ME190L is a 1-unit, advanced undergraduate course on feedback control systems. The prerequisite is ME 132, or equivalent, namely, a first course on feedback systems. You should also be familiar/comfortable with the control system analysis tools in Matlab. Most of the assigned problems will be much more internalized if you complete a concrete, numerical exercise, and the Control System Toolbox in Matlab is the best/quickest route to working through such exercises.

In ME 190L, we will learn an important, effective control-design technique for single-input, single-output systems, called ***loopshaping***, or ***Bode-loopshaping*** or just ***frequency-domain design***. Most likely, in your first class, you learned some of the basic ideas that we will expand upon in this course. The goal of the course is to eventually make you "**the smartest person in the room**" on this topic. Certainly if you pursue a career in control, this knowledge (and many other interesting topics) is valuable, and (I believe) timeless.

The topics covered are

1. Review of material you should/need to know from prior course
2. Definition of open and closed-loop bandwidths, open-loop gain, and closed-loop sensitivity functions
3. Bode plots
4. Nyquist stability criterion, robustness margins
5. Bode phase theorem and elementary loopshaping theorems
6. Advanced loopshaping theorems for unstable plants, and plants with right-half plane (RHP) zeros
7. Limitations on achievable closed-loop performance due to unstable poles and/or RHP zeros, including Bode Integral theorem
8. Loopshaping with undamped (or lightly damped) resonances
9. Computer-aided tools for loopshaping

There is no textbook for the course, but I will post a freely available text that may be used for supplementary reading, if you are interested. **We will mostly work from about 6 or 7 extensive Powerpoint slide decks that I have prepared over the last few years**. Please make sure you ask questions in class, and come to office hours for additional clarification.

Teaching Staff

Instructor: Prof. Andrew Packard (apackard@berkeley.edu (mailto:apackard@berkeley.edu)), 5116 Etcheverry. Office hours are:

> - **Tuesday, 1:00PM-2:30PM**
> - **Wednesday, 9:30AM-11:00AM**
> - **Thursday, 11:00AM-12:30PM**

Please come see me in office hours. Our once-a-week 50 minute class will go by very quickly - I eventually would like to meet you all. Occasionally, my office hours will need to be changed. In that case, I will try to post announcements on weekends, alerting you to any changes in office hours in the upcoming week.

Course Format

ME 190L consists of one lecture/week, weekly homework assignments, online quizzes (which can be repeated as often as you like), a one-hour final exam (during the scheduled final exam time for our class section - more on this later). We will also see if there is an opportunity to do a course project, in teams of 2-4 people. We will discuss the feasability of this during the 3rd or 4th lecture. **A big challenge, for me, is to keep the workload appropriate for a 1-unit class**. You, the students, will need to give me feedback if the workload seems to drift too large.

I. CLASS/LABORATORY SCHEDULE

One hour of lecture per week.

Lectures: Thursday, 10:10AM-11:00AM, 3107 Etcheverry

II. ASSIGNMENTS

(1) Homework

I will try to post a modest (one or two-problem) Homework each Thursday, that covers the material we will learn from that day's lecture. It will be due the following Thursday, at 5:00PM. Please turn the homework in on time. I will create a late-homework policy by the 2nd lecture. More information about how/where to turn in assignments will be discussed/posted soon.

(2) Online Quizzes

There will be weekly online quizzes at bCourses after each lecture. All quizzes associated with a specific lecture should (as a goal for you) be completed before the next lecture, unless otherwise specified. **Nevertheless, you will be able to take each quiz as many times as you like and only your best score will be recorded**. Hence there is no reason to get less than 100% on all quizzes.

III. FINAL EXAM

Not sure (?) about format - open/closed computer, notes allowed. We will discuss this as the semester proceeds.

Final: Tuesday, May 8, 3:00-6:00PM. As mentioned, the exam will not be a 3-hour exam (most likely 1-hour), and we will converge to a single time, or allow some flexibility for each student. We will discuss this in the middle of the term.

If you are on a sports team, or in the band, or represent the university in a similar manner, and will not be available at this time, let me know as soon as possible, and we will make appropriate scheduling arrangements.

IV. PIAZZA

The course discussion forum Piazza is integrated into bCourses (soon, on the sidebar). I will monitor and contribute to this forum, and you are encouraged to use it to seek help from me and your peers. You are also encouraged to contribute not only questions, but also answers to questions that you are comfortable with. Everyone should be automatically signed up.

Course Text and Requirements

There is no required text for the course. We will use extensive PowerPoint slides and some references to freely available material. These resources will be available on bCourses. Two books may be of interest:

- There is a good general-purpose book, "Feedback Systems", by Karl Astrom and Richard Murray that we will refer to. You can purchase the book, or obtain a pdf-version free-of-charge. Check the wiki for more information: **http://www.cds.caltech.edu/~murray/amwiki/index.php/Main_Page (http://www.cds.caltech.edu/~murray/amwiki/index.php/Main_Page)**
- I have posted, in Modules, a copy of "Feedback Control Theory" by J. Doyle, B. Francis and A. Tannebaum. It is more theoretical, and **not** a good general purpose book. But it covers some of the same theoretical issues that we will address, and in that sense, is a useful (and free!) resource for people interested in feedback control systems

In ME190L, you are going to use Matlab and the associated Control System Toolbox. We highly recommend that you install Matlab on your personal computer, using the license available to all UC Berkeley registered students, which can be obtained at **https://software.berkeley.edu/ (https://software.berkeley.edu/) (http://bcourses.berkeley.edu)**

(http://bcourses.berkeley.edu)

Academic Honesty

It is acceptable to discuss (extensively, if desired) with your classmates the material contained in the homework assignments and online-quizzes. *However, we require that your submissions represent your own work.* Copying someone else's work or allowing your work to be copied constitutes cheating, and will result in zero credit for the entire assignment. In addition, students who are found to cheat in assignments or the final exam will be referred to Student Judicial Affairs. For details, see the website of the **Berkeley Center for Student Conduct (http://sa.berkeley.edu/conduct)** .

Honor Code
The student community at UC Berkeley has adopted the following Honor Code**: "As a member of the UC Berkeley community, I act with honesty, integrity, and respect for others."** I join you in pledging to adhere to this code.

Grades and Grading

The course grade will be assigned based on the following percentages:

- 55% Homework
- 20% Online Quizzes (via bCourses)
- 25% Final Exam

As mentioned earlier, it is a challenge for me to create the online quizzes, which is why I have revised the weighting. **The homework is critical, even though I am quite flexible on the due dates.** Of course, regardless of the weighting, if you find any discrepancies between the issued grades and the grades posted on bCourses, please bring them to my attention immediately. In general, the course is curved, to College and Department guidelines, with a 3.5-3.6 GPA. I will say more about this in the second lecture.