

# Math Review 2017

## Field of Economics

### Cornell University

July 29, 2017

**Instructor:** Ram Sewak Dubey  
**Office Hour:** 12:15 -1:15pm

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## 1 Overview

The Field of Economics offers the August Math Review Course for incoming first-year Ph.D. students. The aim of this review is to refresh students' mathematical skills and introduce concepts that are critical to success in the first year economics core courses, i.e., Econ 6090, Econ 6130, Econ 6170, and Econ 6190. The emphasis is on rigorous treatment of proof techniques, underlying concepts and illustrative examples.

There is usually a great deal of variation in the mathematical background of incoming first-year students. However, almost all students have something to gain from the review course. For those who do not have an adequate mathematics background (by a US Ph.D. standard), the course offers an opportunity to catch up on critical concepts and get a head start on the fall classes. For those who took their core undergraduate courses in analysis and algebra some years ago, the course is a good refresher. For those who do not have significant experience with technical courses taught in English, the review offers an opportunity to pick up the math vocabulary that will be in use from the first day of regular instruction.

The Math Review Course is funded by the Department of Economics. There is no charge for students matriculating into the Economics Ph.D. Program. Students matriculating into other Ph. D. programs should contact the Director of Graduate Studies in their Field. There will be a charge for these students, and the DGS in the student's Field must make arrangements to pay that charge before the student may attend the Math Review Course.

The Math Review Course is *not* linked to Econ 6170, Intermediate Mathematical Economics I. There is no course grade, and no record will be kept of your performance. However, the Economics Ph.D. program strongly encourages you to attend. Most students who have taken this course in past years have found it useful, regardless of their prior mathematics training. Perhaps most importantly, the review period is an excellent time to get acquainted with other incoming students, meet the faculty and settle into Ithaca.

## 2 Course Schedule

The course duration will be July 31- August 18. There will be a lecture session each working day. The room for all the sessions is URIS 202.

(A) Session Time:

July 31-August 4, August 7-11, 14-18

Time: 9am-Noon.

(B) There will be a handout of some basic definitions distributed at each session, and practice problems will be assigned on each topic. You are strongly encouraged to at least attempt every problem, as this is the best way to understand the material. The problem sets will be due the following day in class (for example, the problem set given in class on Monday will be due on Tuesday) and I intend to grade some of the questions in each problem set. We will go over the solutions to the problem sets in class.

## 3 Topics covered

- A. Elements of Logic: Statements, Truth tables, Implications, Tautologies, Contradictions, Logical Equivalence, Quantifiers, Negation of Quantified Statements
- B. Proof Techniques: Trivial Proofs, Vacuous Proofs, Direct Proofs, Proof by Contrapositive, Proof by Cases, Proof by Contradiction, Existence Proofs, Proof by Mathematical Induction
- C. Set Theory: Definitions, Set Equality, Set Operations, Venn Diagrams, Set Identities, Cartesian Products, Properties of the Set of Real Numbers
- D. Sequences: Convergent Sequences, Subsequences, Cauchy Sequences, Upper and Lower Limits, Algebraic Properties of Limits, Monotone Sequences

- E. Functions of One Variable: Limits of Functions, Continuous Functions, Monotone Functions, Properties of Exponential and Logarithmic Functions
- F. Linear Algebra: System of Linear Equations, Solution by Substitution or Elimination of Variables, Systems with Many or No Solutions
- G. Vectors *I*: Addition, Subtraction, Scalar Multiplication, Length, Distance, Inner Product
- H. Matrix Algebra *I*: Addition, Subtraction, Scalar and Matrix Multiplication, Transpose, Laws of Matrix Algebra
- I. Determinants: Definition, Computation, Properties, Use of Determinants, Matrix Inverse, Cramer's Rule
- J. Vectors *II*: Linear Independence,  $\mathbb{R}^n$  as an example of Vector Space, Basis and Dimension in  $\mathbb{R}^n$
- K. Matrix Algebra *II*: Algebra of Square Matrices, Eigenvalues, Eigenvectors, Properties of Eigenvalues
- L. Differential Calculus: Derivative of a Real Function, Mean Value Theorem, Continuity of Derivatives, L'Hospital's Rule, Higher Order Derivatives, Taylor's Theorem
- M. Functions of Several Variables: Graphs of Functions of Two Variables, Level Curves, Continuous Functions, Total Derivative, Chain Rule, Partial Derivatives
- N. Unconstrained Optimization: First Order Conditions, Global Maxima and Minima, Examples
- O. Constrained Optimization with equality constraints: First Order Conditions, Constrained Minimization Problems, Examples
- P. Constrained Optimization with inequality constraints: Kuhn-Tucker conditions, Interpreting the Multipliers, Envelope Theorem

## 4 Textbook

There is no textbook for the math review course, however the following books may be helpful. The textbook Mas-Colell et al. (1995) is used in the Microeconomics course sequence. Simon and Blume (1994) and Wainwright and Chiang (2005) are useful textbooks

for Mathematical Economics. It will be useful to refer to Simon and Blume (1994) for understanding the material. Copies of this textbook are available in the libraries. Stricharz (2000) will be our reference book for analysis. Dixit (1990) contains many useful examples. Mitra (2013) is the set of Lecture Notes used in Econ 6170. It should be available at the bookstore at the start of the course.

## 5 Mathematics Proficiency Test

A Mathematics Proficiency Test will be given on Friday, August 18, 2017 from 12:30pm - 3:30 pm in URIS 202. The test will be based on the course material of Economics 6170. If you pass this test, you have satisfied the mathematics proficiency requirement of the field of economics, and need not take the Economics 6170 course. If you fail this test, or if you do not take this test, you can complete the mathematics proficiency requirement of the field of economics by taking the Economics 6170 course for credit, and getting a course grade of B- or better.

If you would like any more information, you can contact me at [rsd28@cornell.edu](mailto:rsd28@cornell.edu). Enjoy your summer and I look forward to meeting you in August.

## References

- Dixit, A. K., 1990. Optimization in Economic Theory, 2nd Edition. Oxford University Press, USA.
- Mas-Colell, A., Whinston, M., Green, J., 1995. Microeconomic Theory. Oxford University Press, USA.
- Mitra, T., 2013. Lectures on Mathematical Analysis for Economists. Campus Book Store.
- Simon, C. P., Blume, L., 1994. Mathematics for Economists. W. W. Norton & Co., New York.
- Stricharz, R., 2000. The Way of Analysis. Jones and Bartlett.
- Wainwright, E. K., Chiang, A., 2005. Fundamental Methods of Mathematical Economics, 4th Edition. McGraw Hill, New York.