CALIFORNIA INSTITUTE OF TECHNOLOGY
Control and Dynamical Systems

CDS 101/110
Problem Set #1

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Note: In the upper left hand corner of the first page of your homework set, please put the class you are taking (CDS 101, CDS 110, ChE 105) and the number of hours that you spent on this homework set (including reading).

All students should complete the following problems:

1. Identify 10 feedback control systems that you encounter in your everyday environment. For each system, identify the sensing mechanism, actuation mechanism, and control computation. Describe the uncertainty that the feedback system provides robustness with respect to and/or the dynamics that are changed through the use of feedback.

2. Read the Jun 2002 New York Times article "For the Spy in the Sky, New Eyes" (available on the course homepage). The article discusses several generations of camera stabilization systems. Identify these different approaches to stabilization and indicate which of them correspond to the use of feedback control. For each of the feedback control systems, describe the sensor, actuator, and computational element. If the information is not available in the article, indicate this and take a guess at what might have been used.

3. (MATLAB/SIMULINK) Download the file "hw1cruise.mdl" from the course web page, which contains a SIMULINK model of a simple cruise controller, similar to the one described in class (see documentation from web page for more details). Figure out how to run the example and plot the vehicles speed as a function of time.

   (a) Leaving the control gainst at their default values, plot the response of the system to a step input and measure the time it takes for the system error to settle to within 95% of commanded change in speed (i.e., 0.5 miles/hour).

   (b) By manually tuning the control gains, design a controller that settles 50% faster than the default controller. Include the gains you used, a plot of the closed loop response, and describe any undesireable features in the solution you obtain.

   All plots should included a title, labeled axes (with units), and reasonable axis limits.

   Note: The purpose of this problem is to give you some familiarity with MATLAB and SIMULINK. Don't worry if you don't yet know how the control law works or why it does what it does. We'll go over this in class later in the term.

4. Complete the course survey attached to this problem set. Please turn this in at the same time as your homework, but do not attach to your homework set.

Only CDS 110a/ChE 105 students need to complete the following additional problems:

5. Perform a web search and find at least one "interesting" example of a control system that you did not know about before starting the search. Provide a short description of the system and give the URL where more information can be found. The most interesting answers to this problem will be posted on the course web page and used as examples in future versions of the course. (Hint: count at how many times and the context in which the words "control" and "feedback" appear in the NY Times article.)

6. (MATLAB/SIMULINK) Download the file "hw1rollmill.mdl" from the course web page, which contains a SIMULINK model of a rolling mill, which is a machine used to create material (paper, steel, etc) of a given thickness (see documentation from web page for more details).

(a) Run the simulation with default parameters and create a plot of the output thickness versus time.

(b) While keeping the proportional gain K_p fixed at its default value, vary the integral gain K_i from zero to twice the default simulation value. Give the value for which the system begins to go unstable. Plot the settling time as a function of K_i for the stable cases.

(c) While keeping K_i fixed at its default value, vary K_p from zero to twice the default simulation value. Give the value for which the system begins to go unstable. Plot the settling time as a function of Kp for the stable cases.

All plots should included a title, labeled axes (with units), and reasonable axis limits.

Note: As in the previous MATLAB problem, it is not necessary for you to understand the dynamics of the plant and control law at this point. This model makes use of some more advanced features in MATLAB and SIMULINK, which you may need to spend some time learning.