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## The Principles of Market Design

### Units 4:

Spring 2023—Monday/Wednesday—2pm-3:50pm

#### **IMPORTANT:**

#### **The general formula for contact hours is as follows:**

Courses must meet for a minimum of one 50-minute session per unit per week over a 15-week semester. Standard fall and spring sessions (001) require a final summative experience during the University scheduled final exam day and time.

(Please refer to the [Contact Hours Reference](#) guide.)

**Location:** Physical address and/or course-related URLs, etc.

#### **Instructor: Afshin Nikzad**

**Office:** KAP 330C

**Office Hours:** Wednesday 3:50pm-4:50pm

**Contact Info:** afshin.nikzad@usc.edu

#### **Teaching Assistant:**

**Office:** Physical or virtual address

**Office Hours:**

**Contact Info:** Email, phone number (office, cell), Skype, etc.

**IT Help:** Group to contact for technological services, if applicable.

**Hours of Service:**

**Contact Info:** Email, phone number (office, cell), Skype, etc.

## Course Description

This course covers fundamental principles in designing successful market mechanisms to allocate resources. These include practical settings such as matching markets where candidates are assigned to jobs or students are assigned schools, and auction markets where goods, rights, or services are sold (such as diamonds, radio spectrum, or online advertisement services offered by platforms like Google, Microsoft, and Facebook). Market design studies structuring successful marketplaces by constructing rules for resource allocation in such markets.

The course has roughly two parts. The first part studies matching markets: these are markets where prices don't do all the work, and the market participants not only choose but also have to be chosen. Thus, a market maker has to ask the market participants about their preferences and try to satisfy them subject to limited availability of resources. The design and analysis of matching markets has played an instrumental role in economic exchanges and allocating public resources such as school seats and radio spectrum, or private services such as ride-hailing and online advertisement.

The second part of the course focuses on auction markets, where the market maker's objective is allocating resources through an auction. We first study scenarios where a single item (a diamond, a house, a company) is sold to a group of potential buyers, and then more complex scenarios where multiple goods are sold, such as in online ad auctions or auctions used by the government for allocating property rights such as radio spectrum licenses or exploration rights to oil companies.

I typically start each subject with presenting a problem about a real-world marketplace and possible interventions to improve the status quo. After providing some background on the subject, we will brainstorm about various possible market designs and their potential flaws. I like the whole class to contribute to this phase by asking questions, proposing alternative designs, and being critical. There will also be some in-class activities. I conclude by discussing optimal designs and the theory behind them.

## Learning Objectives

The goal of this class is introducing you to some of the basic tools for analyzing and designing market mechanisms for allocating resources. Relevant case studies, empirical evidence, or lab/field experiments will be discussed in each topic. You will apply the tools and concepts discussed during each class to an in-class exercise or case study. You will be commended for creativity in the final project, and are not bound to stay within the boundaries of the lectures.

**Prerequisite(s):** None

**Co-Requisite(s):** None

**Concurrent Enrollment:** None

## Course Notes

Copies of lecture slides and other class information will be posted on Blackboard.

## Supplementary Materials

Roth, Alvin and Marilda Sotomayor (1990). Two-Sided Matching: a Study in Game-Theoretic Modeling and Analysis. . (Weeks 2-4 will draw substantially on chapters 2, 4 and 5.)

Roth, Alvin (2015). Who Gets What and Why: The New Economics of Matchmaking and Market Design.

Milgrom, Paul (2004). Putting Auction Theory to Work.

Krishna, Vijay (2002). Auction Theory.

### **Description and Assessment of Assignments**

The formal class requirements are 6 homework assignments (roughly biweekly, each set containing up to two questions), an open-book midterm exam, and a final project. The assignments count for 50% of the grade, the midterm exam for 20%, the final project for 20%, and class participation for 10%.

Each homework is a multipart problem based on the concepts covered in the class/slides. Familiarity with these concepts is necessary and sufficient for solving the problem. The in-class activities/case studies are often relevant/helpful in solving the homework problem.

The midterm exam contains two to three problems (similar to the homework problems but briefer) and evaluates knowledge about the concepts covered in the class/slides. A solid understanding of these concepts/the material discussed in class are sufficient for solving the midterm problems. The readings provide extensive discussions of these concepts, but are not necessary, in the sense that the lecture/slides are self-contained.

The idea behind the final project is to propose and study either an existing organized market or an environment with a potential role for an organized market. Creativity and thinking outside of the box are highly encouraged. You can work in groups of at most two. The expected outcome is (i) a draft of your proposal no more than 3 pages, and (ii) a set of slides aimed for a 5-7 minute (concise) presentation of the proposal. The slides are due by the end of week 15, and the draft is due by the exams week. In the last week of the class some (selected) groups will present their slides. All groups will be evaluated solely based on their submitted draft and slides.

## Grading Breakdown

Including the above detailed assignments, how will students be graded overall? Participation should be no more than 15%, unless justified for a higher amount. All must total 100%.

| Assignment             | Points     | % of Grade |
|------------------------|------------|------------|
| Biweekly assignments   | 50         | 50         |
| Open-book midterm exam | 20         | 20         |
| Final project          | 20         | 20         |
| Class participation    | 10         | 10         |
|                        |            |            |
|                        |            |            |
|                        |            |            |
| <b>TOTAL</b>           | <b>100</b> | <b>100</b> |

## Grading Scale (Example)

Course final grades will be determined using the following scale

|    |              |
|----|--------------|
| A  | 92-100       |
| A- | 84-91        |
| B+ | 78-83        |
| B  | 72-77        |
| B- | 65-71        |
| C+ | 60-64        |
| C  | 55-59        |
| C- | 50-54        |
| D+ | 45-49        |
| D  | 40-44        |
| D- | 35-39        |
| F  | 34 and below |

## Assignment Submission Policy

The assignments will be posted biweekly on blackboard. Each assignment set contains one or two questions, and you have two weeks to complete it from the time of posting.

## Grading Timeline

Each assignment set is expected to be graded within two weeks of the due date. The mid-term exam is expected to be graded within one week of the exam date.

## Course Schedule: A Weekly Breakdown

### The outline of schedule

- Weeks 1-8: Matching Markets (weeks 1-4: one sided markets, weeks 5-8: two sided markets).
- Weeks 9-16: Auction Markets
- The slides are self-contained. Supplementary material/reading is listed below the schedule table.

|         | Topics/Daily Activities   | Readings and Homework                  | Deliverable/ Due Dates |
|---------|---|--|------------------------|
| Week 1  | <b>Introduction/Overview:</b><br>What is market design? An overview of the matching market design and auction market design<br>Reading: |  |                        |
| Week 2  | <b>Core of One-Sided Markets and Applications to House Allocation</b>   | Homework 1 posted. Due in two weeks.   |                        |
| Week 3  | <b>Market Design for Organ Transplantation</b>  |  |                        |
| Week 4  | <b>Pseudo-markets, Competitive Equilibrium, and Application to Course Allocation Mechanisms</b>   | Homework 2 posted. Due in two weeks.   |                        |
| Week 5  | <b>Stable Assignments Put to Work (i): Matching in Labor Markets</b>  |  |                        |
| Week 6  | <b>Stable Assignments Put to Work (ii): School Choice</b>   | Homework 3 posted. Due in three weeks. |                        |
| Week 7  | Midterm exam  |  |                        |
| Week 8  | <b>Dating Platforms: Signaling in Matching Markets</b>  |  |                        |
| Week 9  | <b>The Basics of Auction Theory (ii): Vickrey Auctions, Efficient auctions</b>  | Homework 4 posted. Due in two weeks.   |                        |
| Week 10 | <b>Revenue-Maximizing Auctions: Reserved-prices, Revenue Equivalence, and Relevant Case Studies on Platforms</b>                        |  |                        |
| Week 11 | <b>Common-Value Auctions: Selling a Jar of Coins and The Winner's Curse</b>   | Homework 5 posted. Due in two weeks.   |                        |

|                |  |   |   |
|----------------|--|---|---|
|                |  |   |   |
| <b>Week 12</b> | <b>Multiunit Auctions (i): Online Ad Auctions, Vickery auctions, and Generalized Second-Price Auctions</b> |   |   |
| <b>Week 13</b> | <b>Multiunit Auctions (ii): US Spectrum Auctions, Distributional Objectives in Auctions</b>                | <b>Homework 6 posted. Due in two weeks.</b> |   |
| <b>Week 14</b> | <b>Multiunit Auctions (iii): Matching Auctions and Clinching Auctions</b>                                  |   |   |
| <b>Week 15</b> | <b>Student presentations</b>   |   |   |
| <b>FINAL</b>   |  |   | Date: For the date and time of the final for this class, consult the USC <i>Schedule of Classes</i> at <a href="http://classes.usc.edu">classes.usc.edu</a> . |

**Week 1 – Introduction/Overview:** What is market design? An overview of the matching market design and auction market design

Reading:

- “Who Gets What — and Why: The New Economics of Matchmaking and Market Design” Alvin Roth

**Week 2 – Core of One-Sided Markets and Applications to House Allocation**

Reading:

- “Random serial dictatorship and the core from random endowments in house allocation problems”, A Abdulkadiroğlu, T Sönmez
- “A new solution to the random assignment problem”, A Bogomolnaia, H Moulin
- “The assignment game I: The core”, LS Shapley, M Shubik

**Week 3 – Market Design for Organ Transplantation**

Reading:

- “Kidney exchange”, AE Roth, T Sönmez, MU Ünver
- “Pairwise kidney exchange”, AE Roth, T Sönmez, MU Ünver
- “Global Kidney Chains” Afshin Nikzad, Mohammad Akbarpour, Michael Reese, Alvin Roth

**Week 4 – Pseudo-markets, Competitive Equilibrium, and Application to Course Allocation Mechanisms**

Reading:

- “The efficient allocation of individuals to positions”, A. Hylland, R. Zeckhauser
- “The combinatorial assignment problem: Approximate competitive equilibrium from equal incomes”, E. Budish.
- “The Multi-Unit Assignment Problem: Theory and Evidence from Course Allocation at Harvard”, E. Budish, E. Cantillon

### Week 5 – **Stable Assignments Put to Work (i): Matching in Labor Markets**

#### Reading:

- “The effects of the change in the NRMP matching algorithm”, AE Roth, E Peranson
- “Stability in Large Matching Markets with Complementarities”, Itai Ashlagi, Mark Braverman, Avinatan Hassidim,
- “Near feasible stable matchings with complementarities”, T Nguyen, R Vohra

### Week 6 – **Stable Assignments Put to Work (ii): School Choice**

#### Reading:

- “The New York City High School Match”, Abdulkadiroglu, Pathak, Roth, 2005
- “Strategy-Proofness versus Efficiency in Matching with Indifferences: Redesigning the NYC High School Match”, Atila Abdulkadiroğlu Parag A. Pathak Alvin E. Roth
- “What matters in tie-breaking rules? How competition guides design” Itai Ashlagi, Afshin Nikzad

### Week 7 – **Midterm exam**

### Week 8 – **Dating Platforms: Signaling in Matching Markets**

#### Reading:

- “Preference Signaling in Matching Markets”, Peter Coles, Alexey Kushnir and Muriel Niederle
- “Propose with a Rose? Signaling in Internet Dating Markets”, Soohyung Lee, Muriel Niederle, Hye-Rim Kim, Woo-Keum Kim, 2011

### Week 9 – **The Basics of Auction Theory (i): Sealed-Bid Auctions, First- and Second-Price Auctions, Incentive- Compatibility**

#### Reading:

- Vickrey, William. "Counterspeculation, auctions, and competitive sealed tenders." *The Journal of finance* 16.1 (1961): 8-37.
- Ausubel, Lawrence M., and Paul Milgrom. *"The lovely but lonely Vickrey auction." Combinatorial auctions 17 (2006): 22-26.*

### Week 9 – **The Basics of Auction Theory (ii): Vickrey Auctions, Efficient auctions**

#### Reading:

- Vickrey, William. "Counterspeculation, auctions, and competitive sealed tenders." *The Journal of finance* 16.1 (1961): 8-37.
- Ausubel, Lawrence M., and Paul Milgrom. *"The lovely but lonely Vickrey auction." Combinatorial auctions 17 (2006): 22-26.*

### Week 10 – **Revenue-Maximizing Auctions: Reserved-prices, Revenue Equivalence, and Relevant Case Studies on Platforms**

#### Reading:

- “Optimal Auction Design” Roger Myerson, *Mathematics of Operations Research*, 1981
- “Auctions and Bidding: A Primer” Paul Milgrom, *Journal of Economic Perspectives*, 1989

### Week 11 – **Common-Value Auctions: Selling a Jar of Coins and The Winner’s Curse**

#### Reading:

- “Auctions and Bidding: A Primer” Paul Milgrom, *Journal of Economic Perspectives*, 1989
- “First-price common value auctions: bidder behavior and the 'winner's curse”, John Henry Kagel, *Economic Inquiry*, 1989

### Week 12 – **Multiunit Auctions (i): Online Ad Auctions, Vickery auctions, and Generalized Second-Price Auctions**

#### Reading:

- “Internet Advertising and the Generalized Second-Price Auction: Selling Billions of Dollars Worth of Keywords,” Edelman, Ostrovsky, and Schwarz

### Week 13 – **Multiunit Auctions (ii): US Spectrum Auctions, Distributional Objectives in Auctions**

#### Reading:

- “Putting Auction Theory to Work: The Simultaneous Ascending Auction” Paul Milgrom

### Week 14 – **Multiunit Auctions (iii): Matching Auctions and Clinching Auctions**

#### Reading:

- “On One-Sided versus Two-Sided Matching Games”, Thomas Quint, *Games and Economic Behavior*, 1996
- “An ascending vickrey auction for selling bases of a matroid”, Sushil Bikhchandani, Sven De Vries, James Schummer, Rakesh V. Vohra, 2011

## **Statement on Academic Conduct and Support Systems**

### **Academic Conduct:**

Plagiarism – presenting someone else’s ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in *SCampus* in Part B, Section 11, “Behavior Violating University Standards” [policy.usc.edu/scampus-part-b](http://policy.usc.edu/scampus-part-b). Other forms of academic dishonesty are equally unacceptable. See additional information in *SCampus* and university policies on scientific misconduct, <http://policy.usc.edu/scientific-misconduct>.

### **Support Systems:**

*Student Counseling Services (SCS)* – (213) 740-7711 – 24/7 on call

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention. [engemannshc.usc.edu/counseling](http://engemannshc.usc.edu/counseling)

*National Suicide Prevention Lifeline* – 1 (800) 273-8255

Provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week. [www.suicidepreventionlifeline.org](http://www.suicidepreventionlifeline.org)



*Relationship and Sexual Violence Prevention Services (RSVP) – (213) 740-4900 – 24/7 on call*

Free and confidential therapy services, workshops, and training for situations related to gender-based harm. [engemannshc.usc.edu/rsvp](http://engemannshc.usc.edu/rsvp)

*Sexual Assault Resource Center*

For more information about how to get help or help a survivor, rights, reporting options, and additional resources, visit the website: [sarc.usc.edu](http://sarc.usc.edu)

*Office of Equity and Diversity (OED)/Title IX Compliance – (213) 740-5086*

Works with faculty, staff, visitors, applicants, and students around issues of protected class. [equity.usc.edu](http://equity.usc.edu)

*Bias Assessment Response and Support*

Incidents of bias, hate crimes and microaggressions need to be reported allowing for appropriate investigation and response. [studentaffairs.usc.edu/bias-assessment-response-support](http://studentaffairs.usc.edu/bias-assessment-response-support)

*The Office of Disability Services and Programs*

Provides certification for students with disabilities and helps arrange relevant accommodations. [dsp.usc.edu](http://dsp.usc.edu)

*Student Support and Advocacy – (213) 821-4710*

Assists students and families in resolving complex issues adversely affecting their success as a student EX: personal, financial, and academic. [studentaffairs.usc.edu/ssa](http://studentaffairs.usc.edu/ssa)

*Diversity at USC*

Information on events, programs and training, the Diversity Task Force (including representatives for each school), chronology, participation, and various resources for students. [diversity.usc.edu](http://diversity.usc.edu)

*USC Emergency Information*

Provides safety and other updates, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible. [emergency.usc.edu](http://emergency.usc.edu)

*USC Department of Public Safety – UPC: (213) 740-4321 – HSC: (323) 442-1000 – 24-hour emergency or to report a crime.*

Provides overall safety to USC community. [dps.usc.edu](http://dps.usc.edu)