

University of Rochester Political Science

Psc 407
Mathematical Modeling

Prof. Mark Fey
Fall 2025

Syllabus

This course is part of a rigorous introduction to the main concepts and results in positive political theory. It is the first half of a two course sequence consisting of Psc 407 and Psc 408. The sequence concentrates on the theoretical models used in contemporary political science, and provides the mathematical background necessary to fully understand them.

The sequence of Psc 407 and Psc 408 is designed to be both a rigorous foundation for students planning on taking further courses in the positive political theory field and a self-contained overview of the field for students who do not intend to do additional coursework in the field. This course will focus on developing a range of mathematical tools and applying these tools to social choice theory, which concerns finding an axiomatic basis for collective decision making. It will emphasize rigorous logical and deductive reasoning—a skill which will prove valuable, even to the student primarily interested in empirical analysis rather than modelling.

Students should have, at a minimum, a sound familiarity with basic algebra (solving equations, graphing functions, etc.) and a knowledge of basic calculus. Consistent with department policy, students are required to attend the “math camp” offered in the weeks before the fall semester.

Course Meetings: Lectures for the course will be Tuesdays and Thursdays at 10:00 in Harkness 112.

Course Work: To learn mathematical material, there is no substitute for solving problems. Therefore, problem sets will be assigned most weeks. There will also be a two midterm exams and final exam. A schedule of course work is below.

Grades for the course will be assigned based on the performance on the exams and problem sets. Specifically, final grades will be determined as follows: 30% problem sets, 20% midterm #1, 20% midterm #2, and 30% final exam.

Course Readings: I will distributing class notes that I will closely follow in lecture. This will be the main reference for the course.

In addition, there are a number of books that will act as supplementary texts. The relevant sections of each book are listed below. You do not need to buy all of these books, instead they are meant to provide an additional perspective on the material. These are the supplementary books:

- Cupillari, *The Nuts and Bolts of Proofs*
- Velleman, *How To Prove It*
- Hammack, *Book of Proof*, full text available at <https://www.people.vcu.edu/~rhammack/BookOfProof/>
- Taylor, *Mathematics and Politics*
- Osborne and Rubinstein, *Models of Microeconomic Theory*, full text available at <https://arielrubinstein.tau.ac.il/books.html>
- Binmore, *Mathematical Analysis*
- Brannan, *A First Course in Mathematical Analysis*
- Dangello and Seyfried, *Introductory Real Analysis*
- Tao, *Analysis 1*
- Osborne, *Models in Political Economy*, full text available at <https://www.economics.utoronto.ca/osborne/mpe/index.html>

Topics: Here is the list of the topics and the supplementary readings. Naturally, this schedule may change as the semester unfolds.

Important note: For each topic, the readings are listed in order of increasing complexity. Some of the later listings are quite advanced.

- Sets and Numbers
 - Hammack, chapter 1
 - Velleman, section 1.4
 - Dangelo and Seyfried, section 1.2
 - Tao, chapter 2, 3, 4
- Logic
 - Hammack, chapter 2
 - Velleman, chapters 1 & 2
 - Tao, appendix
- Proofs
 - Cupillari (whole book)
 - Hammack, chapters 4-10
 - Velleman, chapter 3 & 6
 - Dangelo and Seyfried, section 1.1 & 1.4
 - Tao, appendix
- Relations and Orders
 - Hammack, chapter 11
 - Velleman, chapter 4
- Individual Preference and Choice
 - Osborne and Rubinstein, chapters 1 & 2
- Functions and Utility
 - Hammack, chapters 12 & 14
 - Osborne and Rubinstein, chapters 2 & 3
 - Velleman, chapter 5 & 8
 - Dangelo and Seyfried, section 1.3

- Voting and Social Choice
Taylor, chapter 5 & 10
Osborne, sections 1.1-1.4 and 1.7
Osborne and Rubinstein, chapter 20
- Math in One Dimension
Brannan, Chapters 1, 2, 4, 5, 6
Binmore, Chapters 1, 2, 4, , 7, 8, 9, 10, 11, 12
Dangelo and Seyfried, Chapters 2, 3, 4, 5, 11
Tao, Chapters 5, 6, 8, 9, 10
- Social Choice in One Dimension
Osborne, section 1.5
- Math in Multiple Dimensions
Binmore, Chapters 18 & 19
- Social Choice in Multiple Dimensions
Osborne, section 1.6