Syllabus for Math for Economists

ECO 385D, Fall 2017, Unique #34340

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Organizational Basics

We meet Mondays and Wednesdays, 2-3:30 pm in BRB 1.118. The TA's are Peter Toth and Jin Yan. Office hours will be arranged in the first class.

Overview and objectives

The first aim of this class is to cover the mathematical background necessary for your first year in graduate school in economics. This is optimization theory and a bit of probability theory: existence and characterization of optima; parametrized changes in optima; optima in stochastic situations; optima in dynamic situations; and optima in stochastic dynamic situations. A secondary aim is to introduce you to tools and perspectives that will be useful in the later years in your study of economics.

Texts

There is one required book, two recommended books for the course, as well as handouts and papers that will be circulated later in the semester.

- [Req.] D. Corbae, M. B. Stinchcombe, and J. Zeman, (2009). *An introduction to mathematical analysis for economic theory and econometrics.* Princeton University Press
- [Rec.] Sundaram, R. (1996). *A First Course in Optimization Theory.* Cambridge University Press
- [Rec.] A. Mas-Colell, M. D. Whinston, and J. R. Green (MWG), (1995) *Microeconomic Theory.* Oxford University Press

Schedule

The following is a rough guide to the topics and sources.

- Weeks 1-2: parametrized optima; value functions; the argmax correspondence; (monotone) comparative statics; the Kuhn-Tucker theorem. Sources: handout, Ch. 5-8 and 5-9 in Corbae *et al.*, Ch. 1-6 in Sundaram; Appendices M.A, M.C, M.D, M.J, and M.K in MWG, and R. Amir's "Supermodularity and Complementarity in Economics: An Elementary Survey," *Southern Economic Journal* 71(3), 636-660.
- Week 3-4: the spaces $\mathbb{R}^\ell$; the convergence and summability of sequences; completeness; compactness; continuity. Sources: Ch. 3 and 4.3 to 4.8 in Corbae *et al.* and/or your favorite real analysis textbook, Ch. 1-2 in Sundaram.
- Weeks 5-6: convexity; gradients; the Kuhn-Tucker theorem (redux). Sources: Ch. 5 in Corbae *et al.*, appendix M.H in MWG, Ch. 3 in Sundaram, and A. Nagurney's survey "Finance and Variational Inequalities," *Quantitative Finance* I, 209-317.
- Weeks 7-8: countably additive probabilities; measurability; cdf's and integrals; the Borel-Cantelli Lemma; dominated convergence; strong law of large numbers. Sources: Ch. 7 in Corbae *et al.*
- Weeks 9-10: convergence of random variables and probabilities; completeness of the L^p spaces; conditional expectations as projections. Sources: Ch. 8.1-4 in Corbae *et al*, and R. R. Bahadur's "On Fisher's Bound for Asymptotic Variances," *The Annals of Mathematical Statistics* 35(4), 1545-1552.
- Weeks 11-12: stochastic dynamic programming; the contraction mapping principle and value functions; structural properties of value functions. Sources: Ch. 4.11, 6.2, 8.10, and J. E. Smith and K. F. McCardle's "Structural Properties of Dynamic Programs," *Operations Research* 50(5), 796-809.
- Weeks 13-14: fixed points and equilibria; completely monotone functions and expected utility theory. Sources: Ch. 2.9, 5.11 and 12 in Corbae *et al*, and L. Eekchoudt and H. Schlesinger's "Putting Risk in its Proper Place," *American Economic Review* 96(1), 280-289.

Evaluation

- 60% on homework assignments. Each of the 7 two-week section will have a problem set. Your best 6 of the 7 scores will, at 10% apiece be your score on this.
- 40% on a final exam, exact format to be determined.

I encourage you to work together on the homework assignments. The aim of this course is to ease your work in mastering the knowledge offered in your other courses this year. This means that you should know how and when to use the various tools taught in this course, and how and when not to use them. Mostly, but not always, achieving this working knowledge is easier when work is done in groups.

However, I strongly advise you to avoid the temptation to "free ride" on the work of others. You will need to know how to use this material on your own when facing your own research problems, when facing the comprehensive exams. Learn the material, use it, absorb how to use it, but be sure to make it yours.