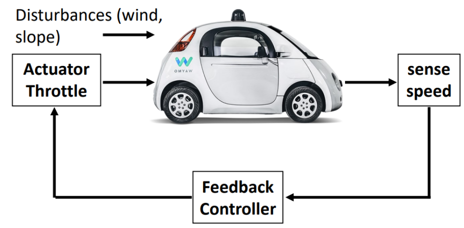
ECE171A: Linear Control System Theory (Spring 2024)

When: Monday/Wednesday/Friday 9:00am - 9:50am
Where: FAH 1101;
Discussion: FAH 1101; Wednesday 1:00pm - 1:50am
Instructors: Yang Zheng (zhengy@eng.ucsd.edu)
Chih-Fan (Rich) Pai (cpai@ucsd.edu)
Course website:
https://zhengy09.github.io/ECE171A/ece171a.html



Course description

This is an undergraduate-level course in classical control theory. The course covers the modeling of physical systems, analysis and performance of linear systems, and basic feedback controls. We emphasize the basic principle of feedback and its use as a tool for altering or inferring the dynamics of systems under uncertainty.

This course focuses on single-input and single-output linear time-invariant control systems emphasizing frequency-domain methods. We present material that is fundamental and foundational for the study and practice of control systems. Concepts include the s-domain, transient and steady-state behavior, PID control, root locus, Bode, Nyquist plots, compensator design, etc.

A **tentative** list of topics that we will cover include

- **Part I: System modeling** (2 weeks): ODEs, linear time-invariant systems, first-order and second-order systems, mechanical systems, RLC circuits, etc.
- **Part II: System analysis** (4 weeks): Laplace transform, transfer functions, block diagram, Steady-State Error, Transient Response, Stability etc.
- **Part III: Feedback control** (4 weeks): PID control, Bode plots, Nyquist plots, stability margin, root locus, Loop analysis/shaping etc.

The students are expected to sign up on Piazza and GradeScope. Discussions and important announcements will happen on Piazza. The homework should be turned in and will be graded on GradeScope.

Pre-requisites

ECE45: Circuits and Systems or MAE 40: Linear Circuits.

It is expected that the students have access to Matlab, which will be used very often in homework problems. Please install it as soon as possible if you haven't yet.

Textbook

1. **Primary Textbook**: Karl J. Astrom and Richard M. Murray, Feedback Systems: An introduction for Scientists and Engineers, Princeton University Press. Second Edition. Available at:

   http://www.cds.caltech.edu/~murray/books/AM08/pdf/fbs-public_24Jul2020.pdf

2. **Additional References:** (You will not need these books. I'm only listing them in case you want to consult additional references.)
   - Dorf, R.C. and Bishop, R.H., Modern Control Systems, Prentice Hall.
   - G. F. Franklin, J. D. Powell, and A. Emami-Naeni, Feedback Control of Dynamic Systems, Addison-Wesley, 8th edition, 2019.
   - A. D. Lewis, A Mathematical Approach to Classical Control, 2003.
3. There are many excellent online references for classical control. My top recommendation is Brian Douglas's Classical Control Theory, which is designed for online learning (short and clear videos).
4. Further reading materials/lecture notes will be distributed on Canvas when needed.

Course grade

The final grade will be based on homework sets, two midterm exams, a final exam, and class attendance.

- **Homework** (35%): There will be 8 homework assignments which are usually due in one week and should be submitted to Gradescope;
- **Midterm exams** (20%): There will be two in-class midterm exams; one will be in Week 4, and another one will be in Week 7 or 8 (exact dates to be announced); 50 minutes each. The midterm exams will be closed-book, closed notes, and closed external links.
- **Final exam** (40%): the final exam will take place on June 12, 8:00 am - 11:00 am (Location: TBA). It will be closed book but you can bring one sheet of notes (page maximum size: Letter; can be double-sided).
- **Class attendance/participation** (5%): Two simple in-class quizzes; Unannounced (2.5% each); answer questions on Piazza.

These weights are approximate; we reserve the right to do minor changes later.

Notes:

1. We will enforce *no late policy*: homework submitted past the deadline will receive 0 credit.
2. If you will be unable to take a midterm, please send an email explaining your situation to me and to the TA **BEFORE** the exam time. The final exam will be given extra weight if a midterm is missed with approval.
3. For the midterm and final exams, you should bring a basic arithmetic calculator. No graphical calculators are permitted. NO communication devices are permitted outside your personal belongings. The exams must be done in a blue book.
4. If you miss one in-class quiz, then your active participation in this course (e.g., answering questions on Piazza) can be used to account for up to 2.5% of the final grade.
5. A standard grade scale (e.g., 93% or more = A) will be used with a curve based on the class performance (e.g., if the top students have grades in the 86% - 89% range, then this will correspond to letter grade A).

Collaboration and Academic Integrity

UCSD's Code of Academic Integrity applies to this course. It is dishonest to cheat on exams, copy other people's work, or fake experimental results. An important element of academic integrity is fully and correctly acknowledging any materials taken from the work of others.

Homework: The due date of each homework assignment will be clearly stated. We expect you to turn in all completed problem sets on time. Late submissions and deadline extensions will not be possible because our schedule is very tight.

Collaboration policy: We encourage working together whenever possible: general discussions on homework sets and lectures. But please note that the work you turn in should be your own! It is not acceptable to copy a solution that someone else has written. Instances of academic dishonesty will be referred to the Office of Student Conduct for adjudication.

No collaboration is allowed on the midterm or final exams.