester as well, in addition to a final exam. It is absolutely vital that students not fall behind in this class, and I highly encourage doing the reading before class starts and coming with questions.

Readings

The primary text for this class is a draft textbook I and Will Moore are co-writing. I will have relevant chapters posted to Blackboard a week ahead of each lecture. The readings from this book are not listed in the course schedule below as it will be fairly obvious what to read when the chapter becomes available. There are many additional places to learn math, and I find that it often helps to vary the sources one considers when stuck. Thus, I list several that you may find useful here. The second and third have been used heavily in the past, and I note the sections relevant to each class in the course schedule below. I will also post Chris Reenock's excellent slides from two years ago as an additional resource. It is important to note that not all material in the text, or even in the sections assigned each week, will necessarily be covered in the class. It is thus important to do the readings.

- Moore, Will H. and David A. Siegel. *Fundamentals for Political Scientists.* This book is not yet published and will be posted to Blackboard with the permission of the authors.
- Simon, Carl and Lawrence Blume. (**SB**) 1994. *Mathematics for Economists.* New York: Norton.
- Hagel, Timothy. 1995. *Basic Math for Social Scientists: Concepts.* Volume 108.
- Ross, Sheldon M. *Introduction to Probability Models.* San Diego: Academic Press.
- ——. 1996. *Basic Math for Social Scientists: Problems and Solutions.* Volume 109.
- Gill, Jeff. 2006. *Essential Mathematics for Political and Social Research.* Cambridge Press.
- Fox, John. 2009. *A Mathematical Primer for Social Statistics.*
- Chiang, Alpha and Kevin Wainwright. 2005. *Fundamental Methods of Mathematical Economics.* Boston: McGraw Hill.
- Namboodiri, Krishnan. 1984. *Matrix Algebra: An Introduction.* Sage Publications.
- Thompson, Silvanus P. and Martin Gardner. *Calculus Made Easy.*
- `http://Math.com`
- `http://mathworld.wolfram.com/`

Course Requirements

- Participation (35%): There are two components to participation: questions during classes, and active participation while presenting the problems. Both are important. However, the largest share of the grade will be based on presentation of the problems from the weekly problem sets. These problem sets will not be graded, and you are encouraged to work together on them. However, I will check your written work to ensure that you complete them, or at least try valiantly to do so. Further, as each presenter will be chosen randomly during class, it is imperitive that each person understand how to do each problem well. At the end of each class session I will assign two participation grades, one to all for general participation, and one to those who presented a problem. These will be averaged for each person using weights determined by the relative number of problems one presented over the course of the semester.
- 3 In-class Exams (45%): The exams will cover the material in Parts II, III, and IV of the class, as noted in the course schedule.
- Comprehensive Final Exam (20%): This exam will be two hours long, be given at a date and time TBD, and will cover all material in the class, as the name implies.

Rough Course Schedule:

(All readings for Thursday unless denoted Tuesday (T)).

(All problem sets are due on the following Tuesday after they are assigned, and all exams occur on Tuesdays as noted below.)

Part I: Building Blocks

Week 1 (T; no class R): Building Blocks: Spaces; sets and operations on sets; unknowns and solving for variables; common mathematical notation; algebra review; methods of proof; relations; mappings; functions; utility representations; limits and continuity; sequences and series; open, closed, bounded, compact, and convex sets.

Reading: **SB** A1, 2.1, 2.2, 5.1-5.4, 7.1, 12; Hagle, 1.1, 1.2, 2.

Part II: Calculus in 1-D

Week 2: Calculus in one dimension; derivatives; interpreting derivatives.

Reading: **SB** 2.3-2.7, 3.1-3.4, 4, 5.5; Hagle, Chapter 3.

Week 3: Higher order derivatives, composite functions, chain rule; derivatives of special functions.

Week 4: Indefinite integrals; definite integrals; fundamental theorem of calculus; techniques of integration.

Reading: **SB** A4; Hagle, Chapter 5.

Week 5: Optimization in one dimension; supremum, infimum, maximum, and minimum; first order and second order conditions.

Reading: **SB** 3.5; Hagle, Chapter 4.

Part III: Probability

Week 6 (Exam 1 T): Sample spaces; events; probability; conditional probability and independence; Bayes' Rule; uncertainty and expected utility; error.

Reading: **SB** A5; Hagle, 1.3.

Week 7: Discrete distributions; expectation and conditional expectation; joint distributions; special discrete distribution functions.

Reading: Hagle, 5; Ross, 1-2.4, 3.

Week 8: Continuous distributions; limit theorems; special continuous distribution functions.

Part IV: Linear Algebra

Week 9 (Exam 2 T): Introduction to linear algebra; systems of linear equations; rank; existence of solutions; vectors and vector algebra; inner products and norms.

Reading: **SB** 6.1, 7.2-7.4 (only to p. 147), 10.1-10.4.

Week 10: Vector spaces; matrix algebra; matrix multiplication; transposes and inverse; identity and null matrices; determinants; Cramer's Rule.

READING: **SB** 8.1-8.4, 9.1-9.2, 10.5-10.6, 11; Hagle, Chapter 6.

Week 11: Quadratic forms; definiteness of quadratic forms; eigenvalues and eigenvectors; Markov processes; more on determinants.

READING: **SB** 16.1-16.2, 23.1, 23.3, 23.6-23.8, 26.1-26.3.

PART V: MULTIVARIABLE CALCULUS AND OPTIMIZATION

Week 12, (Exam 3 T): Introduction to multivariable calculus; functions of several variables; concavity and quasiconcavity; convexity and quasiconvexity

READING: **SB** 13, 14.1-14.3, 21.1-21.3.

Week 13 (T; no class R due to Thanksgiving): Total and partial derivatives; chain rule; gradients, Hessians, and Jacobians; integration; unconstrained optimization.

READING: **SB** 14.4-14.9, 17.1-17.5.

Week 14: Constrained optimization; equality constraints; Lagrange multipliers; inequality constraints; implicit functions and implicit differentiation; comparative statics.

READING: **SB** 15.1-15.4, 18.1-18.6, 19.1-19.4.

Week 15: Review

Final Exam: TBD

Additional Information

University Attendance Policy: Excused absences include documented illness, deaths in the family and other documented crises, call to active military duty or jury duty, religious holy days, and official University activities. These absences will be accommodated in a way that does not arbitrarily penalize students who have a valid excuse. Consideration will also be given to students whose dependent children experience serious illness.

Academic Honor Policy: The Florida State University Academic Honor Policy outlines the University's expectations for the integrity of students' academic work, the procedures for resolving alleged violations of those expectations, and the rights and responsibilities of students and faculty members throughout the process. Students are responsible for reading the Academic Honor Policy and for living up to their pledge to "...be honest and truthful and... [to] strive for personal and institutional integrity at Florida State University." (Florida State University Academic Honor Policy, found at http://dof.fsu.edu/honorpolicy.htm.)

Americans With Disabilities Act: Students with disabilities needing academic accommodation should: (1) register with and provide documentation to the Student Disability Resource Center; and (2) bring a letter to the instructor indicating the need for accommodation and what type. This should be done during the first week of class.

This syllabus and other class materials are available in alternative format upon request.

For more information about services available to FSU students with disabilities, contact the: Student Disability Resource Center
874 Traditions Way
108 Student Services Building
Florida State University
Tallahassee, FL 32306-4167
(850) 644-9566 (voice)
(850) 644-8504 (TDD)
sdrc@admin.fsu.edu
http://www.disabilitycenter.fsu.edu/

Syllabus Change Policy: Except for changes that substantially affect implementation of the evaluation (grading) statement, this syllabus is a guide for the course and is subject to change with advance notice.