Department of Economics, University of Southern California

ECON 504 GAME THEORY with Economic and Financial Applications

26181D UNITS: 4 Fall 2024

LOCATION / TIME: <mark>Monday/Wednesday 12-1.20pm at KAP 163</mark>

INSTRUCTOR: Yilmaz Kocer kocer@usc.edu, **office: KAP 118**

I will respond to emails <u>most probably within hours</u> (will not exceed 24 hours for sure) if sent during reasonable hours 8am-11pm, weekday or weekends. I will be more vigilant on being prompt with my replies closer to exams or assignment deadlines to be of immediate help. Please use "*ECON 504*" in the subject line in your emails for me to respond faster.

OFFICE HOURS: I will be available in person in my office **KAP 118** <u>and</u> on personal zoom room **4 - 7pm on Wednesdays.** I will announce many extra office hours as demand arises throughout the semester. If you can't make them or if you have a short question, email me to arrange another time to meet over zoom or in person.

TEACHING ASSISTANT: Your TA **(tbd)** will hold <u>regular office hours</u> for content and grading related questions. Please email all your <u>grading related questions</u> directly to your TA, <u>and I will only hear grading related questions from your TA first.</u>

Communication: <u>Please email all your grading related questions directly to your TA (if we end up having one).</u> I will respond to emails <u>most probably within hours</u> (will not exceed 24 hours almost surely) if sent during reasonable hours **8am-11pm**, weekday or weekends. I will be more vigilant on being prompt with my replies closer to exams or assignment deadlines to be of immediate help. Please use "*ECON 504*" in the subject line in your emails for me to respond faster.

Course BRIGHTSPACE Website: All course materials; instructions, announcements, discussion/feedback, exams, problem sets, sample exams, in class exercise problems, answer keys, your grades etc. will be posted on *Brightspace* (hereafter "**bs**"). I already put under the *contents* tab the **solution manual** for the end of chapter problems for your textbook, all in a <u>single pdf file</u>. Familiarize yourself with the syllabus, announcements, contents and assignments tabs.

Required Textbook

<mark>Steven Tadelis, Game Theory: An Introduction, Princeton U. Press, ISBN: 9780691129082</mark>

Recommended texts

M. Osborne and A. Rubinstein, *A Course in Game Theory* freely available here.

Mas-Colell Microeconomic theory, Chapters 7,8,9

Advanced Game Theory

G. Mailath and L. Samuelson, *Repeated Games and Reputations*

D. Fudenberg, J. Tirole, *Game Theory*

P. Bolton, M. Dewatripont, *Contract Theory*

COURSE DESCRIPTION: This is a graduate level introduction course in game theory, intended for students who are interested in major applications of game theory in a wide range of economic or financial settings including reputation, herding, auctions, strategic information revelation and information accumulation in markets. The course will cover a combination of standard results in game theory.

This class will enrich your abstract mathematical modelling toolkit by adding a strategic dimension to economic and financial interactions. Similarly, when beliefs, expectations and coordination matter (as it does in so many markets), game theory offers a tangible and coherent set of ideas to understand the web of interactions and outcomes. You will have a concrete understanding of the mechanics of a range of economic and financial phenomena through the game theory lens; beauty contests and coordination in markets, bank runs and currency attacks, the value and public and private information in markets, bubbles and crashes, the role of reputation in markets, theories of bargaining, herding and information cascades, when we can expect strategic information in the market to be hidden and when to be transmitted. We will also look at the "reverse engineered" version of game theory; mechanism design. We will analyze when we can expect to have agents to report truthfully what they know and arrive at a socially good outcome, when people might have incentives to lie. Similarly, we will look at how to design optimal auctions, matching markets, etc.

Prerequisite(s): Intermediate Microeconomics, Basic Game Theory, Basic Optimization and Multivariate Calculus, Basic Matrix Theory.

Recommended Preparation

You should know the very basics of Game Theory (like Nash Equilibrium, Backward Induction...etc.) and should have successfully taken an upper-level undergraduate micro related course. You must feel comfortable with mathematical notation and have some mild training in multivariate calculus, optimization theory, real analysis and probability theory. For the mathematical sophistication level required, you should have perfect command of *Simon & Blume - Math for Econ*. level math; the Lagrangian method and basic optimization, basic logic, intermediate level calculus (multivariate) and some real analysis and probability, and matrix theory.

Class Participation

Even though it is not directly part of your grade, your attendance and active presence in class is essential. Stay engaged, ask questions if anything is unclear, suggest answers to questions I pose, read the textbook and practice with the end of chapter problems (particularly the ones I recommend on Brightspace announcements). The course material is dense, loaded with many ideas, concepts, problems and exercises, so a casual interest and less-than-full commitment will not suffice to be successful in this course. Also, many hints about the assignments, exams will be given during the classes so attending classes is very important.

GRADING CRITERIA:

Grading component	%weight
Midterm Exam February 28th	**25%**
8 Problem Sets due dates TBA (worst 2 omitted)	**40%**
FINAL EXAM December 13th Friday 11am-1pm IN CLASS	**35%**

GRADING

All graded elements in this course will be in the format of technical problems, similar in structure to the end of chapter problems in your textbook(s), or in class exercises.

The Midterm Exam and the Final Exam

The dates are already set as above and they will be in delivered in person in class. No books/notes/cell phones are allowed but calculators are okay, even though I don't think you'll need it. The final exam is cumulative ; it covers all material studied throughout the semester; however it will predominantly (around %80) test the second half of the course (material after the midterm exam), to give equal grading coverage to all topics. The final exam is around 40-50% longer than the midterm exam both in size and in time duration.

Problem SETS   8 problem sets will be assigned throughout the semester, roughly one per 1-2 chapters of textbook content (one for every 1-2 weeks) and the **best 6** will count towards your grade (your worst 2 will be dropped!). I will announce the due dates for the problem sets both in class and on *Brightspace* and you will at least have 5 days to complete it. You may work together on problem sets and form study groups; however, you must each write down your own answers and submit them individually; and be prepared to present them during class if called upon. They will be posted on BS under *assignments* tab, and you are required to submit your work back on BS as a **single legible pdf file**; no hand delivery of problem sets to me or to your TA in person.

IMPORTANT REMINDERS

1) As this course is highly technical/quantitative yet does not have dedicated discussion sessions to practice with problems; it is imperative for you to practice with as many problems as possible yourself.

2) All exams will be delivered in class, no exam taking over zoom under any condition.

3) Students with OSAS accommodations should reach out to me as soon as they get the paperwork, as I cannot accommodate them without the paperwork or retroactively. They should also arrange, in advance, to take the exams in the OSAS office.

4) There will be no opportunities for extra credit in this course.

5) Please ask all grading related questions, emails directly to your TA first. You have two weeks after the announcement of grades for an exam or problem set to voice your concerns about any incorrect grading or missing grades; after that time, the grades for that exam/problem set are fixed and cannot be modified.

After meeting with your TA, if you still feel your work was graded incorrectly, please submit your work and a brief written explanation of your argument. I will regrade the entire answer, which means that your score may go down.

6) I will assume you have a commitment to academic integrity as per the student handbook or the Office of Academic Integrity's website.

7) Please refrain from cell phone or laptop use during class, unless you are using your tablet/laptop solely for note taking purposes, which you should let me know at the beginning of the course.

MISSING an EXAM or a PROBLEM SET:

You will get a 0 score for a problem set, midterm exam or the final exam if you miss it, except in the case of USC registrar's definition of an emergency (See USC Grading and Correction of Grades Handbook) which includes documented medical and family emergencies characterized by severe and unforeseen hardship. According to USC guidelines, "no student is permitted to omit the [final examination]." Per the guidelines, in case of "a documented illness or other [event that meets the registrar's definition of emergency] occurring after the withdrawal deadline for the course," an incomplete grade (IN) will be assigned. Thus, if you miss the final exam for a reason that meets the USC registrar's definition of emergency, you will be assigned an incomplete grade IN for the course.

If you miss a midterm exam for a valid reason as described above, its weight will be pushed towards the next midterm (if there is one) and the final exam. In this case, you should provide me with the proofs of the medical or family emergencies.

Having another midterm or final exam on the same day is not an excuse for not taking it. If you ever have a conflict with an exam date, see me as soon as you are aware of it (it must be at least two weeks in advance). There is no makeup exam for the midterm, the final exam, or the problem sets!

Missing a problem set is less problematic, for both you are having many days to complete it and "dropping your worst 2 problem sets" from your grade is expressly designed to buffer against unforeseen hardships and illnesses and family emergencies. If you miss 3 or more problem sets, I will ask you to document your excuse for all missed problem sets to show they meet the registrar's emergency criterion (in which case I excuse you from); otherwise, you will get 0 credits for all missed problem sets.

Still, I urge you to complete and submit each one of them, to start working on them as early as they are posted on BS. **Late PS submissions will receive NO credit** as I will post the answers on Brightspace right at the deadline, so please submit whatever you have by the deadline to get any credit and please do not email me for an extension.

How to do well in this course: Listen to the lectures carefully and read the relevant sections from your book(s) beforehand. Practice with problems; AS MANY AS YOU CAN! Go over the in-class exercises, problem sets and textbook end of chapter problems very carefully. Make sure to understand the reason behind every equation in the textbook and in the problem sets and exams. Work with your friends on the difficult problems. Learn from

each other. Seek help from your TA and myself; we are here to help you. Both *Tadelis* and *Osborne & Rubinstein* textbooks are excellent textbooks, classics in the field, dense and comprehensive with numerous end of chapter problems for practice.

A –provisionary- summary of coverage; (Chapters from T = Tadelis, R = Osborne & Rubinstein)

A brief summary of Decision theory: We will describe a generic choice situation: actions, outcomes and preferences. We'll briefly go over how choices over alternatives can be represented as "preferences" and these in turn by "utility functions". We will then extend the choice framework to decisions over risky prospects: expected utility and VNM preferences and towards another direction, decisions over time.

Reading: Chapter T:1,2

Introduction to Game Theory We will first describe a strategic situation, as opposed to a decision theoretic one. We will describe a game and its ingredients: Actions / strategies, outcomes, payoffs, solution concepts. Are the "rules" and payoffs of the game known? (Complete vs. Incomplete information games) Is it a one-shot game with simultaneous moves or played over time? (static vs dynamic games). We will start with Static Games with Complete Information; games in normal form.

We will describe the "rationality" and informational assumptions on the players, and describe what a solution concept is, *Reading: Chapter T3*.

Next, we define dominant strategies/ dominated strategies. We will see how we can "purge" dominated strategies iteratively as we expect them not being played by rational players: Iterated Elimination of Dominated Actions. On another vein, we will describe beliefs about the opponent's strategy and best responses to it. We will make a connection between strategies that are best responses to some belief, and those who survive the iterated elimination. We will see these in action in a Cournot Duopoly example. *Reading: Chapter T4, R4*

We will move on to define our first solution concept: *Nash Equilibrium* and study some classical examples in economics: Cournot and Bertrand competition, tragedy of the commons, battle of the sexes, prisoner's dilemma, electoral competition game…We will describe mixed strategies and randomization, and extend our solution concept to Mixed Nash Equilibrium, and prove its existence in finite games. *Reading: Chapter T :5,6 R: 2,3*

We will move on to Dynamic games with complete information, namely extensive form games, and discuss why Nash equilibrium may not be sufficient to address incredible threats. We will define sequential rationality and backward induction; and *subgame Perfect Nash Equilibrium*. *Reading: Chapter T: 7,8,9 R:6*

We will next prove the one-shot deviation principle. Moving on to Repeated Games, we will talk about dynamic tacit collusion, cooperation and reputation using repeated games. We will prove and discuss folk theorems. *Reading: Chapter T:10 , R:8*

We will describe perfect/imperfect public monitoring and private monitoring repeated games.

We will apply the repeated games model to the Rubinstein bargaining and discuss a Legislative bargaining

scenario. **Reading: Chapter T:11, R:7**

We are now ready to incorporate uncertainty and informational concerns: games of incomplete information. Extending the notion of strategy and beliefs, and incorporating Bayesian updating, we will define Bayesian Nash Equilibrium. We will see examples of incomplete information games with Inefficient Trade and with Adverse Selection. **Reading: Chapter T:12, R:2,11**

Mechanism Design; Auction theory: We will talk about "reverse engineering" of game theory; how to design market games where self-interested agents compete to bring about an efficient or in some sense desirable outcome?

We will start with the (major) example of Auction theory. We will discuss different types of auction setups (first price, second price, Dutch, English) and describe the optimal bids and the revenues by the auctioneer, in a simple setting. We will prove the *Revenue Equivalence theorem*. In the *common values* auctions, we will discuss the *Winner's curse*. **Reading: Chapter T:13**

We will study Mechanism design from a more general and theoretical standpoint. We will show the *revelation principle* and study a very useful and general class: *VCG* of mechanisms, *i.e., Vickrey-Clarke-Groves mechanisms* and elaborate on its good qualities and deficiencies. **Reading: Chapter T:14**

We will move on to dynamic games with Incomplete Information and discuss why subgame perfection is not adequate. Formulating the relevant sequential rationality condition, we will describe *Sequential Equilibrium* and *Perfect Bayesian Equilibrium* **Reading: Chapter T:15, R:12**

Signaling game: we will study the standard education signaling a la Spence (1973) and define Separating and Pooling equilibria. We will then talk about some forward Induction refinements to these equilibria **Reading: (Chapter T:16, R:12.3)**

Building a Reputation: we will study the repeated prisoner's dilemma with reputational concerns (the famous "Gang of Four" paper). We will model reputation as the others' favorable belief about your "type". **Reading: (Chapter 17, R:12.3)**

Information Transmission and Cheap Talk; When somebody has the information and yet another has decision rights, can information be transmitted if they have conflicting preferences about what should be done? We will describe a "*cheap talk*" scenario where information is not verifiable and is free (as opposed to the Signaling framework). We will apply the model to Legislative Organization **Reading: (Chapter T:18)**

* The chapter numbers in parenthesis are optional in that we will pick and choose depending on the class interests and capabilities and time left in the semester. The other (core) chapters will be mostly covered except some omissions I will point out as we proceed.

Support Systems:

Counseling and Mental Health — *(213) 740-9355* — *24/7 on call*

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

988 Suicide and Crisis Lifeline — *988 for both calls and text messages* — *24/7 on call* the 988 Suicide and Crisis Lifeline (formerly known as the National Suicide Prevention Lifeline) provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week, across the United States. You can also call (800) 273-8255

Relationship and Sexual Violence Prevention Services (RSVP) — *(213) 740-9355(WELL)*— *24/7 on call*

Free and confidential therapy services, workshops, and training for situations related to gender- and power-based harm (including sexual assault, intimate partner violence, and stalking).

Office for Equity, Equal Opportunity, and Title IX (EEO-TIX) — *(213) 740-5086* Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

Reporting Incidents of Bias or Harassment — *(213) 740-5086 or (213) 821-8298*

Avenue to report incidents of bias, hate crimes, and microaggressions to the Office for Equity, Equal Opportunity, and Title for appropriate investigation, supportive measures, and response.

The Office of Student Accessibility Services (OSAS) — *(213) 740-0776*

OSAS ensures equal access for students with disabilities through providing academic accommodations and auxiliary aids in accordance with federal laws and university policy.

USC Campus Support and Intervention — *(213) 740-0411* Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity, Equity and Inclusion — *(213) 740-2101*

Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency — *UPC: (213) 740-4321, HSC: (323) 442-1000* — *24/7 on call*

Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety — *UPC: (213) 740-6000, HSC: (323) 442-1200* — *24/7 on call*

Non-emergency assistance or information.

Office of the Ombuds — *(213) 821-9556 (UPC) / (323) 442-0382 (HSC)*

A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.

Occupational Therapy Faculty Practice — *(323) 442-2850 or otfp@med.usc.edu*

Confidential Lifestyle Redesign services for USC students to support health promoting habits and routines that enhance quality of life and academic performance.