

University of Mannheim
School of Social Sciences
Chair of Political Economy

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Mathematics for Political Science

Syllabus Fall 2023

Course Description

This self-study course is designed to help you with the mathematical tools useful for the rest of your Master's program, especially for the upcoming mandatory courses in statistics and game theory. The course reviews some mathematical concepts most of you will be familiar with from high school, such as functions, derivatives, integrals, vectors, matrices and probability distributions. The course's objective is to make students familiar and comfortable with notation, reading mathematical statements, and applying various mathematical techniques.

Contents

- Introduction
- Set Theory (The Basics)
 - Sets, Functions
- Analysis I
 - Equations, Differentiation
- Analysis II
 - Optimization, Integration
- Linear Algebra
 - Linear Combinations, Vector Spaces, Matrices
- Probability I
 - Combinatorics, Bayes' Rule
- Probability II
 - Distributions

Readings

Here are some recommended readings. They provide more detailed explanations about the topics and are helpful if you are unfamiliar with the material.

- General
 - Moore/Siegel (2013) *An introductory mathematics course aimed at social scientists, provides good intuitions for basic concepts and applications. It has accompanying video lectures on Youtube.*
 - Gill (2006) *Another introduction to mathematical principles for incoming social science graduate students.*
 - Simon/Blume (1994) *A comprehensive treatment of mathematics for students of economics for both undergraduate and more advanced level.*
 - Sydsaeter/Hammond (2008) *Another standard mathematics textbook for economics undergraduates.*
- Calculus/ Analysis
 - Spivak (2006) *A classic standard textbook for a first class in Calculus for mathematics students at undergraduate level.*
 - Protter/Morrey (1991) *A typical theorem-proof book that covers introductory real analysis for mathematics students at undergraduate level. Short and to the point.*
- Linear Algebra
 - Lay (2011) *A standard introduction for mathematics undergraduates.*
 - Strang (2005) *Another standard introduction for mathematics undergraduates. Strang's MIT video lectures accompanying the textbook are available online for free.*
 - Hefferon (2014) *A theorem-proof style introductory book for mathematics undergraduates with lots of examples and interesting applications. It is free¹.*
 - Axler (2015) *A more rigorous but intuitive treatment of linear algebra for mathematics undergraduates.*
 - The Matrix Cookbook² *An overview over some more advanced matrix calculus.*
- Probability Theory
 - DeGroot/Schervish (2011) *A comprehensive standard treatment of probability and statistics for mathematics undergraduate students. Intuitive and (relatively) rigorous at the same time with lots of exercises.*

¹<https://hefferon.net/linearalgebra/>

²http://www2.imm.dtu.dk/pubdb/views/edoc_download.php/3274/pdf/imm3274.pdf

Additional Resources

Here are some recommended non-textbook extra materials for this course and future references on the topics covered.

Text resources:

- Math Prefresher for Political Scientists
 - Math Part I: chapters 1 to 6

Video resources:

- Essence of calculus
- Essence of linear algebra
- Linear Algebra by Khan Academy
- David Siegel's tutorials

Learning Tools:

- Wolfram Alpha
 - Wolfram Alpha, among other things, is an excellent tool for computing, graphing functions, understanding limits, derivatives, and integrals and their applications.

References

Axler, S. (2015). *Linear Algebra Done Right* (3rd ed.). Undergraduate Texts in Mathematics. Springer.

DeGroot, M. H. and M. J. Schervish (2011). *Probability and Statistics* (4th ed.). London: Pearson.

Gill, J. (2006). *Essential Mathematics for Political and Social Research*. Cambridge University Press.

Hefferon, J. (2014). *Linear Algebra*.

Lay, D. C. (2011). *Linear Algebra and Its Applications*. London: Pearson.

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Simon, C. P. and L. Blume (1994). *Mathematics for Economists*. New York: Norton and Company.

Spivak, M. (2006). *Calculus* (3rd ed.). Cambridge University Press.

Strang, G. (2005). *Linear Algebra and Its Applications* (4th ed.). Brooks Cole.

Sydsaeter, K. and P. Hammond (2008). *Essential Mathematics for Economic Analysis* (3rd ed.). Essex: Pearson.