ECONOMICS 113:
Mathematical Economics

Fall 2014

Basic information

Lectures	Tu/Th 11:00-12:20 Peter 102
Instructor	Prof. Alexis Akira Toda
Office hours	Tu/Th 13:00-14:00, ECON 211
Email	atoda@ucsd.edu
Webpage	`https://sites.google.com/site/aatoda111/`
	(Go to `Teaching` → `Mathematical Economics`)
TA	Paul Feldman, Econ 122, pfeldman@ucsd.edu

Course description

Carl Friedrich Gauss said mathematics is the queen of the sciences (and number theory is the queen of mathematics).[1] Paul Samuelson said economics is the queen of the social sciences.[2] Not surprisingly, modern economics is a highly mathematical subject.

Mathematical economics studies the mathematical foundations of economic theory in the approach known as the Arrow-Debreu model of general equilibrium. Partial equilibrium (things like demand and supply curves), which you have probably learned in Econ 100ABC, considers each market separately. General equilibrium (GE for short), on the other hand, considers the economy as a whole, taking into account the interaction of all markets.

Econ 113 is probably the most mathematically advanced undergraduate course offered at UCSD Economics, but it should have a high return. In the course, we will develop a mathematical model of classical economic thoughts like Bentham's "greatest happiness principle" and Smith's "invisible hand", and prove theorems. Then we will apply the theory to international trade, finance, social security, etc. Time permitting, I will talk about my own research.

Prerequisites

A year of calculus and a year of upper division microeconomic theory (at UCSD these courses are Math 20ABC and Economics 100ABC). Students with very strong mathematics preparation (typically including one quarter of real analysis,

[1] `http://en.wikiquote.org/wiki/Carl_Friedrich_Gauss`
[2] Samuelson "Economics", 10th edition, preface.

UCSD Math 140A or 142A) may enroll without economics prerequisites. Certain 'mathematical maturity' (familiarity with abstract thinking and manipulations of symbols instead of concrete numbers) is helpful, but in my opinion you can acquire it only by self-study.

Text

The required textbook for this course is [1], written by Prof. Ross Starr at UCSD, who has been teaching this course for many years. This book does not contain much examples but is self-contained and pedagogic in that it proceeds from the easy and special case to the difficult and general case. An added bonus is an accessible proof of the Brouwer fixed point theorem. [2, Chapters 1–7] is roughly the same level as [1], but contains lots of examples and exercises and thus may complement your study (though not required). Those who wish to pursue a Ph.D. in economics should get [3, 4], which are standard graduate-level texts. However, [3] may not be useful for learning due to its conciseness.

The course will use a lot of math, as the course title suggests. Relevant topics are basic linear algebra (but not much), calculus, convex analysis, and constrained optimization. For the last two topics, either [5] or my lecture notes for Econ 172B Operations Research (posted at my website) might be useful, but I will cover them briefly in class so you don't need to study in advance.

Preliminary course outline

1. Introduction
2. Definition of Arrow-Debreu model
3. Crash course in convex analysis and convex programming
4. Quasi-linear model: mathematical formulation of Bentham's "greatest happiness principle"
5. First and second welfare theorems: mathematical formulation of Smith's "invisible hand"
6. Existence of equilibrium (correspondences, maximum theorem, Brouwer and Kakutani fixed point theorems)
7. Scope of markets, market failure, and prescriptions
8. International trade and comparative advantage
9. Capital asset pricing theory (CAPM)
10. Overlapping generations (OLG) model and social security
11. My own research

Assignments

There are no assignments for this course (because it is impossible to monitor you to do the assignments by yourselves). However, each lecture note will contain a few exercises. In addition, *you can download past exams from my personal website listed above*, so make sure to check it out. Solve them by yourself: this is the best way to understand the material and to get prepared for the exams. Time permitting, we will go through the solution of some of the problems during the class.

Exams

There will be two midterms and a final. Please mark your calendar:

Midterm 1 Thursday October 23, in class

Midterm 2 Tuesday November 25, in class

Final Wednesday December 17, 11:30–14:30, location TBA

The exam dates are non-negotiable. If you miss a midterm for a documented, university approved reason (*i.e.*, illness, funeral, official university trip, etc.) the weight for that exam will be placed on the final. If you miss a midterm for another reason (*i.e.*, oversleep, vacation, etc.) you will receive a zero for that exam. No one will be allowed to start an exam after the first person leaves it. You are only permitted to use pens, pencils, and a straight edge (*no* calculator).

Grades and CAPE

Your grade will be determined by the formula

$$G = 0.2M_1 + 0.2M_2 + 0.6F,$$

where G is the course grade and M_1, M_2, F are the scores on the midterms and the final. The course grade G will be converted to letter grades at my discretion at the end of the quarter. (So please don't ask me questions like "What is the letter grade corresponding to x points in midterm?")

I will also be evaluated by you, through CAPE (Course and Professor Evaluation, `https://cape.ucsd.edu/`). CAPE results are important to me. To incentivize you to respond to CAPE, if the mid-quarter response rate exceeds 80%, I will post the solution to past Midterms 2. Similarly, if the end-quarter response rate exceeds 80%, I will post the solution to past Finals. (I will give you the solution to past Midterms 1 for free.)

Regrade requests must be made through a written statement *before* the start of class one week after the exam was first passed back. Extensions will only be permitted if you have a documented, university approved reason for missing the entire week after the exam was first passed back. If you request a regrade I reserve the right to regrade your entire exam and your score could go up, down, or stay the same. My regrade decision is final.

Questions

The best opportunity to ask questions is *during* the class, for two reasons. First, you can resolve your question immediately (assuming I know the answer). Second, your classmates are likely to have similar questions, so they can benefit from questions being resolved and I benefit by saving time. If you have a question outside of class that cannot be resolved by Googling or discussing with your friends, please first ask your TA. If still unresolved, you can show up during my office hour listed above (no appointment necessary).

How to do well in this course

Get your favorite math text (linear algebra and calculus) or my lecture notes of Econ 172B at hand so that you can refer if necessary. Experience tells that (this is *true*) students who regularly attend classes outperform those who don't, so come to class. Ask questions during the class whenever you don't understand. Read the lecture notes. Solve exercises and past exams (posted at my web page) without looking at the solutions. If you do well in this course, you have a good chance to be admitted to a good Ph.D. program (and therefore get a lucrative job in the future). Let me know if you need a letter of recommendation.

Academic integrity

I take academic dishonesty seriously. Any student found guilty of academic dishonesty will earn a failing grade for the course. In addition to this sanction, the Council of Deans of Student Affairs will also impose a disciplinary penalty.

UCSD policy:
`http://senate.ucsd.edu/manual/appendices/appendix2.pdf`

Facts about academic integrity:
`http://students.ucsd.edu/academics/academic-integrity/facts.html`

Consequences of cheating:
`http://students.ucsd.edu/academics/academic-integrity/consequences.html`

References

[1] Ross M. Starr. *General Equilibrium Theory: An Introduction*. Cambridge University Press, second edition, 2011.

[2] Truman F. Bewley. *General Equilibriuim, Overlapping Generations Models, and Optimal Growth Theory*. Harvard University Press, Cambridge, MA, 2007.

[3] Gerard Debreu. *Theory of Value*. Cowles Foundation Monograph 17. Yale University Press, New Haven, 1959.

[4] Andreu Mas-Collel, Michael D. Whinston, and Jerry R. Green. *Microeconomic Theory*. Oxford University Press, Cambridge, Massachusetts, 1995.

[5] Rangarajan K. Sundaram. *A First Course in Optimization Theory*. Cambridge University Press, NY, 1996.