Math Camp Syllabus (Econ 703)

John Kennan

August 2023

August 16-31, 4:30-6:45 MTWThF, 6102 Soc Science Sept 6-Sept 13, 5:30-8:00 Wednesdays, 6102 Soc Science Office Hours (6434 Soc Science): Mondays, 1:30-3:30 (or by appointment)

$\mathbf{T}\mathbf{A}$

Jakob Juergens

Course Description

The course reviews some math that will be used in the first-year economics PhD courses.

Textbook and Materials

The following texts are recommended.

Rangarajan K. Sundaram, A First Course in Optimization Theory, Cambridge University Press, Cambridge, 1996.

Mathematical Appendix in *Microeconomic Theory*, by Andreu Mas-Colell, Michael D. Whinston, and Jerry R. Green, Oxford University Press, 1995 (this is the text for 711/713; MWG below).

The following book is also worth having (it is written by a mathematician, with no coverage of the economics applications in Sundaram's book, but this is a mathematician who is a good writer, with an interest in the history of the subject, so the book is very readable).

Stephen Abbott, "Understanding Analysis", Springer, 2001

I will also post some notes.

Course Outline (subject to change)

- 1 Sets, Numbers, Functions, Relations; Proofs
 - Supplementary material: MWG, M.B
- 2 Sequences
 - Convergence, Cauchy Sequences
- 3 Metric Spaces
 - Open and Closed Sets, Compactness, Completeness
 - Supplementary material: MWG, M.F
- 4 Continuity and Differentiability
 - Mean Value Theorem
 - Supplementary material: MWG, M.A
- 5 More Functions
 - Implicit Function Theorem, Inverse Function Theorem, Quadratic Forms

- Supplementary material: MWG, M.E
- 6 Unconstrained Optimization
 - Weierstrass Theorem, Taylor Polynomials, First Order Conditions and Second Order Conditions
 - Supplementary material: Sundaram Chapter 2, 3 and 4; MWG, M.J
- 7 Optimization with Constraints,
 - Lagrangean multipliers
 - Kuhn-Tucker Theorem
 - Envelope Theorem
 - Linear Programming
 - Supplementary material: Sundaram Chapter 5,6; MWG, M.K, M.L, M.M
- 8 Convexity
 - Convex Sets and Functions
 - Separation Theorems
 - Supplementary material: Sundaram Chapter 7 and 8; MWG, M.C, M.G
- 9 Inequalities
 - Cauchy-Schwarz
 - Jensen
- 10 Linear Algebra
 - Vector Spaces
 - Linear Transformations
 - Eigenvalues
 - Cholesky decomposition
 - Supplementary material: MWG, M.D
- 11 Fixed Points Theorems
 - Tarski Theorem
 - Contraction Mapping Theorem
 - Brouwer Theorem
 - Supplementary material: MWG, M.I
- 12 Dynamic Programming
 - Bellman Equations
 - Supplementary material: MWG, M.N
- 13 Difference Equations and Differential Equations

Grading

- Problem Sets (20%). There will be homework assignments. You may work on assignments in small teams, but each student is responsible for writing up and turning in independent answers. Turn in pdf files, generated by some version of TeX (e.g. LaTeX LyX is a good way to do this); diagrams can be drawn by hand and scanned (although computer-generated diagrams would be better). No late assignments will be graded.
- Midterm Exam (30%): There will be one midterm examination

– Midterm, 5:30 - 7:30, Friday September 1

• Final Exam (50%): There will be a final exam covering material for the entire course

- Final, 5:30 - 7:30, Wednesday September 13

Assignments