Management Science and Engineering 246
Game Theory with Engineering Applications

Tuesdays and Thursdays, 2:15 PM–3:30 PM
Y2E2, Room 111
3 credits

Instructor:

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Course webpage:

Course materials are available at `http://eeclass.stanford.edu/msande246`.

Course description:

Game theory is a formal approach to analyzing the strategic interactions between multiple decision makers. Although traditionally a subfield of economics, elements of game theoretic modeling are increasingly used in a broad spectrum of fields. In this course we will develop the basics of game theory, with a heavy emphasis on applications to engineering systems. The focus will largely be on the basics of non-cooperative game theory.

The theoretical topics to be covered are below; all sections of the course will be heavily supplemented by examples drawn from various engineering contexts. Students seeking a more traditional economic treatment of the material should consider taking Economics 203N.

1. *Introduction* (1 lecture). Course overview; examples of applications in engineering.

2. *Static games of complete information* (5 lectures).
    (a) Basic definitions: static game, strategic form, complete information
    (b) Common knowledge
    (c) Iterated strict dominance and dominance solvability
    (d) Nash equilibrium: pure, mixed, existence
    (e) Discussion of the concept of Nash equilibrium
    (f) Competition models: Cournot, Bertrand
    (g) Efficiency and fairness
3. *Dynamic games of complete information* (4 lectures).
    (a) Basic definitions: dynamic game, extensive form
    (b) Perfect equilibrium
    (c) Subgame perfect equilibrium and backward induction
    (d) Stackelberg equilibrium
    (e) Repeated games: definitions, folk theorems, and trigger strategies
    (f) Bargaining
4. *Static games of incomplete information* (3-4 lectures).
    (a) Basic definitions: types
    (b) Bayesian Nash equilibrium
    (c) Auctions: Revelation principle, first price, second price, revenue equivalence
5. *Dynamics games of incomplete information* (3-4 lectures).
    (a) Basic definitions: beliefs
    (b) Perfect Bayesian equilibrium: signaling games
    (c) Reputation
6. *Applications* (as time permits).
    (a) Supply chain contracting and operations management
    (b) Network resource allocation

Grading

You are responsible for keeping up with all announcements made in class and for all changes in the schedule that are posted on the class website.

The grade will be based on the following:

- 30% problem sets
- 30% midterm (to be held February 5, 2009)
- 40% final exam (to be held March 18, 2009)

There will be a total of 6-7 problem sets. Depending on their length and difficulty, the total number of points in each set might vary. You can discuss the assignments among yourselves, but everybody must turn in his/her own written solutions in his/her own words. If you are having difficulty, find help right away— *do not wait until you fall even further behind!*

Homework will be posted on the course website with associated due dates. We will post solution sets the day homeworks are due. *Late assignments will receive no credit.*

Please familiarize yourself with the Stanford Honor Code; violations will be prosecuted to the fullest extent of the (Stanford) law.

Exams

Please note the midterm date—February 5, 2009—and the final exam date—March 18, 2009 (as set by the registrar). Except for medical necessity, there will be no alternate exam dates; you should only register for the class if you are certain you can attend the exams on these dates.

Prerequisites

This course is intended for master's students and first year Ph.D. students, and is targeted at students with little or no prior exposure to game theory. We will expect students to be mathematically mature, with preparation at least at the level of **Math 51**. Students should have had exposure to probabilistic reasoning, at the level of **MS&E 120** or **EE 178**. It will be helpful to have had some exposure to linear programming at the level of **MS&E 211**, as well as microeconomic theory at the level of **MS&E 241**; however, the latter two courses are not required prerequisites.

If you have concerns about your preparation, contact Prof. Johari via e-mail prior to registering for the course.

Textbook

The textbook is *Game Theory for Applied Economists*, by Robert Gibbons. In addition, there is a required course supplement of three chapters on game theory taken from *Microeconomic Theory*, by Andreu Mas-Colell, Michael Whinston, and Jerry R. Green. Both texts can be collected from the Stanford Bookstore.