

IEOR E4407: Game Theoretic Models of Operations

Fall 2011

Instructor: Vineet Goyal, vgoyal@ieor.columbia.edu

Teaching Assistant: Shyam S Chandramouli, sc3102@columbia.edu

Schedule: TR, 9:10-10:25am, Fayerweather 313

Office Hours: Monday 5-6pm, 304 Mudd or by appointment.

TA Office Hours: TBA

Course Website: <https://courseworks.columbia.edu/>

Description. In today's world of open markets, there are many competing firms in any given sector of the economy who act in their self-interest to maximize revenues/profits. Therefore, it is important to model this mutual interaction among various firms and their strategic behavior to make sound business decisions. This is a basic course in Game Theory that introduces students to such strategic thinking. Students will learn the theory of games and auctions and gain insights into their application to operations management. No previous knowledge of game theory is assumed; students who have taken a game theory class should consult the instructor prior to enrollment.

Prerequisites. Probability, Basic calculus.

Tentative List of Topics

1. Static Games of Complete Information
 - Nash equilibrium
 - Cournot and Bertrand models
 - Mixed strategy
2. Dynamic Games of Complete Information
 - Stackelberg model
 - Sequential bargaining
 - Repeated games
3. Static Games of Incomplete Information
 - Bayesian Nash equilibrium
 - The revelation principle
4. Dynamic Games of Incomplete Information
 - Perfect Bayesian equilibrium
 - Signaling games
5. Single Object Auction
 - Equivalence of open-and-closed auctions
 - First and Second-price auctions. Reserve price
 - Revenue Equivalence Principle
 - Risk averseness and asymmetry of bidders

- Resale and efficiency
6. Mechanism Design
 - Revelation principle
 - Optimal mechanisms and Efficient mechanisms
 7. Auctions with interdependent values. The winner's curse. Collusion.
 8. Multiple Object Auction
 - Equilibrium and efficiency
 - Revenue equivalence
 - Combinatorial Auctions
 9. Applications such as sponsored search auctions, and supply chain contracts.

Required Text.

1. R. Gibbons, *Game Theory for Applied Economists*, Princeton University Press, 1992.
2. V. Krishna, *Auction Theory*, Academic Press, 2002. (Ebook available for download through CU Libraries).

Other References.

1. M.J. Osborne, and A. Rubinstein, *A Course in Game Theory*, MIT Press, 1994.
2. D. Fudenberg and J. Tirole, *Game Theory*, MIT Press, 1991.
3. F. M. Menezes and P. K. Monteiro, *An Introduction to Auction Theory*, Oxford University Press, 2005.

Organization and Grading.

Homeworks. There will be approximately 7 homeworks that must be individual work and submitted at the start of the session it is due. Students may discuss homework exercises with others but no person should rely on a written solution of a homework exercise, even if one is available. If you discuss a problem with anyone and use his/her ideas in any way, then you must acknowledge this in your solution. **NO Late submissions** will be accepted.

Midterm and Final. The course will have a midterm and a final exam. Midterm will be held in class on October 20th. The date for the Final will be determined by the Registrar.

Class Participation. The participation grade is based on the instructor's evaluation of the quality of each student's progress and contribution to class discussions during the semester. You should note that in general quality is more important than quantity.

The grade will be assigned using the following weights.

- Homeworks: 25%
- Class Participation: 5%
- Midterm: 30%
- Final: 40%