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Location: MUEN E131  
Meeting Times: MWF 1:00-1:50  
Office Hours: MWF 10:30 – 11:30  
(or by appointment)

**Course website:**

All course materials will be posted on the [Canvas](https://canvas.colorado.edu/) website that can be accessed at <https://canvas.colorado.edu/>.

**Course Description:**

Economists are increasingly involved not just in studying but in designing practical market mechanisms. These include auctions to sell diamonds, timber, electricity, procurement contracts and radio spectrum; matching algorithms to assign students to schools, or candidates to jobs; as well as marketplaces and mechanisms to sell internet advertising, trade financial securities, or reward innovation. The field of market design studies how to construct rules for allocating resources or to structure successful marketplaces. It draws on the tools of game theory and mechanism design to identify why certain market rules or institutions succeed and why others fail.

The course consists of three parts. In the first part, we review the fundamental concepts from the game theory and develop strategic thinking. In the second part, we look at the “matching markets” that operate without prices, highly unusual for economics. Examples include assigning students to schools, assigning donor kidneys to transplant patients and college admissions. The third part of the class is on auctions and good auction design. Examples range from simple auctions used by eBay and Christie’s to auctions used in financial markets, auctions used by Google, Facebook and Microsoft to sell advertising, and auctions used by government to sell large-scale complex assets such as radio spectrum.

**Textbook/Readings:**

A textbook for this class is “*Market Design*” by *Guillaume Haeringer*. Additional readings will be indicated in lecture slides and available on the class website.

The readings are mostly economics journal articles, or popular press articles, that provide some context for the class. All of the listed papers (at least large parts of them) should be readable.

**Informal Readings:** A book “*Thinking Strategically*” by Avinash Dixit and Barry Nalebuff is a very famous book suitable for the Game Theory part of the class. A book “*Who Gets What — and Why: The New Economics of Matchmaking and Market Design*” by Alvin E. Roth is an easy read suitable for the Matching part of the class.

**Prerequisites:**

The course is available to students who have completed ECON 3070 Intermediate Microeconomic Theory.

**Required Level of Mathematics:**

The class does not require prior knowledge of mathematical concepts beyond the ones covered in ECON 1088. However, the course includes a great deal of math, economic theory and extensive strategic arguments. Students should expect theoretical arguments in every class.

**Attendance and Administrative Drops:**

A student can miss **two** classes without excuse. After that, any unauthorized missed classes will be reflected in the course grade (see below). Any student who miss ALL three first class meetings (27, 29 and 31 August) will be administratively dropped from the class.

**Assessment:**

There will be two midterm exams, the final exam, ten problem sets.

1. Ten problem sets (20% total, 2% each)
2. Attendance (10%, nonlinear impact)
3. Midterm exams (20% each)
4. Final Exam (30%)

There will be no make-up exams. A student who misses a midterm due to an excused absence will have the additional weight shifted to the final.

Feel free to form study groups to review and discuss lecture/reading materials, and homework assignments but you must submit individual work for grading.

The Economics Department provides a free drop-in tutorial lab which provides assistance on all core courses in the major, and occasionally on other undergraduate courses in the Department. Its website is

<https://www.colorado.edu/economics/undergraduate/drop-tutorial-lab>.

**Tentative Course Outline:**

1. Administrative Material (first lecture)
2. Game Theory (weeks 1-5, 12 lectures)
  - a. Dominance (3 lectures)
  - b. Nash Equilibrium (5 lectures)

- c. Mixed Strategies & Dynamic Games (2.5 lectures)
  - d. Bayesian Games and Mechanism Design (1.5 lectures)
- 3. Midterm 1 (in class, on Oct 1<sup>st</sup>)**
- 4. Matching (weeks 5 - 9) (10 lectures)
  - a. Two-Sided Matching (3 lectures)
  - b. Two-Sided Applications (2 lectures)
  - c. One-Sided Matching, Kidney Exchange (2 lectures)
  - d. School Choice (3 lectures)
- 5. Midterm 2 (in class, on Nov 5<sup>th</sup>)**
- 6. Auctions (weeks 9 – 16, 18 lectures)
  - a. Auction Theory (5 lectures)
  - b. Auction Design (3 lectures)
  - c. Common-Value Auctions (2 lectures)
  - d. Multi-Item Auctions (3 lectures)
  - e. Sponsored Search Auctions (3 lectures)
  - f. Financial Exchanges (2 lectures)
- 7. Final Exam (Dec 17<sup>th</sup>, 1:30 pm)**

#### **Detailed Course Outline with topics:**

1. **Overview of the class.** *Topics:* syllabus, overview of the content, introduction into game theory and market design

#### **Game Theory:**

2. **Static Games.** *Topics:* static games, dominant strategies, Nash Equilibrium
3. **Dynamic Games.** *Topics:* dynamic games, subgame perfect equilibrium and backward induction
4. **Incomplete Information.** *Topics:* simple games with incomplete information, concept of Bayesian Nash equilibrium, simple auction games

#### **Matching:**

5. **Introduction to Matching Markets.** *Topics:* “marriage market” and one-to-one matching, stable matches, the Deferred Acceptance algorithm, existence result, optimal matches for both sides of the market, incentives of participants, “roommate problem”, nonexistence result, redefinition of the stability for the “roommate problem” and existence result.

*Readings:*

“College Admissions and the Stability of Marriage” by David Gale and Lloyd Shapley (1962)

6. **Stable Matching and Orderly Markets.** *Topics:* stable matchings and orderly markets, the problem of market unravelling, case study: medical residents and the NRMP, medical fellowships, law clerks, college admission

*Readings:*

“What Have We Learned from Market Design” by Alvin Roth (2008)

“The Re-Design of the Matching Market for American Physicians: Some Engineering Aspects of Economic Design” by Alvin Roth and Elliott Peranson (1999)

7. **House Allocation and Kidney Exchange.** *Topics:* the House Allocation Problem, efficient outcomes and the core, serial dictatorship, the top trading cycles algorithm and its variations, kidney exchanges

*Readings:*

"A Kidney Exchange Clearinghouse in New England" by Alvin Roth, Tayfun Sonmez and Utku Unver (2005)

“Kidney Exchange: A Life-Saving Application of Matching Theory” (2005)

8. **School Choice.** *Topics:* School Choice Problem, the Boston algorithm and its incentives, deferred acceptance and top trading cycles as alternatives, problem of ties, case studies: NYC and Boston

*Readings:*

“The New York City High School Match” by Atila Abdulkadiroğlu, Parag Pathak and Alvin Roth (2005)

“The Boston Public School Match” by Atila Abdulkadiroğlu, Parag Pathak, Alvin Roth and Tayfun Sonmez (2005)

“School Choice” by Joseph Malkevitch

## **Auctions:**

9. **Introduction to Auction Theory.** *Topics:* private value model, first and second price sealed bid auctions, all pay auctions, ascending auctions, the revenue equivalence theorem, eBay auctions - equivalence and nonequivalence to the second-price auction

*Readings:*

"The Bidding Game" National Academy of Sciences Beyond Discovery Report (2003)

10. **Designing Good Auctions.** *Topics:* how to design an auction, facilitating entry, reserve prices, bidder subsidies, collusive bidding, optimal auction design

*Readings:*

"What Really Matters in Auction Design" by Paul Klemperer (2002)

11. **Common Value Auctions.** *Topics:* common value model, the winner's curse, examples and applications, aggregation of information, application to oil lease auctions

*Readings:*

"An Empirical Study of an Auction with Asymmetric Information" by Ken Hendricks and Robert Porter (1988)

"Anomalies: The Winner's Curse" by Richard Thaler (1988)

12. **Multi-Unit Auctions.** *Topics:* multi-unit auctions, uniform price, pay-as-bid price (discriminatory), demand reduction, Vickrey pricing and efficient auction design, case study: treasury auctions

*Readings: TBA*

13. **Sponsored Search Auctions.** *Topics:* the sponsored search market, Google's advertising auction, bidding incentives and equilibria, other ways to run the auction, Facebook's Vickrey auction, optimal design in search auctions (Yahoo case study)

*Readings:*

"The Economics of Internet Search" by Hal Varian (2007)

"Online Advertising: Heterogeneity and Conflation in Market Design" by Jonathan Levin and Paul Milgrom (2010)

- 14. Financial Markets and High-Frequency Trading.** *Topics:* electronic markets for trading equity and other financial securities, the use of auctions for IPOs, real-time trading and market clearing, competition between exchanges

*Readings:*

"Concept Release on Market Structure" by SEC (2010)

"The High-Frequency Trading Arms Race: Frequent Batch Auctions as a Market Design Response" by Eric Budish, Peter Cramton and John Shim

- 15. Large-Scale Auctions for Radio Spectrum.** *Topics:* auctions to award property rights for radio spectrum, design of FCC auctions, evidence from US and Europe

*Readings:*

"Winning Play in Spectrum Auctions" by Jeremy Bulow, Jonathan Levin and Paul Milgrom

"The Biggest Auction Ever: The Sale of the British 3G Telecom Licenses" by Ken Binmore and Paul Klemperer

- 16. Combinatorial Auctions.** *Topics:* complementarities, auction design issues, winner determination problem, pricing rules, case studies: airport slot auction FAA, truckload auctions.

*Readings:*

"Spectrum Auction Design" by Peter Cramton

## **University Policies**

If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines

accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the [Disability Services website](http://www.colorado.edu/disabilityservices/students) (www.colorado.edu/disabilityservices/students). Contact Disability Services at 303-492-8671 or [dsinfo@colorado.edu](mailto:dsinfo@colorado.edu) for further assistance. If you have a temporary medical condition or injury, see [Temporary Medical Conditions](#) under the Students tab on the Disability Services website and discuss your needs with your professor.

Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, please see me at least two weeks prior to any conflicts due to religious observances. See the [campus policy regarding religious observances](#) for full details.

Students and faculty each have responsibility for maintaining an appropriate learning environment. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. Class rosters are provided to the instructor with the student's legal name. I will gladly honor your request to address you by an alternate name or gender pronoun. Please advise me of this preference early in the semester so that I may make appropriate changes to my records. For more information, see the policies on [classroom behavior](#) and the [Student Code of Conduct](#).

The University of Colorado Boulder (CU Boulder) is committed to maintaining a positive learning, working, and living environment. CU Boulder will not tolerate acts of sexual misconduct, discrimination, harassment or related retaliation against or by any employee or student. CU's Sexual Misconduct Policy prohibits sexual assault, sexual exploitation, sexual harassment, intimate partner abuse (dating or domestic violence), stalking or related retaliation. CU Boulder's Discrimination and Harassment Policy prohibits discrimination, harassment or related retaliation based on race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. Individuals who believe they have been subject to misconduct under either policy should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127. Information about the OIEC, the above referenced policies, and the campus resources available to assist individuals regarding sexual misconduct, discrimination, harassment or related retaliation can be found at the [OIEC website](#).

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to [the academic integrity policy](#). Violations of the policy may include: plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access

to academic materials, clicker fraud, resubmission, and aiding academic dishonesty. All incidents of academic misconduct will be reported to the Honor Code Council ([honor@colorado.edu](mailto:honor@colorado.edu); 303-735-2273). Students who are found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code Council as well as academic sanctions from the faculty member. Additional information regarding the academic integrity policy can be found at the [Honor Code Office website](#).

The Office of Victim Assistance can be reached at 303-492-8855. Its <http://www.colorado.edu/ova/>.