CALIFORNIA INSTITUTE OF TECHNOLOGY
Control and Dynamical Systems

CDS 101 - Principles of Feedback and Control
CDS 110 - Introductory Control Theory
ChE 105 - Process Control

Fall 2002

Instructor
R. Murray, 109 Steele
murray@cds.caltech.edu

Co-instructors
M. Dickinson (BE/Bio)
E. Klavins (CS)
H. Mabuchi (Ph/CDS)
D. MacMartin (CDS)

Teaching Assistants
Sean Humbert (head TA; jshumber@cds.caltech.edu)
Tim Chung (timothyc@its), Lars Cremean (lars@cds),
Zhipu Jin (jzp@cds), Shreesh Mysore (shreesh@its)
Office hours: Sundays, 5–7 pm, 110 Steele

Lectures
M2-3, W1-3; 102 Steele
F2-3, 102 Steele (optional)

CDS 101 vs CDS110a/ChE 105 CDS 101 is a 6 unit (2-0-4) class intended for advanced students in science and engineering who are interested in the principles and tools of feedback control, but not the analytical techniques for design and synthesis of control systems.

CDS 110a/Che 105 is a 9 unit class (3-0-6) that provide a traditional first course in control for engineers and applied scientists. It assumes a stronger mathematical background, including working knowledge of linear algebra and ODEs. Familiarity with complex variables (Laplace transforms, residue theory) is helpful but not required.

Lectures The main course lectures are on Mondays from 2–3 pm and Wednesdays from 1–3 pm in 102 Steele. CDS 101 students are not required to attend the Wednesday lectures, although they are welcome to do so. In addition, optional lectures will be held on Fridays from 2–3 pm in 102 Steele on supplemental topics. The schedule for these optional lectures is given below.

Grading The final grade will be based on homework sets, a midterm exam and a final exam.

- Homework: 50%
  Homework sets will be handed out weekly and due on Mondays by 5 pm to the box outside of 102 Steele. *Late homework will not be accepted without* **prior** *permission from the instructor.*

- Midterm exam: 20%
  A midterm exam will be handed out at the beginning of midterms week (30 Oct) and due at the end of the midterm examination period (5 Nov). The midterm exam will be open book and computers will be allowed (though not required).

- Final exam: 30%
  The final exam will be handed out on the last day of class (4 Dec) and due at the end of finals week. It will be an open book exam and computers will be allowed (though not required).

Homework policy Collaboration on homework assignments is encouraged. You may consult outside reference materials, other students, the TA, or the instructor. All solutions that are handed in should reflect your understanding of the subject matter at the time of writing. MATLAB scripts and plots are considered part of your writeup and should be done individually.

Course Text and References There is no required text for CDS 101 or CDS 110/ChE 105. You may find the following texts useful:

- B. Friedland, *Control System Design: An Introduction to State-Space Methods*, McGraw-Hill, 1986.
- G. F. Franklin, J. D. Powell, and A. Emami-Naeni, *Feedback Control of Dynamic Systems*, Addison-Wesley, 2002.
- N. E. Leonard and W. S. Levine, *Using Matlab to Analyze and Design Control Systems*, Benjamin/Cummings, 1992.
- B. C. Kuo, *Automatic Control Systems*, Prentice-Hall, 1995.

These have been put on reserve in the Sherman Fairchild Library. Additional online references may be found on the course homepage.

Office and library hours The TAs will hold office hours on Sundays from 5–7 pm in 110 Steele. In addition the CDS library will be open from 2–7 pm on Sunday afternoons for students interested in getting together to discuss problems. The supplemental textbooks for the course will be available in the library during the library hours.

All students must show up for office hours at least once in the first three weeks of the course (even if you just stop in and introduce yourself to the TAs).

Class homepage Information on the class is available via the class homepage:

`http://www.cds.caltech.edu/~murray/cds101`
`http://www.cds.caltech.edu/~murray/cds110`

All course handouts and other administrative data about the course are available via the class homepage.

Software Computer exercises will be assigned as part of the regular homeworks. The exercises are designed to be done in MATLAB, using the Control Toolbox and SIMULINK. Caltech has a site license for this software and it may be obtained from ITS:

`http://www.its.caltech.edu/its/services/sitelicensing/sitewide/matlab.shtml`

An online tutorial is available at

`http://www.engin.umich.edu/group/ctm/basic/basic.html`

Course outline

Week	Date	Topic	Friday lecture (optional)
1	30 Sep	Course administration Introduction to feedback and control	MATLAB tutorial (Humbert)
2	7 Oct	Dynamics and modeling	Insect flight control (Dickinson)
3	14 Oct	Stability and performance	Aerospace control applications (TBD)
4	21 Oct	State space control systems	Internet congestion control (Klavins)
5	28 Oct	Controllability	Midterm review (Humbert)
6	4 Nov	Transfer functions	Biological sensors and actuators (Dickinson)
7	11 Nov	Loop analysis of feedback systems	Quantum feedback control (Mabuchi)
8	18 Nov	State space and PID feedback	Mirror control of Keck and CELT (MacMartin)
9	25 Nov	Frequency domain control design	Thanksgiving
10	2 Dec	Uncertainty analysis	Final review (Humbert)