EE361: Control Systems

Homework 3

Due Fri Mar 22, 2 PM

Spring 2019

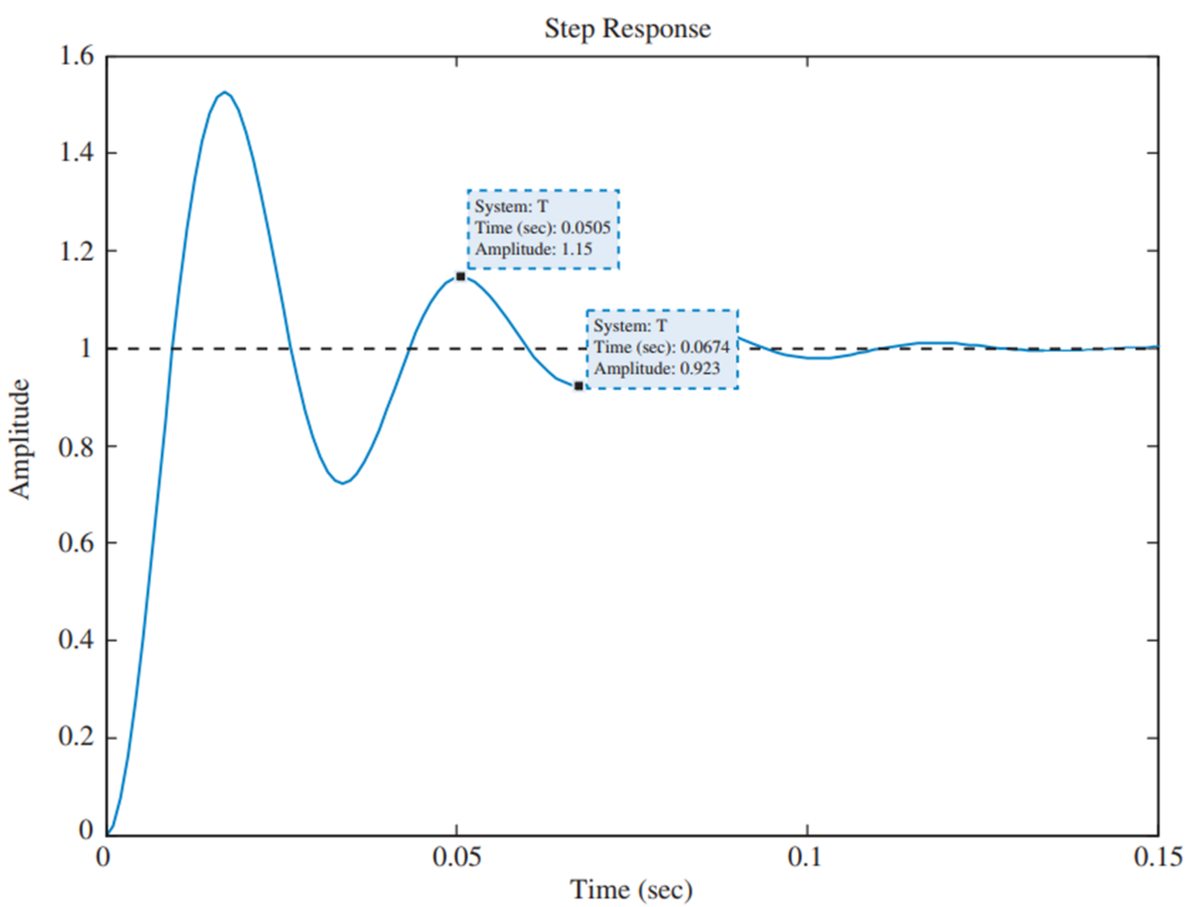
Some tips to avoid plagiarism cases:

- Do not copy the solutions of your classmates.
- Your are encouraged to discuss the problems with your classmates in whatever way you like but make sure to REPRODUCE YOUR OWN SOLUTIONS in what you submit for grading.
- Cite all the online sources that you get help from.
- Keep your work in a secure place.

Problem 1

The response of the deflection of a fluid-filled catheter to changes in pressure can be modeled using a second-order model. Knowledge of the parameters of the model is important because in cardiovascular applications the undamped natural frequency should be close to five times the heart rate. However, due to sterility and other considerations, measurement of the parameters is difficult. A method to obtain transfer functions using measurements of the amplitudes of two consecutive peaks of the response and their timing has been developed. Assume that the figure is obtained from catheter measurements.

Using the information shown and assuming a second-order model excited by a unit step input, find the corresponding transfer function.



Problem 2

A human responds to a visual cue with a physical response,as shown in the figure below. The transfer function that relates the output physical response $P(s)$, to the input visual command, $V(s)$ is

$$G(s) = \frac{s+1}{s^2+7s+10}$$

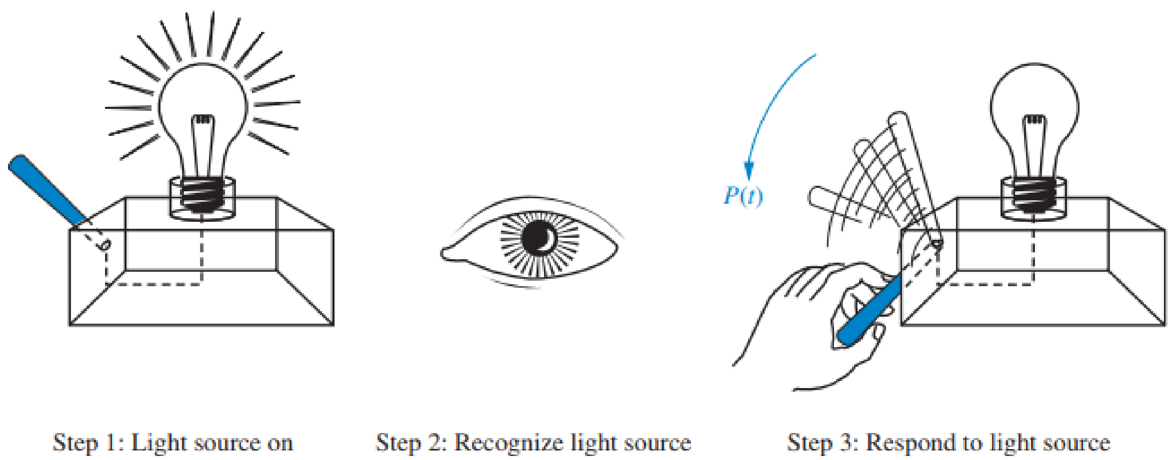


Figure 1

(a) Plot poles and zeros of the system in the s-plane.

(b) Evaluate the output response for a unit step input using the Laplace transform.

(c) Represent the transfer function in state space.

(d) What are the eigenvalues of the matrix A?

(e) Use MATLAB to simulate the system and attach a plot of the step response.

(f) Repeat parts (a) to (e) for the following transfer function and compare the graphs.

$$G_2(s) = \frac{s-1}{s^2+7s+10}$$

Problem 3

Consider the following transfer function.

$$G(s) = \frac{s^3+4s^2+3s+1}{s^4+s^3+6s^2+26s+20}$$

(a) Using Routh's table, determine how many of its poles do not lie in the left half plane?

(b) What is the value of $\lim_{\tau\to\infty} \int_0^\tau |g(t)|\, dt$? Explain.

(c) Is this system internally stable? Explain.

(d) Is this system BIBO stable? Explain.