Econ 205: Mathematics Overview

Late Summer 2008, Profs. Joel Sobel and Joel Watson

This course is a rapid review of topics in analysis, calculus, and optimization. The main objectives of the course are to (i) expose students to the basic mathematical definitions and methods that are used in the Ph.D. core sequences and (ii) stimulate interaction between the first-year class, in particular in fostering study groups that will be useful in the core courses. Some students will find the course challenging, while some with recent mathematics training will find much of the material review. Everyone should recognize the importance of ongoing mathematical study.

<u>Lecture Schedule</u>: 8:30-11:00 a.m. daily (Monday through Friday) from Tuesday, August 26, through Monday, September 15. *A lecture will be given on Labor Day (September 1) unless class participants agree to hold an extra afternoon class session on another day*. There will also be a problem-solving and help session every day or two in the afternoon; this session may also be occasionally used for the presentation of optional material. The classroom will be available most afternoons for students to work together on course material.

<u>Exams</u>: The final examination will take place on Friday, September 19, or on Monday, September 22 (everyone will take the examination on the same day). There will also be a few graded quizzes.

<u>Problem Sets</u>: Working through exercises is an important part of learning mathematics. The course outline includes a list of exercises from the textbooks; supplemental problems will also be provided. Students should work diligently on them. This work will neither be collected nor graded.

<u>Grading</u>: All entering Ph.D. students are required to pass the final examination of this course. Each students who takes the course for credit will receive a grade calculated as the maximum of his/her final exam grade and a weighted average of the final exam grade (75%) and grades on quizzes. Students with very good training in mathematics are allowed to skip the lectures, but *everyone* must take the final examination.

<u>Textbooks and Reference Material</u>: The following textbook is available at the bookstore:

(SB) Simon and Blume, *Mathematics for Economists* (Norton).

Having access to this or a comparable textbook is recommended. Students are welcome to use any other suitable book as a primary reference. Other textbooks that cover some of the course material are:

Binmore, *Calculus* and *Mathematical Analysis* (Cambridge)
Chiang, *Fundamental Methods of Mathematical Economics*,
Dixit, A., *Optimization in Economic Theory* (Oxford),
Intriligator, M., *Mathematical Optimization and Economic Theory* (Prentice-Hall),
(JP) Johnsonbaugh and Pfaffenberger, *Foundations of Mathematical Analysis*,
Marsden and Tromba, *Vector Calculus*, and
(N) Novshek, *Mathematics for Economists*.

Econ 205 Course Outline, Fall 2008, Profs. Sobel and Watson

Topic	Reading	Exercises
The Real Line		
1. Basic set theory, functions, real numbers, properties	JP 1, 3, 5	1.1-1.5, 5.1-5.5
(intervals, bounds, inf, sup, min, max)	N 1	
	SB 1, 2, A1	2.4, 4.1, 4.2
2. Mathematical induction; methods of proof	JP 6, 7	6.1, 6.2, 6.5, 7.3
	SB A1	
3. Sequences, subsequences, convergence	JP 10-14,	10.1-10.4, 10.9, 10.11, 11.9
	16 (to p50)	12.1-12.4, 13.1, 13.3, 14.1
	N 3	
	SB 29	
4. Bolzano-Weierstrass theorem, Cauchy condition	JP 18, 19	18.1, 18.2, 18.5, 19.1, 19.4
	SB 29	
5. Functions, limits of functions, continuity	JP 2, 30-33	30.1, 30.2, 30.8, 31.3, 32.5, 33.1, 33.2
	N 1	
	SB 2	
6. Differentiation	JP 48, 49	48.1, 48.2, 49.1, 49.2
(continuity, chain rule, l'Hopital's rule)	N 1	
	SB 2, 4	2.7-2.9, 211, 2.12, 2.15, 2.16, 3.1, 4.4-4.6
7. Mean-value theorems and Taylor's theorem	JP 49, 50	50.1, 50.2, 50.4
	N 1	
	SB 30	2.1, 30.7, 30.8
8. Univariate optimization, concavity, convexity	N 1	
(first- and second-order conditions)	SB 3	3.4, 3.5, 3.11
Euclidean Space and Vector Calculus		
9. Concepts of Euclidean space	N 2,3	3.1,3.4,3.6-13
(vectors, matrices, geometry of real-valued	SB 10, 12, 23	10.1-10.3, 10.11-10.13,
functions, metrics, open/closed/compact sets,		10.27-10.31, 10.32, 10.38-10.40
continuity, eigenvalues, quadratic forms)		23.1-23.5, 23.47-23.52
10. Differentiation	N 5	5.1-7
(gradient, continuity, chain rule,	SB 13, 14	13.17, 13.21, 14.1, 14.2, 14.11, 14.13,
iterated partials)		14.18, 14.20-14.22
11. Taylor's theorem	N 5	
	SB 14, 30	14.24.14.28, 30.13, 30.14
12. Unconstrained optimization, concavity, convexity	N 5	
(first- and second-order conditions)	SB 16, 17, 30	17.1, 17.2
13. Implicit function theorem, envelope theorem	N 7,8	8.2-5, 8.8, 8.10
	SB 15	15.6, 15.8, 15.13, 15.18, 15.21, 15.22
14. Overview of constrained optimization	N 5	6.1-36
(quasiconcavity, first-order conditions, =, ≥)	SB 18,19	18.2-18.7, 18.10-18.12, 18.15, 19.3, 19.4
[15. Overview of dynamic optimization]		
(continuous or discrete)		
16. Integration	(JP 51-58)	
	N 1	1.1-3
	SB A4	A4.1-A4.4
17. Overview of differential equations	SB 24, 25	
18. Lead-in for the core sequences (examples)		