

## Mathematical Economics

Instructor Roger D. Congleton

E-mail: Congleto@gmu.edu

Website: RDC1.net

Office 11 Carow Hall

Phone: 993 2328 office

Office Hours: Tuesday: 1:15 - 2:45, Thursday 1:15 - 2:45 and by appointment

### Main Texts and References:

The Class Notes are the main text for the course. PDF **versions of the class notes** are available at the class website: <http://rdc1.net/class/MathEcon/MAindex.html>

Chaing, A. C. and K. Wainwright (2005) *Fundamental Methods of Mathematical Economics*[Paperback] McGraw Hill Higher Education; 4th edition (June 1, 2005)

### Optional Text and References:

Dixit, A. K. and Nalebuff, B. J. (1993) *Thinking Strategically : The Competitive Edge in Business, Politics, and Everyday Life*. New York: W.W. Norton & Company; ISBN: 0393310353

Debreu, Gerard (1975) *Theory of Value* New Haven: Yale University Press. (paper)

### Other Useful Text:

McCain, R. A. (2009) *Game Theory and Public Policy* (Edward Elgar - Dec 9, 2009)

## Overview and Purpose of Course

The purpose of this course is to introduce the students to "model building" as practiced by the economics profession and rational choice strands of political science and sociology. To this end, students are introduced to the mathematical tools and concepts that are most frequently used in economic models of the firm and consumer behavior. The course focuses on mathematical representations of optimizing individuals in a wide variety of "choice settings." The models can be used to analyze decision making in any setting in which individuals have reasonably clear goals (objective functions) and confront reasonably clear constraints. The methods developed can be used to analyze traditional economic decisions by firms and consumers, and other choice settings in politics and law.

The course is lecture and note based. All of the core material is covered in class and in the lecture handouts. The textbooks provide additional material and explanations that may help students better understand the concepts and tools developed in class. The textbooks also serve as a reference library for those whose models demand additional tools and to decipher published work that use additional tools.

As in any mathematics or economics course, successfully mastering the material means that the student should be able to apply the mathematical tools and concepts to model settings beyond

those explicitly covered in class. For example, the term paper requires students to analyze a choice setting or economic problem of their own design using the tools developed in class.

### TENTATIVE COURSE OUTLINE

Date	Topic	Chapter Readings
9/2	<b>I. Introduction: The Mathematical Analysis of Rational Choice</b> Scope of Course, Usefulness and limitations of deductive methodology. <b>Mathematical Concepts:</b> weak ordering, compact sets, convexity, continuity, functions.  <b>Economic Applications:</b> consumer theory, the theory of the firm <b>Problems:</b> Handout, V1.1, 1.6, 1.11 (See also C12;V7; M1)	CW: 1-3
9/09	<b>II. Derivatives and Optimization</b>  <b>Mathematical Concepts:</b> partial derivative, chain rule, first and second order conditions, concavity, quasi-concavity, homothetic functions, objective function, constraints, substitution method.  <b>Economic Applications:</b> the profit maximizing firm, cost-benefit analysis <b>Problems:</b> Handout, V3.1, 3.4, 3.5, 3.3, 4.1 (See also C9; V27 )	CW: 6, 7.1-7.5,12.5-12.9
9/16	<b>III. Scarce Resources: Constrained Optimization</b>  <b>Mathematical Concepts:</b> Lagrangian multipliers, Lagrangian method, Kuhn -Tucker method, Kuhn Tucker Sufficiency Theorem, Arrow-Enthoven Sufficiency Theorem  <b>Economic Applications:</b> Consumer Theory, Social Welfare Functions <b>Problems:</b> Handout, C12.2 1,3,4; C12.5 1,2; V: 7.2, 7.5 (See also C12,21; V9,10)	CW: 9, 12.5-12.9, 13.4
9/23	<b>IV. Comparative Statics in Abstract Models: The Implicit Function Theorem</b>  <b>Mathematical Concepts:</b> derivatives of implicit functions, neighborhood, continuity, duality. <b>Economic Applications:</b> Supply and Demand, Reaction functions <b>Problems:</b> C8.5 1,2,3 C8.6 1,2,4 ; V 5.1, 5.2, 5.3, 5.4, 6.1,6.3 (See also C8;V6, Mme)	CW: 8.1-8.5 , 13.4-13.5
9/30	<b>V. Time and Uncertainty in Economic Choices</b>  <b>Mathematical Concepts:</b> Probability Function, Series, Expected Value, Present Value, Convergence, Limit Point, Taylor Series, <b>Economic Applications:</b> Intertemporal choice, Decision making under uncertainty, Stability analysis.	LF: 4.4

**Problems:** Handout, C6.6 1,2,3 C6.7 4 C13.5 4,5; V11.5, 11.9, 11.11 (See also C6.6, 13.5; V11, Mmf)

10/07 **VI. More on Decision Making under Uncertainty**

**Mathematical Concepts:** Probability Density Function, Integrand, definite and indefinite integrals, risk aversion, subjective rate of time discounting.

**Economic Applications:** Continuous Discounting, Economic Growth, Risk and Uncertainty, Totals from Marginals, Measures of Risk Aversion

**Problems:** Handout, C13.2 1,2,4 C13.5 1,2 C13.6 2 ; V11.7; K3:3,4,5,8 (See also C13, V11, M6)

10/14 **VII. Applications of the Rational Choice Model**

CW: 16.4-16.5

To Crime: The Wealth Maximizing Criminal (Becker, *JPE* 1968: 169-217)

To Politics: Tax Revenue Maximizing Leviathan (Buchanan and Brennan, *JPubE*, 1977: 255-73)

To the selection of a Central Banker (Waller, C. J., *AER*, 1992: 1006-12)

To the assignment of liability to lenders (Lewis and Sappington, *AER*, 2001:724-730.)

10/21 **VIII. More Applications and Review for Midterm (study guide handout)**

10/28 *Midterm Exam*

11/04 Exams returned and Reviewed

11/04 **IX. The Existence of General Equilibrium** (short lecture, as time permits)

LF 6.3

**Mathematical Concepts:** weak preference ordering, excess demand correspondence, Walras' law, upper semi-continuity, Brouwer's fixed point theorem, Kakutani fixed point theorem

**Economic Application:** Walrasian Equilibrium

**Problems:** Handout, V 17 1-6, 11,13, (See also V17, 21; Debreu 5,7; M 15-17)

11/11 **X. Interdependent Decisionmaking in Small Groups: An Introduction to Game Theory**

M:2-3

**Mathematical Concepts:** strategy, payoff, non-cooperative games, pure and mixed strategies, Existence of Nash equilibrium, prisoner's dilemma game, zero sum game

**Economic Applications:** Reaction (best reply) Functions, Duopoly, Monopolistic Competition, Tragedy of the Commons

**Problems** Handouts: V15.1, 15.3,16.10, V15.2, 15.7 (See also V15, M7)

11/18 **XI. Applications of Non-Cooperative Game Theory** M: 4-7

**Economic Applications:** contest success functions, Stackelberg games, rent-seeking, anarchy, and the courts--also if time permits: contract enforcement, coalition formation, majority rule cycles Externality Theory, Signalling and Screening (Varian, Chapter 25), Contract Design and Enforcement: Moral Hazards, Separating and Pooling Equilibria.

**Problems** V15.2, 15.7, M9:B5, B7, B11, B14 (See also V15; K8,9.)

11/25 THANKSGIVING BREAK *no class*

12/02 **XII. More Applications of Non-Cooperative Game Theory** M: 3-7

Static and dynamic competition, Applications from Hirschliefer and, also, if time permits:

R&D in Duopoly (D'Aspermont and Jacquemin, *AER*, 1988: 1133-1137.)

Theory of Anarchy (Skaperdas, *AER*, 1992:720-739.)

Political Influence and Dynamic Consistency (Garfinkel and Lee, *AER*, 2000: 649-666)

Problems M: 13B3, 13B4, 13B8, 14B1, 14B3, 14C4, 14C8

12/09 **Papers Due**

12/09 XIII. Review for Final Study Guide/Class Notes

12/16 **Final Exam: 7:30-10:15** (necessarily comprehensive, but oriented toward material covered in second half of the semester)

**Grades:**

70%	2 exams
25%	1 Short Paper using Math-econ tools on a topic of interest
<u>5%</u>	Homework (from handouts)+Class Participation Bonus
100%	

**Grades are based on the following set of minimums**  $A > 88$   $B > 77\%$   $C > 66\%$

**For Additional or Extended Study, See:**

Varian, Hal R. *Microeconomic Analysis* 3rd Ed. New York: W. W. Norton and Co., 1992. ISBN 0 393 95735 7.

De La Fuente, A. (1999) *Mathematical Methods and Models for Economists*. New York: Cambridge Univ Press (Paper Edition, Trd); ISBN: 0521585295

Hirschliefer, J. (2001) *The Dark Side of the Force: Economic Foundations of Conflict Theory* Cambridge: Cambridge University Press, 2001, 366 pp (paper).

Dixit, A. K. and Nalebuff, B. J. (1993) *Thinking Strategically: The Competitive Edge in Business, Politics, and Everyday Life*. New York: W.W. Norton & Company; ISBN: 0393310353

Chiang, A. C., *Elements of Dynamic Optimization*, McGraw Hill, 1992.

Debreu, G. *Theory of Value*, Cowles Foundation Monograph 17, New Haven: Yale University Press, 1959.