ECONOMICS 113:
Mathematical Economics

Fall 2020

Basic information

Lectures	Tu/Th 9:30-10:50, Remote, via Zoom (see Canvas for link and password)
Instructor	Prof. Alexis Akira Toda
Office hours	Tu 16:00-17:00, via Zoom (same link as class)
Email	atoda@ucsd.edu
Webpage	`https://alexisakira.github.io/` (Go to `Teaching` → `Econ 113`)
TA	Wanchang Zhang, waz024@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 Department, 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

Calculus, linear algebra, upper division microeconomic theory (at UCSD these courses are Math 20ABC, Math 18, and Econ 100ABC) are required. Students with strong mathematical background (typically including one quarter of real analysis, UCSD Math 140A or 142A) may enroll without economics prerequisites. **Although not required, because the lectures are "proof-based", prior or concurrent enrollment in**

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

Math 109 or Math 140A is highly recommended. Students with inadequate mathematical background should take other mathematics courses before enrolling in Econ 113.

Textbook

The textbook for this course is [1], written by UCSD Emeritus Professor Ross Starr, who has taught this course for many years before I took over. This book does not contain many 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 205 Mathematics for Economists (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. International trade and comparative advantage
8. Capital asset pricing theory (CAPM)

Evaluation

Each year the evaluation is based on a quiz, a midterm, and a final. This year I will change the format as follows in order to cope with the challenges related to the pandemic. The course grade will be based on reflection notes (30%), problem sets (30%), and a final exam (40%).

Reflection notes (30%) There will be a short graded assignment every week that will be due by 17:00 on Friday. The assignment is meant to promote better reflection and learning of the materials and you will be expected to submit answers to the three questions below after each lecture:

1. What were the most important 1-2 new things you learned from the lecture and/or readings that you did not know before class? Describe one way in which what you learned connects to either a different subject/topic you are interested in, or a personal experience.

2. What were 1-2 points discussed in lecture/readings that you are still confused/unclear about and would like some further clarification on?

3. What topics/questions would you like to learn more about or discuss more based on content covered in the lecture/readings?

Research on pedagogy shows that such reflection notes are highly effective at promoting learning and helps to make faculty and students accountable for what they have taught/learned in each lecture. They will be graded on a discrete 0-1-2 scale (2: thoughtful response that engaged with the content of the lecture/readings; 1: cursory responses that meet a minimum standard; 0: otherwise).

The deadlines are sharp: not turning in by the deadline results in 0 points and no excuses are accepted for missing the deadline.

Problem sets (30%) There will be two problem sets. The first and second problem set will be posted on Canvas immediately **after the lecture that finishes covering the topics 1–5 and 6–8, respectively**. Each problem set will consist of a few end-of-chapter exercises from the corresponding lecture notes. To give you a reasonable amount of time to complete the problem sets but to minimize the chance of getting outside help, the deadline will be 17:00 of the following day (for Tuesday lecture, deadline is Wednesday; for Thursday lecture, deadline is Friday).

I highly recommend that you attempt to solve end-of-chapter exercises on your own well in advance. Waiting until the actual problem sets are posted is likely too late to prepare.

Again, deadlines are sharp and no excuses are accepted for missing the deadline.

Final exam (40%) Past exams and abridged solutions are posted on my personal website. Although the exam format may change due to the pandemic, according to the course listing, the final exam is currently scheduled at **8:00-11:00 on Thursday December 17**, and you should make yourself available for this time slot.

Per UCSD Academic Senate Regulations[3] a final exam is required. Hence failure of taking the final exam for any reason will result in a letter grade F, regardless of the overall performance in other categories.

Questions

The best opportunity to ask questions is *during* the class, for two reasons. First, you can resolve your question immediately (assuming—well—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. So, don't be shy, please ask questions. If you have

[3] `https://senate.ucsd.edu/operating-procedures/educational-policies/courses/epc-policies-on-courses/policy-exams-including-midterms-final-exams-and-religious-accommodations-for-exams/`

a question outside of class that cannot be resolved by a Google search 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). I and the TAs reserve the right not to respond to questions by emails. Most questions can be resolved by Google searches; if not, please use the office hours.

How to do well in this course

Get your favorite math text (linear algebra and calculus) or my lecture notes of Econ 205 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 (very) well in this course, you have a good chance to be admitted to good Master (Ph.D.) programs (and therefore get a lucrative job in the future).

Miscellaneous

- Email writing tips:
  `https://alexisakira.github.io/misc/email`
- Letter of recommendation policy:
  `https://alexisakira.github.io/misc/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:
`https://senate.ucsd.edu/Operating-Procedures/Senate-Manual/Appendices/2`

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-Colell, 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.