COURSE DESCRIPTION

Students in economics need several important mathematical tools. These include calculus for functions of one or several variables as well as multivariate optimization of one or several constraints. Linear algebra is also used in economic theory, econometrics and has important applications to game theory. Such tools are helpful not only for economic theory, but also in many branches of applied economics, including public finance, industrial organization and labor economics.

This course has two goals: (i) it will provide some mathematical tools needed to understand important concepts in economics; (ii) it will show how these mathematical tools are applied in seminal topics in economics.

The course will be divided in two parts. The first part will cover mathematical topics, such as real analysis, linear algebra and optimization. The second part applies the math tools learned in the first part to fundamental topics in economics, such as game theory, auction theory and information economics.

This course will make full use of basic differential and integral calculus listed in the prerequisites. Please do not register for this class if you do not thoroughly understand those topics.

Prerequisites: Econ 300, 301, Math 203, 215, 215A, 241 or 251A.

Learning objectives:

This course is intended to assist economics majors in becoming comfortable with the basic mathematical tools used in economic analyses. This course is designed to accomplish the following learning objectives. Students should develop skills that allow them to:

1) Thoroughly understand mathematical methods and concepts employed in economic models. Mathematical techniques include, but are not limited to, differential calculus, linear algebra, constrained optimization using the Lagrange multiplier method and select topics in real analysis.

2) Competently apply mathematical methods in problems and applications that aim to analyze economic problems.

Mastering these goals will prove useful in concurrent and later courses as well as in future work and research. It will also provide a solid foundation that will allow undergraduates to provide useful analytical economic services to an employer. Finally, an understanding of mathematical economics will allow students to comprehend the articles in the leading economics journals and keep up with advances in economic science after graduation.
TEXTBOOKS

A mix of the following books:


A revised version of the required books will be provided on the first class. Do not buy books until advised in class.

ASSESSMENT

There will be regular homework assignments, a midterm exam and a final exam.

Homeworks: 30 %
First midterm: 30 %
Final Exam: 40 %

Class participation will be a consideration in marginal cases. Students are responsible for attending all class meetings, to submit homeworks on time, participate in discussion, and to hear announcements about adjustments to the schedule. Lectures will often present material not in the textbook. You are nonetheless responsible for understanding such material. If you don’t understand it, ask for further explanation or additional references.

There will be no make-up exams. You are required to take the exams during class time when scheduled.

TENTATIVE TOPICS
(some of them may be skipped)

Part I. Mathematical tools

1. Logic, Sets, and Real Numbers
2. Mappings, Vector Spaces, Norms, Metrics
3. Basic topology
4. Linear algebra
5. Continuity and differentiation
6. Unconstrained optimization
7. Constrained optimization (The Lagrange Theorem, The Kuhn-Tucker Theorem)
8. Probability, Bayes rule (i.e., conditional probability)
9. Risk, risk aversion, stochastic dominance
Part II. Applications

1. Introductory game theory
   - Sub-game perfect Nash equilibrium. Reinhard Selten, Nobel prize winner 1994
   - Incomplete information games. John C. Harsanyi, Nobel prize winner 1994

2. Modeling knowledge
   - Agreeing to disagree. Robert J. Aumann, Nobel Prize winner 2005
   - (Milgrom-Stokey) No-trade theorem. Paul R. Milgrom, Nemmers Prize winner 2008
   - E-mail game. Ariel Rubinstein, Nemmers Prize winner 2004

3. Auction theory
   - Optimal auction design. Roger B. Myerson, Nobel Prize winner 2007

4. Bargaining
   - Rubinstein bargaining model. Ariel Rubinstein, Nemmers Prize winner 2004

5. Information Economics
   - Lemmon market. George A. Akerlof, Nobel Prize winner 2001

6. Implementation theory (Mechanism design theory)
   - Nash implementation. Eric S. Maskin, Nobel Prize winner 2007
   - VCG mechanism. William Vickrey, Nobel Prize winner 1996

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