EE128 MIDTERM

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1

The following Bode plot for the magnitude of a transfer function of a physical system has been determined from laboratory measurements.

Estimate the following:
1) The order of the system.
2) The transfer function.
3) The overshoot, settling time and rise time of the step response.
4) The amplitude of the output when the input is a sinusoid of unit amplitude and frequency 1 Hz.
5) Roughly sketch the phase as a function of the angular frequency.
Also answer the following:
6) How would you design a feedback control for the above physical system so that the resulting system is of type 1? (I.e., what kind of compensation would you use?) Why?
7) Roughly sketch the step response.

2

1) Sketch the root locus of the transfer function whose poles and zeros are as below.

2) Is it possible to achieve an arbitrarily small overshoot by using only proportional control?
3) How would you find graphically the minimum overshoot that can be achieved with proportional control?
4) Below you see another root locus. Is everything correct?

3

Consider the transfer function

$$G(s) = \frac{s+1}{s(s-10)(s-5)}.$$

1) Is the system BIBO stable?
2) Sketch the Bode plots (magnitude and phase).
3) Sketch the Nyquist plot.
4) Can the system be stabilized with proportional control?
5) Check your answer to 4) by drawing the root locus.

4

Consider the following feedback system:

Assuming that $K > 0$, determine the set of (real) numbers K, z for which the system is stable. Draw this set.

5

You are given the following simple circuit:

1) Write state equations. To do this, first select appropriate state variables.
2) What is the transfer function from v to i?
3) What is the natural frequency of oscillations?
4) Is the transfer function you found low-pass or high-pass?
5) Suppose that the resistor R is replaced by a non-linear resistor. Would you still be able to write state equations? Would you still be able to find the transfer function from v to i?

6

Consider the following linear differential equation:

$$\dot{x} = \begin{bmatrix} -2 & 0 \\ 1 & 3 \end{bmatrix} x + \begin{bmatrix} 1 \\ 5 \end{bmatrix} u.$$

The state x is the vector

$$x = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

and the input u is a scalar. Now consider the following two cases:
(i) The input is u and the output is x_1.
(ii) The input is u and the output is x_2.
1) Are these systems BIBO stable?
2) If not, which of the two systems can be stabilized using proportional control?
3) If both of them can be stabilized, which one would you prefer?