Management Science and Engineering 246
Game Theory with Engineering Applications

Tuesdays and Thursdays, 2:15 PM–3:30 PM
Building 200, Room 303
3 credits

Instructors:

Feryal Erhun
Assistant Professor
Management Science and Engineering
Terman Engineering Center, Room 305
E-mail: ferhun@stanford.edu
Office hours: Tuesday and Thursday, 4:00–5:30 PM

Ramesh Johari
Assistant Professor
Management Science and Engineering
Terman Engineering Center, Room 319
E-mail: ramesh.johari@stanford.edu
Office hours: Monday, 5:00–6:30 PM; Thursday, 5:15–6:45 PM

Course assistant:

Christina Aperjis
E-mail: caperjis@stanford.edu
Office hours: TBA

Enrollment:

This is the first year this course is being taught, and so we would like to prevent it from becoming too large. If necessary, we will cap enrollment at 50 students.

Course webpage:

The course webpage will be accessible through the following link:

`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
   (h) Basic elements of cooperative games
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
   (g) Reputation
4. *Static games of incomplete information* (3 lectures).
   (a) Basic definitions: types
   (b) Bayesian Nash equilibrium

(c) Revelation principle

(d) Auctions: first price, second price, revenue equivalence

5. *Production and operations management* (3 lectures).

   (a) Supply contracts: buy-back contracts, revenue sharing contracts, option contracts, etc.

   (b) Capacity games: capacity allocation, postponement, outsourcing, etc.

   (c) Other topics: the impact of organizational structures on R&D and innovation, licensing, etc.

6. *Information systems and networks* (3 lectures).

   (a) Networked systems: Internet service provider competition, energy market design

   (b) Reputation in online environments: eBay, Google, Amazon

   (c) Algorithm design using game theory: resource allocation in networks

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 7, 2006)
- 40% final exam

There will be a total of at most 6 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. Absolutely no help from other sources. Homework is meant to be a learning tool. If you are having difficulty, find help right away— *do not wait until you fall even further behind!* Good sources of help are CA and the instructors. Homework will be posted on the course website with associated due dates. Late assignments carry no credit.

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

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. 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. Erhun or 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, we have 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. In addition, we will put several additional useful materials to consult on reserve at the Terman Engineering Library, or on our website, as appropriate.