

Fall 2024

## Economics 41000: Game Theory

Syllabus (preliminary)

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**Instructor:** George J. Mailath, [gmailath@econ.upenn.edu](mailto:gmailath@econ.upenn.edu); PCPSE 522

**Description:** An introduction to game theory and its applications to economic analysis. Game theory studies the strategic interactions of agents (often called “players” or decision-makers). An example of a *strategic* interaction is the pricing behavior of two petrol (gas) stations on the same intersection. Each station, in choosing its price, will both respond to the current price of the other station and to how it believes the other station will respond to its price. The course will provide a theoretical overview of modern game theory, emphasizing common themes in the analysis of strategic behavior in different social science contexts.

**Prerequisites:** ECON 2100 (Intermediate Microeconomics), MATH 1070 (Mathematics of Change, Part 1) and MATH 1080 (Mathematics of Change, Part 2) OR MATH 1400 (formerly 104, Calculus, Part 1) and MATH 1410 (formerly 114, Calculus, Part 2).

The course assumes knowledge of multivariate calculus (at about the same level as my Econ 2100 intermediate micro class) and basic probability. At the same time, a certain level of “mathematical maturity” will be helpful.

## 1 Logistic Overview

1. **Lectures** will be delivered during the regularly scheduled class time (Mondays and Wednesdays, 10:15am-11:45am).
2. **Assignments** will be assigned about every two weeks.
3. **The final grade** will be determined by three inclass exams (75%) and assignments (25%).
4. **Canvas** will be used to post announcements, slides, lecture notes, assignments, solutions, and additional handouts. You are responsible for regularly checking, downloading and reading materials posted on the site, as they form an integral part of the class.

## 2 Course Outline

1. Normal Form Games, Domination and Iterated Domination
2. Beliefs and Expected Payoffs
  - (a) Attitudes Towards Risk
3. Rationalizability

- (a) Best Responses
  - (b) Mixed Strategies
  - (c) Application: A Location Game
  - (d) Application: Social Unrest
4. Nash Equilibrium
- (a) Application: Cournot Oligopoly
  - (b) Application: Median Voter Theorem
  - (c) Mixed Strategies
  - (d) Application: Bertrand Competition with Capacity Constraints
  - (e) Strictly Competitive Games
5. Extensive Form Games
- (a) Credibility and Backward Induction
  - (b) Value of Commitment
  - (c) Subgame Perfection
  - (d) Application: Cost-reducing Investments
  - (e) Application: Capacity Competition
  - (f) Application: Advertising
6. Bargaining
- (a) The Finite-Horizon Alternating-Offer Game
  - (b) The Infinite-Horizon Alternating-Offer Game
  - (c) Outside Options and Breakdown
  - (d) Nash Bargaining Solution
  - (e) Application: The Hold-Up Problem
7. Repeated Games
- (a) Infinitely-Repeated Games
  - (b) Repeated Prisoner's Dilemma
  - (c) Application: Collusion
  - (d) Application: Efficiency Wages
  - (e) Application: Reputation for Quality
8. Static Games of Incomplete Information
- (a) A Cournot Example
  - (b) Purification
  - (c) Application: Auctions
  - (d) Beliefs About Beliefs
  - (e) Higher Order Beliefs

## 9. Dynamic Games of Incomplete Information

- (a) Example: Dirty Faces
- (b) Cheap-Talk Games
- (c) Signaling Games
- (d) Application: Lemons
- (e) Application: Job Market Signaling
- (f) Application: Guarantees
- (g) The Chain Store Paradox

## 3 Logistic Details

1. **Handouts, assignments, solutions and other material prepared by the TAs and myself are *not* for distribution to those outside of the current class.**
2. **Ed Discussion** will be used for all class discussions and questions. Any questions to do with class material and organization should be posted there. Post all content-related questions about assignments, lectures, and the course on Ed Discussion. This is a great way to collaborate with classmates. Course instructors will monitor, and occasionally post, on this forum. There is a link to Ed Discussion in canvas.
3. **Email.** Use for correspondence that is not appropriate for Ed Discussion. Emails will receive a response within 24 hours Monday through Friday. *Include Econ 4100 in the subject line.*
4. **Assignments must** be uploaded on Canvas. **No late work is accepted.**

- Write-ups must be your original work. You may not use materials containing solutions or partial solutions to the assignments (including solutions prepared by current or former students). If your analysis contains information from outside sources, you should properly cite those sources (this includes any use of AI tools such as chatGPT).

While you are required to complete the assignments individually, I encourage learning from one's peers. In particular,

- (a) discussing the *general* ideas behind the problems is always a good idea, but
- (b) writing formal solutions should be *completely individual*, done in the equivalent of separate rooms.

As discussions of general ideas gradually become more specific, some judgment is unavoidable, but here's the kind of interaction I have in mind: If a peer conveys an idea which seems central to the solution, *do not write it down.....immediately*. Approach the problem again on your own as if afresh, influenced by however much of their idea you remember. If you can re-create it without notes, you have mastered it, and I'm happy to give you credit. In this way we can let everyone help each other learn, while steering a wide berth around simple copying.

- **All deadlines are strict**—no submissions will be accepted after the deadline. Since you may experience connectivity issues, do **NOT** wait till the last minute before uploading. NO EXCEPTIONS. You can resubmit your solutions before the deadline, so there is absolutely no reason to wait to the last minute to submit your final version!
- Check your submission once uploaded to make sure you have uploaded the correct file, and that it is legible. **THIS IS YOUR RESPONSIBILITY!**
- The upload option is restricted to PDF. You can scan your exam using a free phone app such as Dropbox or Genius Scan. This is important for two reasons: the scanning app enhances the image to make it more legible and the result is a **single** PDF file that you can then upload on Canvas.
- **Advice on how to write out solutions:** At times, the posted solutions provide additional details that a correct answer will not need. However, it is typically the case that in order to appropriately justify your answer, you will need to explain *why* you are doing a particular calculation. It is not enough to present a correct calculation, you need to provide enough detail so we know why you did that calculation.

Writing out the structure of your argument is also beneficial to you, because it will help you clarify your own thinking.

5. The Economics Department Course Policies, which include rules about exams, make-up exams, grading appeals, etc., can be found at <http://economics.sas.upenn.edu/undergraduate/course-information/course-policies>.

Students are expected to abide by the Code of Academic Integrity in the completion of assignments and exams (<https://catalog.upenn.edu/pennbook/code-of-academic-integrity/>).

6. **Regrades:** Any request for a regrade must be in writing to me with a written explanation of the issue (email is fine). Any request for a regrade of a homework or exam must be submitted within one week of the posting of the grade. I will discuss the request with the grader and communicate the result with you. The entire homework or exam is regraded, and there is no guarantee that the grade will not go down (this does not apply if the issue is a mistake in totaling the final score). While we make every effort to avoid errors, errors do occasionally creep in. Without an “all regrade” policy, a bias towards only correcting errors in one direction is introduced.
7. **Assessment:** The final grade will be determined by three inclass exams (75%) and the assignments (25%). If you are unable to complete one of the homeworks or take one of the first two midterms for an excused reason, the remainder of the grades will be scaled up appropriately. If you are unable to take the third midterm for an excused reason, the remainder of the grades will be scaled up appropriately, with increased weight placed on the assignments 5 and 6.