Economics 510: Advanced Microeconomic Theory
Fall, 2019

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ADVANCED MICRO THEORY: MARKET DESIGN

Class Description. In this course, we study the design and use of market-based mechanisms to solve problems of economic resource allocation. The goal is to sustain, mentor research experience of students who are major in economics. First, we will focus on matching markets, in particular the use of centralized market mechanisms to assign campus houses, offices and courses to students, workers to jobs, kidneys to transplant patients and so forth. After a short detour to an introduction to game theory, we study auction theory and its application in eBay, Google Keyword auctions, and double auctions in financial markets.

Prerequisites. The course catalog lists the prerequisites as: Economics 400 and 410. Ideas you brushed with in microeconomics (Econ 101, 410) will be extensively revisited. Some parts of the class will require familiarity with basic set theory, calculous (taking derivative, ordinary differential equation), linear algebra (vector, matrix), probability theory and some amount of symbol manipulation.

Class Requirements. There will be 5 *homework assignments*. You may discuss difficulties with your classmates, and myself (in that order) if you are stuck. But you need to submit your individual copy of each homework assignment. No late homework will be accepted! Please be aware that it is your responsibility to point out any grading or clerical errors within one week of receiving the assignment back.

There will be 2 in-class *closed-book midterms*. The 2nd midterm will only cover material since the first midterm. If a student misses a midterm, the weight of that midterm in the course grade will be added to the weight on the student's final. An exception will be made for University-approved absences (see http://catalog.unc.edu/policies-procedures/attendance-grading-examination/); students with this type of absence may request a make-up examination at a time convenient to both student and instructor.

You will have to write a short *term paper*. You may work in groups of up to 3 students. This will be a 10–15 pages paper. I will provide a set of topics, which will be discussed after the first midterm. You can also work on your own topic as long as I approve it. By October 24th you either choose one of the topics I suggested or get me approved for the topic you find by yourself. I encourage you to discuss the topic with me as early as possible as my office may become crowing on October 23rd. The purpose of the term paper is to simulate the scenario where you can use the class-room knowledge to change the world. When you choose the topic, you need to think of the target audiences/clients who are interested your suggestion. The term paper needs to fulfill the following criteria.

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- You are expected to find a real-world market which operates inefficiently.
- You are expected to identify the inefficiency of the current system. Possible approaches include (i) theoretical analysis, (ii) interviewing of participates or administrators of the current mechanism, (iii) collecting data or survey and conduct statistical analysis.
- You are expected to propose a method to improve the efficiency of the market and convince others your method outperforms the current system. Possible approaches include (i) theoretical analysis, (ii) survey of potential participants, (iii) numerical simulation, etc.

At the end of the semester, one of the team members will make a 20-minus presentation for your paper; while other team members collect the questions and feedbacks from other students and record their names. Students will be rewarded by participation points by asking non-trivial questions and giving valuable suggestions. You are also encouraged to write a formal report/ email to give suggestion/feedback to your classmates' presentation. After the presentation, each team needs to (i) summarize the suggestions that they receive in the presentation and address them point by point in a reply document, and (ii) improve the paper based on these suggestions. Notice that if the suggestions are unreasonable or impossible to be done, one also needs to give a convincing explanation in the reply document. The term paper will be graded based on the presentation, the post-presentation improvement of the paper, the reply to suggestions, and the exposition of the paper. Each team needs to submit their electronic copy (pdf file) of the paper and the reply document.

Grades for the class will be based on:

- Homeworks (20%)
- Midterm (20% each) (In class, on Sep 24th, Nov 19th)
- Participation and Feedback on Classmate's Project (10%)
- Term paper (30%)

I expect you to arrive on time and prepared for the day's class. If you have to leave the class before it ends, you need to inform me in advance with a legitimate reason!

Horner Code. The standard honor code applies. See https://studentconduct.unc.edu for details.

Readings. The textbook for this class is

- Haeringer, Guillaume, *Market Design: Auctions and Matching*, MIT Press, 2017

The textbook has a self-contained appendix for game theory. For more detailed discussion on game theory, see

- Gibbons, Robert, *Game Theory for Applied Economists*, Princeton University Press, 1992

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Below I list some *advanced readings*- they develop the underlying theory at a more sophisticated level than we will attempt in this course. However they may be worth a read, especially if you develop a strong interest in the area and/or want to study further.

- Roth, Alvin, *Who Gets What — and Why: The New Economics of Matchmaking and Market Design*, Eamon Dolan/Houghton Mifflin Harcourt, 2015.
- Roth, Alvin and Marilda Sotomayor, *Two-Sided Matching Markets*, Cambridge University Press, 1989.
- Milgrom, Paul, *Putting Auction Theory to Work*, Cambridge University Press, 2012.
- Krishna, Vijay, *Auction Theory*, Academic Press, 2009.

You are also recommended to read Alvin Roth's blog: http://marketdesigner.blogspot.com

Class Logistics. The class meets on Tuesday and Thursday 2:00-3:15pm at Gardner Hall 209. You are expected to attend all classes. There is no lecture on the following dates: Oct. 17th (fall break) and Nov. 28th (Thanksgiving). Course materials (assignments, handouts and related research papers) will be posted on Sakai.

Syllabus Changes. Exam dates and other aspects of the syllabus may be changed if necessary.

Contacting Me. My e-mail is lifei@email.unc.edu. To make the communication efficient, please identify yourself (full name) and mention the course number (econ 510) before asking any questions. Please make the subject of the email informative. My office is Gardner 300B. My office hours are Wednesday 2:00-3:00pm or by appointment.

Tentative Agenda. Below is a list of topics we would like to cover in this course, in the order we will see them. However, this may be adjusted over the course of the semester to account for time constraints, and to adjust for class interests. In terms of exams, you *will not be responsible* for material I do not cover, and I will update this list to account for changes.

1. Introduction to Market Design (1 lecture)
   a. Logistics for course
   b. Why design markets
   c. Introduction to Two-Sided Matching Problems

2. Two-sided Matching Theory (4 lectures)
   a. Stability as a solution concept
   b. Existence of stable matching/ stability of proposal algorithm
   c. Man-optimality of men proposing
   d. Incentives
   e. Rural hospitals theorem
   f. One-to-many matching

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3. Applications: National Residency Matching Program (1 lecture)
   a. History of NRMP
   b. How 2-sided matching is applied
   c. Complication 1: matching with couples
   d. Complication 2: incentives
   e. Complication 3: anti-trust case

4. Theory of Allocation (One-Sided Matching without Transfer) (2-3 lectures)
   a. Serial dictatorship mechanism
   b. Top trading cycles mechanism
   c. YRMH-IGYT mechanism

5. Applications: Kidney Exchange (1 lecture)
   a. Top trading cycles and chains

6. Applications: School Choice (1 lecture)
   a. Strict Priority: DAA vs TTC
   b. Constrained Choice (optional)
   c. Tie-Breaking

7. Random Assignment (2 lectures)
   a. Ordinally efficiency
   b. Probabilistic serial mechanism

8. Single-Unit Auction Theory (2-3 lectures)
   a. Second-Price Auction
   b. First-Price Auction
   c. Revenue Equivalence
   d. Reserve price

9. Common-Value Auction (1 lecture)

10. Multi-Unit Auction (1-2 lectures)

11. Applications: Keyword Auctions (1 lecture)
    a. The Google Model
    b. The Facebook Model

12. Double Auctions and Financial Markets (if time allows)