Introduction to Dynamic Systems

One major objective of this course is to train students to understand and model the dynamics of change. Differential equations are used as a mathematical language to facilitate discussions on dynamic phenomena. A good fraction of the time in this course will be spent in discussing some mathematical tools to analyze the dynamic models. However, the focus is not on the tools but on how such tools can help us to think about the dynamics of change as well as on how to deal with such change.

The analytical part of the course will be on mathematical analysis of linear and nonlinear dynamic systems. The notions of equilibrium, stability, growth and limit cycle will be introduced and discussed in terms of some classic examples in ecology, economics and competition. The course will also give an introduction to Catastrophe Theory, which provides a mathematical model for certain discontinuous phenomena like the crash of the stock market and the extinction of species.

The class also involves real case discussions on new product introduction, technology innovation and industry competition. In these discussions, students will learn how to use the mathematical models to help derive a qualitative but analytical argument on how to shape a dynamic environment by asserting influence on the formation of the dynamic structure that governs changes. This skill is the foundation for formulating and implementing dynamic strategy.

The course concludes with optimal control theory. Optimal economic growth model is used to illustrate how the theory is applied to economic modeling analysis.

Class Hour
Time: 2:45-4:00pm (Monday, Wednesday), Location: Skilling Auditorium
It will be televised on the channel E4. Attendance at the class is recommended.

Problem Sessions
Time: 4:15-5:05pm (Friday), Location: Gate B01
Starting from the 2nd week, April 13th
It will be televised on the channel E5. Attendance at this session is optional and you may watch this online later.
Instructor
Professor Edison Tse
Terman Engineering, Room 412
Phone: 723-4777
E-Mail: etse@stanford.edu
Office Hour: M/W 11:00-12:00 pm

Administrative Assistant
Roz Morf
Terman Engineering, Room 405

Course Assistants
• Kihoon Kim, Terman Engineering, Room 490, Friday 5:10-7:10 pm, kihoon@stanford.edu
• Veronica Chin, Terman Engineering, Room 475, Tuesday 12:00-2:00 pm, chinv@stanford.edu
• Hasan Ilhan, Terman Engineering, Room 301, Friday 4:00-6:00 pm, hilhan@stanford.edu, Tel. 650-725-1628 (For SCPD students only)
• DaeYoung Chung, Terman Engineering, Room 401, Thursday 4:00-6:00 pm, bigyoung@stanford.edu

Prerequisites
Math 103 Matrix Theory and Its Applications or equivalent
Matlab is required to solve dynamic equations, especially optimal control problems.

Required Textbook

Most of the mathematical material is covered in the book. Supplementary class notes will cover many examples and case studies that are not found in the book.

Grading Policy
• 30% Mid-term Exam (In-class: May 9, 2007)
• 30% Final Exam (One day Take-home: June 6, 2007)
• 40% Final Group Project
Midterm and Final exam
Midterm will cover all materials one week before the scheduled date. Midterm exam is closed book. You are expected to take the midterm and final exam on the date given. There are no makeup exams! Final exam will cover everything and you should know how to use Matlab in order to solve optimal control problems.

Final Group Project
For the project, you will be working in groups, which you are encouraged to form very early in the quarter. Recommended group size is 5. The projects will focus on your ability to build model that helps understand the dynamics of a certain system, usually related to current world issues and to present your model well enough to make your colleagues understood.

Class Participation
Your presence and participation in class are essential for gaining mastery of the material. At first sight it might seem to you that the concepts in this course are easy and might be quickly taken before an exam. Experience shows that this first impression is incorrect, and in this course we therefore require your attendance and participation. Although class participation will not be graded, your participation can have a great impact on your exam.

Problem Sets
Problem Sets will be distributed but will NOT be graded. You are not required to hand in your solutions. Solution sets will be distributed. They are just for your practice.

Honor Code
The Honor Code is the University’s statement on academic integrity written by students in 1921. It articulates University expectations of students and faculty in establishing and maintaining the highest standards in academic work:

- The Honor Code is an undertaking of the students, individually and collectively:
  - that they will not give or receive aid in examinations; that they will not give or receive unpermitted aid in class work, in the preparation of reports, or in any other work that is to be used by the instructor as the basis of grading;
  - that they will do their share and take an active part in seeing to it that others as well as themselves uphold the spirit and letter of the Honor Code.

- The faculty on its part manifests its confidence in the honor of its students by refraining from proctoring examinations and from taking unusual and unreasonable precautions to prevent the forms of dishonesty mentioned above. The faculty will also avoid, as far as practicable, academic procedures that create temptations to violate the Honor Code.

- While the faculty alone has the right and obligation to set academic requirements, the students and faculty will work together to establish optimal conditions for honorable academic work.
Specially, adhering to the Stanford Honor Code implies that all work in exams must be done individually. We expect students to create an environment in which Honor Code violation is not to be tolerated. More details can be found at http://www.stanford.edu/dept/vpsa/judicialaffairs/guiding/honorcode.htm

**Students with Documented Disabilities**

Students who have a physical or mental impairment that may necessitate an academic accommodation or the use of auxiliary aids and services in a class must initiate the request with the Disability Resource Center (DRC). The DRC will evaluate the request along with the required documentation, recommended appropriate accommodations, and prepare a verification letter dated in the current academic term in which the request is being made. Please contact the DRC as soon as possible; timely notice is needed to arrange for appropriate accommodations. The DRC is located at 123 Meyer Library (phone: 723-1066).

**More Information**

Please visit our class website at http://coursework.stanford.edu
Course Outline and Tentative Schedule

04/04 Introduction, Solution of Linear Dynamic Systems  
(Chapter 2.1, 2.8, 4.1, 4.3, 4.4, 4.5, 4.6, 4.7)  
04/09 A simple Grabber-Holder Model, McDonald’s and VCR Examples  
(Notes)  
04/11 Linear Two-sided Market (Notes)  
04/16 Macro-behavior of a Linear Dynamic System  
(Chapter 5.7, 5.9, 5.10)  
04/18 Nonlinear Dynamic Systems (Chapter 9.1-9.5)  
04/23 Dynamic Competitive Power (Notes)  
04/25 Predator-prey Model, Crowding Model, Ecological system  
(Chapter 10.3, 10.4)  
04/30 Create a New Game in Business Competition (Notes)  
05/02 Catastrophe: Fast and Slow Dynamics (Notes)  
05/07 Stock Trading Model, Insects and Trees Model (Notes)  
05/09 Midterm (In-Class)  
05/14 Optimal Control in Modeling Application, Maximum Principal  
(11.1-11.3)  
05/16 Infinite Time Optimal Control with time discounting (Notes)  
05/21 Calculation of Optimal Path (Matlab Simulation)  
05/23 Pricing in Two-sided Market (Paper)  
05/28 Memorial Day (No Classes)  
05/30 Dynamic Optimal Game Modeling (Paper)  
06/04 Project Presentation  
06/06 Project Presentation, Final Exam Distribution  
06/07 Final Exam Submission