Boston University
Department of Economics

2008 PhD Summer Math Camp

Aug 12, 2008-Aug 22, 2008

Instructor	Yang Lu
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Office Hours	3pm-4pm (every day that we have class)
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Course Web Page	http://people.bu.edu/yanglu/

Classroom	**SSW 315**
Class Times:	Lectures: 10am-12pm, 1pm-2pm
	Problem sessions: 2pm-3pm

Schedule

M	T	W	Th	F	Sa	S
	12	13	14	15		
18	19	20	21	22		

Course Overview

The purpose of this course is to provide incoming economics PhD students with the mathematical background necessary for studying EC 705 (Mathematics for economists) in the fall. This course will help students get up to speed with new techniques, and also serve as a review and refresher for topics students may have forgotten.

Aside from covering mathematical tools, it is my hope that this course will mentally prepare you for graduate school. Thus, if you are interested, during this course we can have some informal discussions about what graduate school is like, what you can expect from your first year here, and strategies for succeeding in the graduate program.

Assignments

I will give daily problem sets relating to the material we discuss, and we will go over solutions in the afternoon problem sessions. Since this course is not for credit, I will not be collecting these assignments. However, I recommend that you solve these problems yourself prior to the problem session. This will help you to learn the materials, and it will give you a chance to start working in groups if you wish. It is very important that you learn to work together with other students. Because 1) this will be very helpful in getting through difficult assignments to survive the first year; 2) the people you work with now may later become your coauthors!

References

I try to make the math camp less dependent upon a textbook. So it is OK if you do not have any of the reference books/materials below. However, most of the topics we cover can be found in:

- Carter, M. (2001): *Foundations of Mathematical Economics*.

This book will be the primary reference of EC 705 (Mathematics for economists).

For the part after integration, I will follow:

- The *Appendix on Mathematical Methods* of Barro, R., and X. Sala-i-Martin (2003): *Economic Growth.*

This appendix is around fifty pages long and will be our first reference in differential equations and optimization theory. It also offers valuable shortcuts in linear algebra and multivariate calculus.

Optional:

If you have interest in Real Analysis, here is one very nice introductory book:
- Bartle, R., and D. Sherbert (2000): *Introduction to Real Analysis*

A real analysis book that is a step up from Bartle and Sherbert is:
- Rudin, W. (1976): *Principles of Mathematical Analysis*.

This book is for those who have some background in analysis or are willing to take a course in analysis (Rudin is the usual text for the 511-512 real analysis sequence in the BU math department).

If you are interested in other topics that are not covered in the math camp, here is an online resource containing a tremendous amount of free information, mostly in the form of lecture notes, on mathematics for economist.
- Econphd.net: http://www.econphd.net/notes.htm#Mathematics

Course Outline

This is a tentative outline of the topics for the summer math camp. Note that this list of topics is a bit ambitious for the amount of time we have, so we may not be able to cover everything. Topics marked with a * below will be of higher priority. Also, this list is subject to time-inconsistency and will be updated along the progress of the course.

I. Preliminaries* (2)
• Logical statements and proof techniques
• Elementary set theory

• Cartesian products and relations: sup/inf vs max/min, distance in R^n
• Open sets, and closed sets in R^n
• Convergence and compactness in R^n
• Functions as mappings
• Continuity of functions

II. Linear Algebra* (1.5)
• Vector spaces and subspaces; Linear independence and basis
• Linear functions and matrix representations
• Kernel and range
• Fundamental Theorem of Linear Algebra
• Inverse and Determinant
• Positive and negative definiteness, and semi-definiteness

III. Differentiation* (2)
• Definition and rules
• Mean Value Theorems, L'Hospital's Rule, and Taylor's Theorem
• Multivariable functions: Gradient and Hessian
• Vector-valued functions: Jacobian and derivatives of matrix functions
• The Implicit Function Theorem
• Homogeneous functions and Euler's Formula
• Concave (convex) and quasi-concave (quasi-convex) functions

IV. Integration (Riemann Integral) (0.5)
• Definition and basic properties
• Change of variables and integration by parts*
• The Fundamental Theorem of Calculus
• Differentiation with respect to the variable of integration

V. Difference and Differential Equations (2)
• Eigenvalues and eigenvectors *
• Systems of linear difference equations*
• First-order linear ordinary differential equations
• Systems of linear ordinary differential equations

VI. Static Optimization (1)
• Unconstrained maximization*
• Constrained maximization with equality constraints *
• Shadow price and Envelope theorem *
• Constrained maximization with inequality constraints

VII. Dynamic Optimization (optional)
• Discrete time: the Maximum Principle
• The Ramsey model and the transition dynamics
• From discrete time to continuous time: an analogue