Control Theory Intro: Home Assignment #5

November 1, 2021

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Introduction

The purpose of this home assignment is to base your understanding in root locus sketching and control design. You may either use the rlocus command in Matlab or sketch by hand. It is recommended to do both!!!!!!!

Your solutions should be presented in a PDF (not Word!) file. You should submit also a **.m** file. The first line should print your ID.

>> disp('ID_STUDENT_1 ID_STUDENT_2') % disp('ID_STUDENT_1') if only one student is submitting.

For clarity of the script, you can separate the different sections of the script with a **%%**. This will automatically create a block in your script. In order to run specifically this block of code press 'Ctrl+Enter'. To run the entire script press 'F5'.

1 Sketch a Root locus

Sketch the root locus for the following transfer function

$$G_cG(s) = \frac{K}{(s^2+2s+2)(s+1)} \tag{1}$$

2 State space system

Consider the system represented in state variable form,

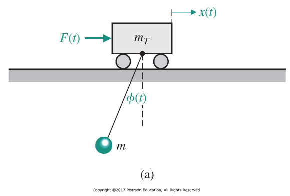
$$\begin{aligned}\dot{x} &= Ax + Bu\\ y &= Cx + Du\end{aligned} \tag{2}$$

where,

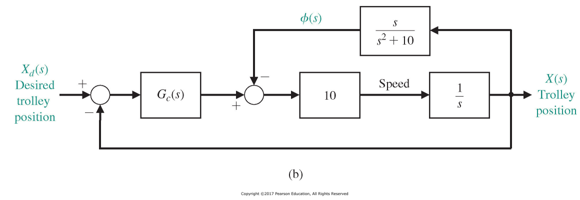
$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -5 & -2-k \end{bmatrix}, B = \begin{bmatrix} 1 \\ 0 \\ 4 \end{bmatrix}$$

$$C = \begin{bmatrix} 1 & -9 & 12 \end{bmatrix}, D = [0].$$

1. Determine the characteristic equation.
2. Using the Routh-Hurwitz criterion, determine the values of k for which the system is stable.
3. Plot the root locus and compare the results to those obtained in (b).



(a) Pilot crane control system.



(b) Block diagram.

Figure 1: Pilot crane system proportional control.

3 Pilot crane

A pilot crane control is shown in Fig. 1(a). The trolley is moved by an input $F(t)$ in order to control $x(t)$ and $\phi(t)$. The model of the pilot crane control is shown in Fig. 1(b). Design a controller that will achieve control of the desired variables when $G_c(s) = K$.

4 Settling time design

A unity feedback system has a loop transfer function

$$G_cG(s) = \frac{K(s^2 + 3s + 6)}{s^3 + 2s^2 + 3s + 1} \tag{3}$$

Sketch the root locus and select a value for K that will provide a closed step response with settling time less than 1 second and overshoot less than 7.5%. Simulate the system for the chosen value of K.

Hint - Try different values of K until you get the desired response.