Control Theory Intro: Home Assignment #6

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Introduction

The purpose of this home assignment is to base your understanding in frequency domain and Bode plot sketching. You may either use the bode 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 Bode plot

For each of the following transfer functions, sketch the Bode plot and determine the crossover frequency (that is, the frequency at which $20\log_{10}|G(j\omega)| = 0dB$):

$$G(s) = \frac{1000}{(s+10)(s+30)} \tag{1}$$

$$G(s) = \frac{100}{(s+0.2)(s^2+s+20)} \tag{2}$$

$$G(s) = \frac{50(s+100)}{(s+1)(s+50)} \tag{3}$$

$$G(s) = \frac{100(s^2+14s+50)}{(s+1)(s+2)(s+500)} \tag{4}$$

2 Space robot

For the successful development of space projects, robotics and automation will be a key technology. Autonomous and dexterous space robots can reduce the workload of astronauts and increase operational efficiency in many missions. Figure 1 shows a concept called a free-flying robot. A major characteristic of space robots, which clearly distinguishes them from robots operated on earth, is the lack of a fixed base. Any motion of the manipulator arm will induce reaction forces and moments in the base, which disturb its position and attitude.

The control of one of the joints of the robot can be represented by the loop transfer function

$$G_cG(s) = \frac{781(s+10)}{s^2+22s+484} \tag{5}$$

1. Sketch the Bode diagram of $G_cG(j\omega)$.
2. Determine the maximum value of $20\log_{10}|G_cG(j\omega)|$, the frequency at which it occurs, and the phase at that frequency.

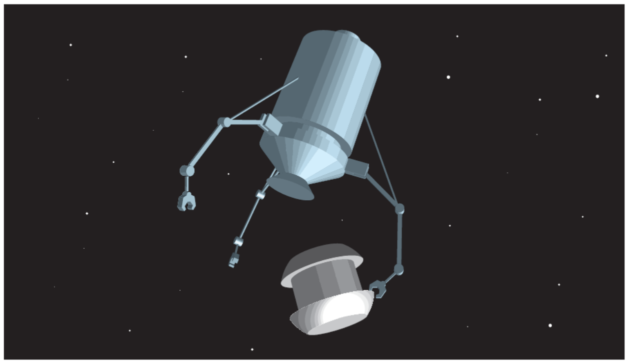

Figure 1: A spring-mass-damper system.

3 Closed loop system

Consider the system given in Figure 2 where,

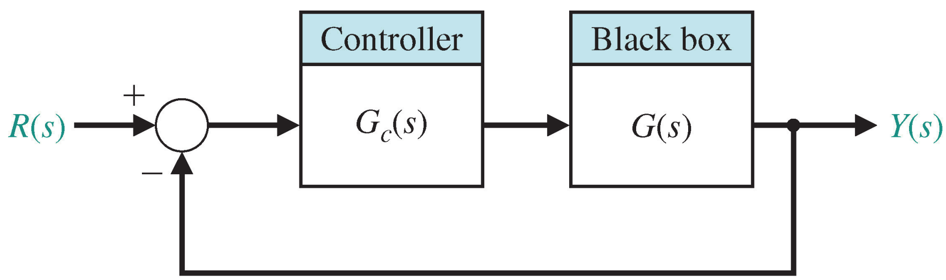

Figure 2: Closed loop system.

$$\begin{aligned} G(s) &= \tfrac{1}{s(s^2+2s+2)} \\ G_C(s) &= \tfrac{K(s+5)}{s+10} \end{aligned} \tag{6}$$

1. Find K such that the velocity error coefficient $K_v = 10$.
2. Draw the Bode plot of the open-loop system.
3. From the Bode plot, find the frequency corresponding to 0 dB gain.