EE 648: Network Economics and Games
Fall 2020

Department of Electrical and Computer Engineering
University of Southern California

Time: Monday and Wednesday 2:00PM-3:20PM (from August 24 to November 24, see Viterbi graduate courses schedule https://viterbigrad.usc.edu)
Location: Online
Instructor: Ashutosh Nayyar

Office Hours: Monday and Wednesday 3:45-4:45PM (on Zoom)
Email: ashutosn@usc.edu

Prerequisites: EE 503

Course Overview: This course will provide an introduction to game theory and mechanism design with an emphasis on engineering applications in networks. It will cover the fundamentals of game theory as a mathematical framework for strategic interactions among self-interested agents. Both static and dynamic settings will be covered. Solution concepts for games (e.g. Nash equilibrium) will be introduced along with analytical and computational methods for finding them. The role of imperfect information in games will be discussed. The course will introduce mechanism design as a framework for designing incentives/protocols in decentralized systems with self-interested agents. It will also cover the analysis and design of auctions for resource allocation. Applications in spectrum auctions, congestion control, wireless pricing and power control, pricing of differentiated services, smart grids and network security will be discussed throughout the course.

Intended Audience:
The course is intended for PhD and MS students in Electrical and Computer Engineering, Computer Science, Industrial and Systems Engineering, and Civil and Environmental Engineering.

Learning Objectives:
1. Introduce students to the theory and mathematical framework of strategic games in static and dynamic settings.
2. Introduce computational methods and algorithms for equilibrium computation in games.
3. Model and analyze various instances of strategic interaction in networks.
4. Introduce the theory of mechanism design and auctions.

Suggested Texts:
Primary: *A Course in Game Theory* by M. Osbourne and A. Rubinstein, MIT Press, 1994 (pdf available online).

Secondary: *Game Theory* by M. Maschler, E. Solan and S. Zamir, Cambridge University Press, 2013.

Supplementary:
- *Game Theory* by D. Fudenberg and J. Tirole, MIT Press, 1991.
- *Algorithmic Game Theory* by N. Nisan, T. Roughgarden, E. Tardos and V. Vazirani (eds.), Cambridge University Press, 2007.
- *Network Games: Theory, Models, and Dynamics* (Synthesis Lectures on Communication Networks) by I. Menache and A. Ozdaglar.

Topics to be covered:
1. *Strategic games:* Static games of complete information, Nash equilibria, Existence of equilibria, Games with infinite strategy spaces, Examples from networks.
2. *Games with special structures:* Zero-sum games, Potential games, Supermodular games.
3. *Computation of Nash equilibrium:* Finite games, LQG games.
4. *Bayesian games:* Static games with imperfect information.
5. *Extensive games with perfect information:* Subgame Perfect Equilibrium.
6. *Repeated games:* Nash folk theorems.
7. *Extensive games with imperfect information:* Sequential equilibrium and perfect Bayesian equilibrium.
8. *Dynamic and stochastic games:* Games with symmetric and asymmetric information.
9. *Fundamentals of mechanism design*.
10. *Auctions:* Efficient and optimal auctions, Myerson's optimal auction design, Auctions for resource allocation in networks.

Grading:
1. Home Works: 25%
2. Mid-Term Exam(s): 40%
3. Project Presentation and Report:35%

Students will be required to work on a small research project. This can involve reading papers related to game theory, mechanism design, network economics etc. and/or doing something original. Students will present their work in a project presentation and submit a project report. The project evaluation will be based on the presentation in class, the project report and the novelty of new ideas presented.

Statement on Academic Conduct and Support Systems

Academic Conduct

Plagiarism - presenting someone else's ideas as your own, either verbatim or recast in your own words - is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in *SCampus* in Section 11, *Behavior Violating University Standards* https://scampus.usc.edu/1100-behavior-violating-university-standards-and-appropriate-sanctions/. Other forms of academic dishonesty are equally unacceptable. See additional information in *SCampus* and university policies on scientific misconduct, http://policy.usc.edu/scientific-misconduct/.

Discrimination, sexual assault, and harassment are not tolerated by the university. You are encouraged to report any incidents to the *Office of Equity and Diversity* http://equity.usc.edu/ or to the *Department of Public Safety* http://capsnet.usc.edu/department/department-public-safety/online-forms/contact-us. This is important for the safety whole USC community. Another member of the university community - such as a friend, classmate, advisor, or faculty member - can help initiate the report, or can initiate the report on behalf of another person. *The Center for Women and Men* http://www.usc.edu/student-affairs/cwm/ provides 24/7 confidential support, and the sexual assault resource center webpage sarc@usc.edu describes reporting options and other resources.

Support Systems

A number of USC's schools provide support for students who need help with scholarly writing. Check with your advisor or program staff to find out more. Students whose primary language is not English should check with the *American Language Institute* http://dornsife.usc.edu/ali, which sponsors courses and workshops specifically for international graduate students. The *Office of Disability Services and Programs* http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.html provides certification for students with disabilities and helps arrange the relevant accommodations. If an officially declared emergency makes travel to campus infeasible, *USC Emergency Information* http://emergency.usc.edu/ will provide safety and other updates, including ways in which instruction will be continued by means of blackboard, teleconferencing, and other technology.