University of Minnesota
Department of Applied Economics
Math Review Course
Summer 2017

DATES:
Monday Aug 7th – Friday Aug 25th

INSTRUCTOR:
Vanee Dusoruth
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TIME & PLACE:
M – F 9:00 am – 12:00 pm
Room 119 Ruttan Hall

OFFICE HOURS:
M – F 12:00 pm – 1:00 pm

Course Description.

This is a non-credit course for incoming Ph.D. students in Applied Economics and related fields. Current MS students may also participate if interested. In the next three weeks, the goal is to review the fundamental concepts that will be useful in the Microeconomic Theory sequence (APEC 8001– 8004) and Econometrics sequence (APEC 8211– 8212). Some sessions are more applicable to APEC 8001 – 8004 and others more for APEC 8211 – 8212.

Advanced method and field courses may require more advanced tools that may not be covered in this course. Please come prepared with pencil, paper and a calculator. In addition to reviewing key math and probability concepts, we will also work through several problems that will allow you to apply the tools we learn hands-on in class. I will assign some suggested exercises for you to work through after each class. Each morning when we meet, we will go over the exercises as a group. There are no grades assigned for this course.

Please note that for those of you who plan to take the Microeconomic courses in the Economics Department (ECON 8101 – 8104), another math review course is offered through the Economics Department. I highly advise you to consult with the Director of Graduate Studies: Dr. Joe Ritter (apecdgs@umn.edu) and your intake advisor to discuss whether this is an appropriate route for you.

Recommended texts.

While the texts listed here will be useful references in your first year study, they are optional for this course. I will be distributing my own notes during lecture.

- Mas-Colell, Andreu, Michael D. Whinston, and Jerry R. Green. "Mathematical Appendix" in Microeconomic Theory, 926-970. Oxford: Oxford University Press, 1995.
- Simon, Carl P., and Lawrence Blume. Mathematics for Economists. New York: W. W. Norton & Company, Inc., 1994.
- Takayama, Akira. Mathematical Economics. New York, NY: Cambridge University Press, 1997.
- Varian, Hal. Microeconomic Analysis. New York, NY: Norton & Company, 1992.

In addition to these reference texts, I may be drawing concepts and examples from the following books:

- Greene, William H. Econometric Analysis. Upper Saddle River, NJ: Prentice Hall. 2011.
- Howard & Rorres. Elementary Linear Algebra. New York, NY: John Wiley & Sons, Inc. 2000.
- Rudin, Walter. Principles of Mathematical Analysis. New York, NY: McGraw-Hill, 1976.
- Wooldridge, Jeffrey M. Econometric Analysis of Cross Section and Panel Data. Cambridge, MA: The MIT Press, 2012.
- Wooldridge, Jeffrey. Introductory Econometrics: A Modern Approach. Mason, OH: Thomson South-Western, 2006.

This course and related material is also guided by previous Math Review instructors namely: Adan Murillo, Martha Rogers, & Yanghao Wang.

Course Schedule.

This is a tentative schedule of the material I plan to cover in the upcoming weeks. As we progress through the course, some changes and adjustments are quite likely. Thank you for your flexibility. Let's have some math fun!

1. Introduction to mathematical notations and logic Aug 7

Goal: In this section, the objective is to get acquainted with useful mathematical notations that you are likely to encounter in economics, especially in theorems and proofs.

- 1.1 Mathematical notation
- 1.2 Numbers
- 1.3 Necessity and sufficiency
- 1.4 Theorems and proofs

2. Basic topology of the reals Aug 8

Goal: First, we define some topological properties of real numbers $\mathbb{R}$ and then review the set product R^n. Mainly, the idea is to go over important concepts such as completeness, transitivity and continuity which are essential to understanding many key definitions you will be exposed to.

- 2.1 Sets, sequences and limits
- 2.2 Open and closed sets
- 2.3 Convex sets
- 2.4 Bounded sets
- 2.5 Compact sets
- 2.6 Functions and properties of relations
- 2.7 Continuity

3. Calculus, differentiation and integrals Aug 9 – 11

Goal: After reviewing the rules of differentiation and integration, we examine the main concepts and theorems where economics and calculus come together. We visit partial derivatives and discuss how they play in definitions such as concavity and semi-definiteness. If these are new terms to you, no worries, we will cover these carefully.

- 3.1 One-variable calculus and rules of differentiation
- 3.2 Integrals and related properties
- 3.3 Maxima and minima
- 3.4 Review of Euclidean n-space
- 3.5 Multivariable calculus (*functions of several variables*)
- 3.6 Partial, total, and higher order derivatives

4. Real valued functions and correspondences Aug 14 – 16

Goal: We go through various topics related to functions and correspondences. These sections may seem quite abstract. However, they often relate to concepts in common economic knowledge. We touch on some intuitive examples from theory as we go through this part.

- 4.1 Definition of functions and correspondences
- 4.2 Homogeneous functions and Euler's theorem
- 4.3 Concavity and quasi-concavity in functions
- 4.4 Implicit function theorem

5. Fixed point theorems Aug 17

Goal: We briefly touch on the following theorems which are often invoked in economic theory, especially some important proofs that you'll be exposed to. Some of these will particularly be helpful in doing the heavy lifting to establish the existence of an equilibrium, for example. We will only briefly cover these so you are familiar with the concepts.

- 5.1 Brouwer's fixed point theorem
- 5.2 Kakutani's fixed point theorem

6. Matrices and linear algebra Aug 17 – 18, 21

Goal: In this part of the class, we go through some of the basic instruments that you will need in your econometrics courses. We also cover some more advanced matrix calculus that will be particularly helpful in micro theory.

- 6.1 Introduction to matrices and matrix operations
- 6.2 Transpose and trace
- 6.3 Matrix Calculus
- 6.4 Determinants, inverses and related properties
- 6.5 Systems of linear equations, independence and rank
- 6.6 Eigenvalues, & eigenvectors

7. Probability theory Aug 22 - 23

Goal: Changing gears a bit, we dive into the world of probability. Some basic knowledge of statistics is assumed. The aim is to give you a review of a handful of results, common probability distributions, and concepts that you may see in APEC 8211 - 8212 and encounter more broadly.

- 7.1 Random variables and distributions
- 7.2 Moments and properties
- 7.3 Covariance and correlation
- 7.4 Conditional expectation
- 7.5 Sampling distributions
- 7.6 Brief review of large sample distribution theory
- 7.7 Optimizing expected values

8. Unconstrained and constrained optimization Aug 24 - 25

Goal: Here, we tackle optimization and we'll use most of tools we learned so far. We typically require that objective functions, such as cost or profit functions, be tuned for optimal performance, often subject to a given set of constraints. A significant part of what we do in the first year of Micro involves some kind of optimization.

- 8.1 Unconstrained maximization
- 8.2 Kuhn Tucker and constrained maximization
- 8.3 Envelope theorem

9. If we get to it, on the last day we will have a "Miscellaneous" session on other random math concepts that may have been missed.