Management Science and Engineering 236H (previously 246)
Game Theory with Engineering Applications

Tuesdays and Thursdays, 2:15 PM–3:30 PM
Green Earth Sciences 124
3 credits

Instructor:

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Course webpage:

Course materials will be available at `http://eeclass.stanford.edu/msande236h`.

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 of current interest to engineering students. The focus will largely be on the basics of non-cooperative game theory.

The topics to be covered are below; all sections of the course will be heavily supplemented by examples drawn from various engineering contexts. Applications will be drawn from social networks, online marketplaces, advertising auctions, resource allocation in networks, and production and service operations.

Note that this year's course is a more mathematically rigorous version of MS&E 236. Students uncertain of their preparation should consider taking MS&E 236 next year instead. Students seeking a more traditional economic treatment of the material should consider taking Economics 203N.

Note: There will be no lecture on January 6.

1. *Static games of complete information* (8-9 lectures).
   (a) Basic definitions: strategic form, common knowledge
   (b) Iterated strict dominance and dominance solvability
   (c) Nash equilibrium: pure, mixed, existence
   (d) Application: advertising auctions
   (e) Best response dynamics
   (f) Negative externalities: competition models, congestion effects
   (g) Positive externalities: social networks, network effects
   (h) Efficiency and fairness
2. *Dynamic games of complete information* (3-4 lectures).
   (a) Basic definitions: dynamic game, extensive form
   (b) Subgame perfect equilibrium and backward induction
   (c) Stackelberg equilibrium
   (d) Repeated games: definitions, folk theorems, and trigger strategies
   (e) Stochastic games
3. *Static games of incomplete information* (4 lectures).
   (a) Basic definitions: types
   (b) Bayesian-Nash equilibrium
   (c) Auctions: Revelation principle, first price, second price, revenue equivalence; common value auctions and the winner's curse; revenue maximization
4. *Dynamics games of incomplete information* (1-2 lectures).
   (a) Basic definitions: beliefs
   (b) Perfect Bayesian equilibrium: signaling games
   (c) Herding

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:

- 20% problem sets
- 40% midterm (take-home; assigned February 8)
- 40% final exam (to be held March 16)

Problem Sets

There will be a total of 4 problem sets. Problem sets will be assigned on Thursdays and *due two weeks later, no later than 5:00 PM, in the homework drop box in Huang Engineering Center.* All assignments will be posted to the course website. Problem sets are assigned and due as follows:

- Problem Set 1 handed out on January 6, due January 20
- Problem Set 2 handed out on January 20, due February 3
- Problem Set 3 handed out on February 10, due February 24
- Problem Set 4 handed out on February 24, due March 10

Depending on their length and difficulty, the total number of points on a problem set may vary; each problem will be graded from 1 to 3 points.

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; no exceptions will be made.*

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

Exam policy

Please note the take home midterm date—February 8, 2011—and the final exam date—March 16, 2011 (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 take 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.