**BOSTON COLLEGE**
Department of Economics

**Math for Economists (EC 311.01 – Fall 2011)**
Campion 302: T Th (12 – 1:15)

*Economists don't use a lot of math, but they do use math a lot!*

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This is an introductory course in the use of mathematical methods in economics, with an emphasis on model building and analysis. The approach is two dimensional:

- Mathematics: we will cover topics in univariate and multivariate calculus, linear algebra, real analysis, optimization, and if time permits, difference and differential equations. (Note that the course is misnamed: there is in fact a second semester *Math for Economists* course, which we call *Econometrics*.)
- Economics: we will be working through a large number of applications in micro- and macroeconomics.

This is an Economics course… with a focus on the language of mathematics, and tools and applications (rather than lemmas, theorems and proofs). If you are really just interested in the math, I recommend the math department, which offers excellent courses in each of the topic areas listed above.

Most of you are taking other economics courses, which will be using some of the tools we are covering in this class. Please let me know if there are particular applications that you'd like to see us cover, and I'll try to work those into the semester.

**Prerequisites**: At least one intermediate economics course (EC 201, 202, 203 or 204) and MT 100 (or its equivalent). No exceptions. Students also should have taken at least one math course at Boston College (if your last math class was high school calculus, this course may be too advanced for you).

**Required text**: Jeffrey Baldani, James Bradfield, and Robert Turner, *Mathematical Economics, 2nd ed.* (BBT)

A copy of BBT will be placed on reserve at the O'Neill Library. Also: I will be distributing and posting fairly detailed lecture notes.

**Some additional texts:** There is no need to purchase any of these (most are available at O'Neill). I list them just because sometimes it is useful to see a different presentation of the material. Warning: Most of these are more technical than BBT.

- Carl P. Simon and Lawrence E. Blume, *Mathematics for Economists* (New York, NY: Norton, 1994).
- Malcolm Pemberton & Nicholas Rau, *Mathematics for Economists: An Introductory Textbook, 2nd ed.* (Manchester, UK: Manchester University Press, 2006)
- Michael Klein, *Mathematical Methods for Economics, 2nd ed.* (Reading, MA: Addison Wesley, 2001)

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- Alpha C. Chiang and Kevin Wainwright, *Fundamental Methods of Mathematical Economics, 4th ed.* (New York, NY: McGraw-Hill, 2005).
- Michael Hoy, John Livernois, Chris McKenna, and Ray Rees, *Mathematics for Economics, 2nd ed.* (Cambridge, MA: MIT, 2001)

**Grading**:

- Two Mid-Term exams (50% total): the first exam will be in mid-October and be based on Chapters 1-4 of BBT; the second exam will cover Chapters 5-8 and take place in mid-November. (You will have at least one week's notice of the actual mid-term exam dates.)
- Comprehensive Final exam (40%): Monday, Dec 19th @ 12:30 PM.
- Problem Sets (10%): There will be about five problem sets over the course of the semester, each graded on a 10 point scale. Feel free to work together on these, but please submit your own write-up. Course grades on Problem Sets will be curved.

Only in extraordinarily compelling situations will I even consider the possibility of a "make up" exam. It is your responsibility to plan your schedule accordingly.

**BlackboardVista**: All handouts, problem sets, exams, and answers will eventually be posted on the course's BlackboardVista site. Let me know if you have trouble accessing that material.

**Calculators/computers**: You are not allowed to use programmable, graphing, or business calculators, computers, phones or similar electronic devices during the exams or quizzes. You may use five function calculators {+, -, *, /, =}… however, they will be probably be unnecessary as the quiz and exam questions will be written so that the arithmetic will be *so simple that even a cave man could do it*.

**Academic Integrity:** The Deans have requested that I remind you that you will be held to Boston College's standards of academic integrity. If you have any questions as to what that means, please go to http://www.bc.edu/integrity .

**Topics**:

We will be following the presentation in BBT (the outline numbers below correspond to the BBT chapters). I may pick and choose amongst the applications if we get behind schedule.

As with all great things,[1] the course divides into three parts (with an exam following each Part):

A. Univariate Calculus and Linear Algebra
B. Multivariate Calculus and Unconstrained Optimization
C. Constrained Optimization

[1] This is, of course, a reference to the opening line in Caesar's *Gallic Wars*: "Gallia Est Omnis Divisa in Partes Tres."

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**Part A: Univariate Calculus and Linear Algebra**

1. Introduction: Mathematical models; Optimization; Envelope theorem; Appendix (calculus review)
2. Optimization Intro – Applications
   - Micro: Labor unions; Profit maximization (differing market structures; taxes)
   - Macro: Simple Keynesian model I
3. Matrix Theory – Linear Algebra: Scalars, vectors and matrices and operations; Systems of linear equations; Inverse and identity matrices; Cramer's Rule
4. Linear Models – Applications
   - Micro: Competitive markets; Differentiated products; Duopolies
   - Macro: Simple Keynesian model; ISLM

**Part B: Multivariate Calculus and Unconstrained Optimization**

5. Multivariate Calculus: Partial and total derivatives; Differentials; Implicit functions; Level curves; Homogeneity
6. Multivariate Calculus – Applications
   - Micro: Tax incidence (differing market structures); Utility maximization; Homogeneity of demand (consumers and producers)
   - Macro: Balanced budget multipliers; Monetary policy effectiveness
7. Unconstrained optimization: Optimization (univariate and multivariate); Concavity and convexity; Positive and negative definiteness; Comparative statics
8. Unconstrained optimization – Applications
   - Micro: Cost minimization; Efficiency wages; Multiplant firm; Multimarket monopoly; Pollution taxes and emissions
   - Statistical estimation: OLS

**Part C: Constrained Optimization**

9. Constrained optimization with binding constraints: Lagrangian methods; Comparative statics; Value functions and Lagrange multipliers I
10. Constrained optimization with binding constraints – Applications
    - Micro: Cost minimization and conditional demand; Profit and utility maximization; Labor supply; Pareto efficiency
    - Macro: Inter-temporal consumption; Transactions demand for money

This is the likely end of the semester … But if there is time, we will continue with selections from the following (likely beginning with Chapters 15 and 16):

11. Constrained optimization with inequality constraints: One variable optimization; Non-negativity constraints; Inequality constraints (Kuhn Tucker); Linear programming (and duality)
12. Constrained optimization with inequality constraints – Applications
    - Micro: Utility maximization; Two-good diet problem; Sale maximization; Labor supply
    - Macro: Inter-temporal consumption (with liquidity constraints)
13. Value functions and the Envelope Theorem: Unconstrained optimization; Constrained optimization; Lagrangian multipliers
14. Value functions and the Envelope Theorem – Applications
    - Micro: Roy's Identity; Shephard's Lemma; Duality; Slutsky symmetry conditions; Cost functions (TC, MC and AC): SR and LR; Two part tariffs; Ramsey taxes
15. Dynamics: Difference and differential equations; Appendix (eigenvalues and eigenvectors; dynamic optimization)
16. Partial adjustment models
    - Micro: Marshallian (quantity) adjustment; Cobweb; nFirms in an oligopoly; Fisheries
    - Macro: ISLM; Philips curve; Solow growth model

**In Addition**: While I think that BBT text is excellent, we may cover some additional topics (which, as far as I can determine, are not in that text), including, but not limited to:

- Sets (closed, bounded and compact); correspondences; inverse functions
- Cartesian products and Euclidean space; rank and linear (in)dependence
- Limits and convergence; present values
- Continuous and monotonic functions
- First and second order Taylor series approximations; differentiability; gradients
- Exponents and logarithms
- Integration (briefly)
- Very simple topology: Fixed point theorems

These topics will be woven into the material.