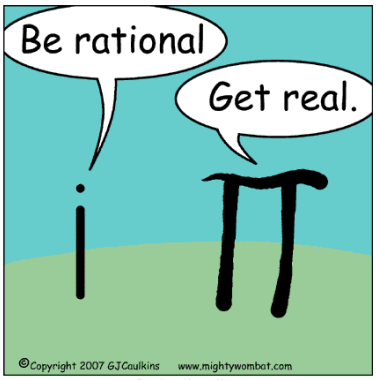
# Mathematical economics

## Course outline

This is a course on the basic mathematical methods necessary for understanding the modern economics literature and the following cartoon.




An understanding of mathematical methods is necessary if you are to engage the literature – whether or not you want to use them in your own research. To illustrate this, here are abstracts of some papers that were published in the American Economic Review Papers and Proceedings 2007, which means that they are at the cutting edge of the literature. I am sure that you will find at least one of these papers interesting. On my website, you can download the papers and you will find that all of them require basic mathematical economics for you to understand them.

### The transparency of politics and the quality of politicians

by Andrea Mattozzi and Antonio Merlo

The article looks at transparency in government and how it affects the quality of political candidates. It points out that potential political recruits are heterogeneous with respect to their political skills and as a result may work in the market sector or work for the party and become a professional politician. If they go into politics, they are of benefit to the party only if they are able to raise at least enough funds to cover his or her salary, which is determined in equilibrium by the outside option of working in the market sector where individuals are paid based on their expected political skills. The article makes the supposition that an increase in the transparency of politics reduces the average quality of politicians.

### The neuroeconomic theory of learning
by Andrew Caplin and Mark Dean

The article focuses on neuroeconomic research. Neuroeconomics suggests that economics are influenced by base human biological urges. The article gives the example of risk aversion, which to an economist captures preferences among wealth lotteries, and from a neuroscientific viewpoint is a broader concept related to the amygdala and fear responses. The article talks about the need for a common conceptual language. The article states that while the natural assumption within economics is that inference is Bayesian, this assumption lacks predictive power in complex environments.

### How occupied France financed its own exploitation in WWII
Filippo Occhino, Kim Oosterlinck and Eugene White

The article examines the fiscal policies by which the Vichy government of Occupied France in World War II financed the payments demanded by Germany after the 1940 armistice. It also presents the policies the post-Liberation French government imposed to deal with the aftermath of those costs. Currency exchange rates imposed by Germany made French goods cheap to purchase, in effect financing the occupation of France through French economic activity. Wage and price controls led to contraction of the French economy exacerbated by the forced draft of French labor for the German economy. The Vichy government was left with an accumulation of debt. The postwar government of France raised taxes, but did so to finance social expenditure, coping with the debt by allowing rampant inflation to lower its value.

### Inequality and happiness
Karen Dynan and Enrichetta Ravina

The article examines whether the well documented increase in U.S. income inequality has affected the relative subjective happiness in different income groups. The study's methodology and mathematical foundation are given. An increase in income is found to significantly raise an individual's reported happiness. However, when other variables are introduced, discrepancies in that pattern are found. Persons with above-average incomes who are not extremely wealthy are more likely to gauge their happiness by comparison to other persons in their group within geographic proximity, i.e., their neighbors. Members of below average income groups are much less likely to do the same. This suggests the relationship between income and happiness is a complex one.

### Guilt in games
Pierpaolo Battigalli and Martin Dufwenberg

In this article the authors attempt to develop a model than can measure guilt. They develop game forms that result in a monetary payout to participants as a result of the action of another individual. Strategic failure to secure that payment would incur guilt, according to the authors. The article seeks to evolve measures that could be applied to economic circumstances that could be affected by guilt. The authors suggest that guilt would have the most impact in circumstances that might alter the well being of social groups, in contractual obligations and for work teams.

## Course details

Course code: Econ 630
Class time: Th 7.20pm-10pm, Fall 2008
Date of midterm I: 9/11 (see Prerequisites section for more details)
Date of midterm II: 10/23
Date/time of final: 12/11 7.30pm
Class location: East Building 122

Class website: http://www.omar.ec/ and then go to teaching

Course instructor: Omar Al-Ubaydli (just call me Omar)
Email: omar@omar.ec
Office hours: Tuesday 2-3pm in Enterprise 346

Teaching assistant: Billy Foster
Email: wfoster1@gmu.edu
Office hours: Wednesday 6-7pm in Enterprise 346

If you are a student with a disability and you need academic accommodations, please see me and contact the Office of Disability Resources at 703-993-2474. All academic accommodations must be arranged through that office.

Make sure that you regularly check your email as official class and university communications will occur over email.

## Prerequisites

Admission to the PhD programme at GMU requires at least one year of calculus and one year of statistics. Apart from a quick-fire review that I will do at the beginning of the course, this material will be assumed.

For those who are rusty or uncertain, I recommend that you purchase a copy of the Edward Dowling's *Introduction to Mathematical Economics* (McGraw Hill). Amazon.com sells them for about $13. Familiarise yourself with the following chapters: 1-4, 7-10, 14-15. The first midterm will occur on the third class and will essentially cover this material. The material covered by the chapters is:

*Basic differentiation, basic unconstrained optimisation, exponential/logarithmic functions, elementary linear algebra, basic definite/indefinite integration.*

There is also a good chance (we are awaiting confirmation) that there will be a math boot camp during August that will help students in this material. This will not be essential. Further details will be sent as soon as they are confirmed.

## Grading

There will be 2 midterms, a final and 4 problem sets. The weighting will be: problem sets (20%), midterm I (10%), midterm II (30%), final (40%).

While there is no grade for class attendance, you are strongly recommended to attend class as the manner in which material is presented will often deviate substantially from the main text. Moreover, some material will only be covered in class. All material covered in class is examinable.

You can work together on homework in groups of no more than two, but you still have to hand in work individually. If you collaborate with another, please write down the name of your colleague on the assignment that you turn in.

All answers to problem set and exam questions require *full* workings for full credit. If only the answer is given without any workings, the answer will receive zero points, regardless of whether or not it is correct.

The distribution of the final letter grades is not fixed in advance (i.e., I do not grade purely on a curve). **However to pass the course, you must demonstrate an understanding of the basic concepts covered.** Regardless of your research preferences, you will almost certainly come across substantial mathematical material. There are a few fields that have only limited applications of mathematical methods. However the department does not want you taking these fields just because you can't do the maths in the other ones. Passing this course is essential to demonstrating that.

When I set exams, 'demonstrating an understanding of the basic concepts' usually (but not always) corresponds to a score of approximately 50%. I do this because I want to maximise the variation in grades based on ability rather than good/bad luck on the day of the exam. For example, if a B corresponds to about 85%, then I'm sure you've all taken exams where you knew the material well but a couple of silly mistakes take you down from a A to a B. This kind of thing rarely happens in my exams.

Thus, for my class, any preconceptions you have about what score corresponds to what grade based on your previous education should be disregarded. Your measure of success in an exam is: 'how much understanding did I demonstrate', not 'how many points did I get'.

## Readings

It is very difficult to have a unique textbook for this course. All the ones that I have found are either too applied, lacking some important formalism, or too formal, lacking applications and operating more as reference texts.

The implications are that you should:

1. Make sure you attend class because class notes are paramount.
2. Wait before deciding which textbook to buy.
3. I will try to post scanned chapters from various textbooks within copyright guidelines to limit your need to purchase more than one book.

The principle course text book will be:

Simon and Blume (1994) *Mathematics for Economists*. Norton (1st edition).

Additional textbooks that you may find useful and that I will draw from are:

Dowling (2000) *Introduction to Mathematical Economics*. McGraw-Hill (3rd edition).
Chaing and Wainwright (2005) *Fundamental Methods of Mathematical Economics*. McGraw-Hill (4th edition).
Nicholson (2007) *Microeconomic Theory: Basic Principles and Extensions*. South-Western College (10th edition).

## Course plan

1. Review of chapters from Dowling (see Prerequisites).
2. Fundamentals: sets, functions, relations.
3. Linear algebra: solving linear systems, matrix algebra, vector algebra, linear independence.
4. Multivariate calculus: limits and open sets, multivariate functions, partial/total derivatives, implicit functions.
5. Optimisation: unconstrained optimisation, constrained optimisation, equality/inequality constraints, Lagrange multipliers, smooth dependence on parameters, convexity/concavity.
6. Probability: random variables, moments, independence.
7. Applications I – consumer theory: preference ordering, Marshallian/Hicksian demand, Slutsky equation, indirect utility.
8. Applications II – expected utility theory: risk aversion, insurance.