

The purpose of this course is to teach students to formulate problems as mathematical games and provide the basic tools to solve them. The course covers:

- Static games, starting with two-player zero-sum games and eventually building up to n-player non-zero sum games. Saddle-points, Nash equilibria, and Stackelberg solutions will be covered.
- Dynamic optimization (dynamic programming) for discrete and continuous time.
- Dynamic games, both open and closed-loop policies. Saddle-points and Nash equilibria will be covered.

The intended audience includes (but is not restricted to) students in communications, controls, signal processing, and computer science. The class will be entirely project-oriented and the students are strongly encouraged to choose a project that is relevant to their own area of research.

### Instructor

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Office hours: Please email or phone in advance to schedule for an appointment.

**Course Web page:** <http://www.ece.ucsb.edu/~hespanha/ece594d/>

### Pre-requisites

Graduate level-matrix theory with introduction to matrix analysis and computations: SVD's, pseudo-inverses, variational characterization of eigenvalues, perturbation theory (e.g., ECE 210A).

A review of basic probability theory is encouraged.

### Textbook

The main textbooks are:

- [1] Tamer Başar and Geert Olsder. *Dynamic Noncooperative Game Theory*, 2<sup>nd</sup> ed. SIAM Classics in Applied Mathematics, 1999. ISBN 0-89871-429-X.
- [2] Drew Fudenberg and Jean Tirole. *Game Theory*. MIT Press, 1991. ISBN 0-262-06141-4
- [3] D. Bertsekas. *Dynamic programming and optimal control, vol I*, Athena Scientific. Athena Scientific, 1995. ISBN 1-886529-12-4.

The classes will follow closely chapters 1-6 of Başar' book [1].

### Projects

The following two types of projects are possible in this course:

1. Solution of a research problem relevant to the student's area of research
2. Independent study of a topic not covered in class (e.g., reading a paper or book chapter). Possible topics include:
  - a. N-person games in extensive form (Sec 3.5 of [1])
  - b. Static infinite games (Ch. 4 of [1])
  - c. Learning and evolution in repeated games (pp. 23-29 of [2])
  - d. Markov games
  - e. Computer network games (security, resource management)
  - f. Pursuit-evasion (Ch. 8 of [1])
  - g. Cooperative games

A one-page project proposal is due on **Nov 1st**. The project evaluations will be based on your class presentations

## Detailed Syllabus

The following is a tentative schedule for the course. As revisions are needed, they will be posted on the course's web page. The right-most column of the schedule contains the recommended reading for the topics covered on each class. Students are encouraged to read these materials prior to the class.

<b>Class</b>	<b>Content</b>	<b>References</b>
#1, Set 27	Course overview	
#2, Oct 2	Introduction to noncooperative games	Ch 1 of [1]
#3, Oct 4	Zero-sum games: Matrix form	Secs 2.1-2.2 of [1]
#4, Oct 9	Mixed strategies	Sec 2.2 of [1]
#5, Oct 11	Minimax Theorem	Secs 2.2-2.3 of [1]
#6, Oct 16	Zero-sum single-act games: Extensive form	Secs 2.3-2.4 of [1]
#7, Oct 18	(cont.)	Sec 2.4 of [1]
#8, Oct 23	Zero-sum multi-act games: Extensive form	Sec 2.5 of [1]
#9, Oct 25	Bimatrix games	Secs 3.1-3.2 of [1]
#10, Oct 30	N-person games: Matrix form	Secs 3.3 of [1]
#11, Nov 1	Computation of mixed strategies	Secs 3.4 of [1]
#12, Nov 6	N-person games: Extensive form	Secs 3.5 of [1]
#13, Nov 8	Static infinite games	Secs 4.1-4.4
#14, Nov 13	Infinite dynamic games	Secs 5.1-5.3
#15, Nov 15	Dynamic (one player) optimization	Secs 5.5-5.6
#16, Nov 20	Dynamic zero-sum games	Secs 5.5-5.6, 6.1-6.2, 6.5
Nov 22	<i>Thanks giving</i>	
#17, Nov 27	Linear quadratic games (H-infinity control)	Secs 6.1-6.2, 6.5
#18, Nov 29	<i>TBA</i>	
#19, Dec 4	<i>Project presentations</i>	
#20, Dec 6	<i>Project presentations</i>	