Department of Electrical & Computer Engineering
Prairie View A&M University

Ph.D. Preliminary Examination in Control Systems

Spring 2012

Write legibly.
No points will be given for answers that show no work.

Do not use cell phone during the examination.

Note: Each problem is worth 20 points.

Name: ______________________ Date: March 30, 2012

1. For the unity negative feedback system with

$$G(s) = \frac{K(s+2)(s+3)}{(s^2+2s+2)(s+4)(s+5)(s+6)},$$

do the following:

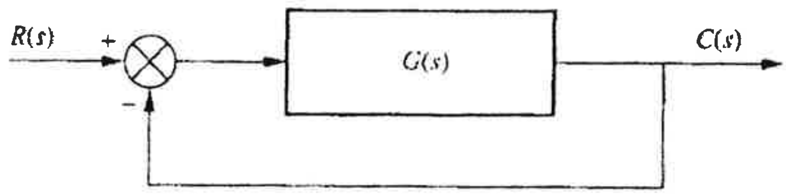
a) Sketch the root locus.

b) Find the jw-axis crossing and the gain, K, at the crossing.

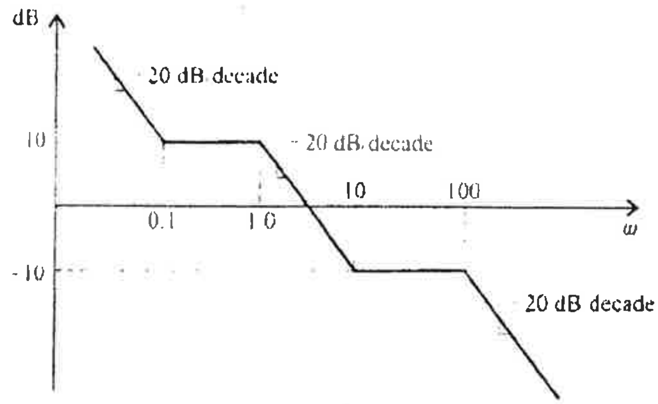
c) Estimate all breakaway and break-in points.

d) Find angles of departure from the complex poles.

e) Find the gain, K, to yield a damping ratio of 0.3 for the closed-loop dominant poles.



2. An engineer is called in to consult on a control system in a piece of equipment in the field. No one can find the design report or test results from the original design of the control system. The engineer, therefore, decides to take a frequency response of the control system by opening the feedback loop. The resulting asymptotic gain-frequency characteristic is obtained.



Determine the transfer function, G(s)H(s).

3. The open-loop transfer function of a feedback control system is given by the following:

$$G(s)(s) = \frac{20}{s(0.2s+1)(0.4s+1)}$$

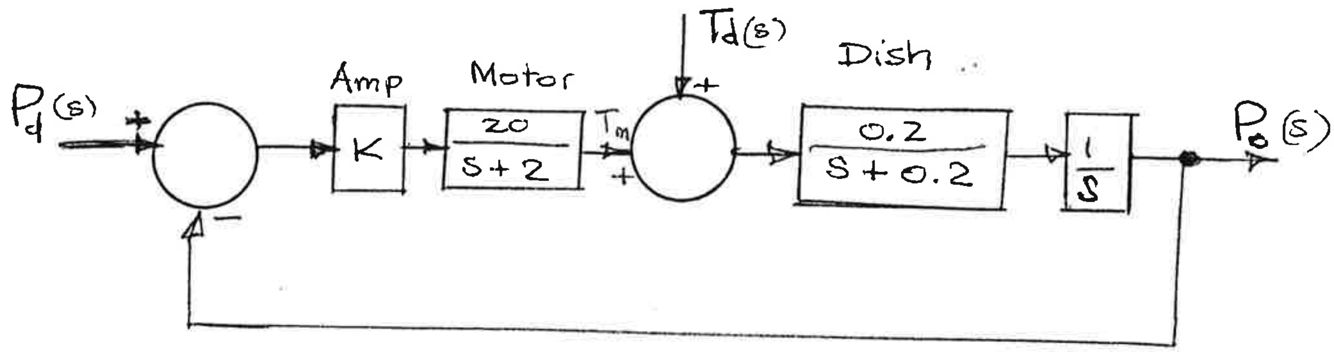
(a) Sketch the Nyquist diagram, and determine whether the control system is stable.

(b) Determine the intersection of the G(jw)H(jw) and the negative real axis of the G(jw)H(jw) plane analytically, and find the values of the frequency, w, and location of the intersection on the negative real axis.

(c) What is the maximum value of gain for this control system before the roots of the characteristic equation cross the jw axis and go into the right half-plane?

4.The angular positioning of a satellite tracking dish is accomplished using a controlled DC motor in a unity-gain feedback control system shown in the figure below, where Pd is the desired angular position and Po is the actual angular position of the dish to track the satellite.

A strong wind acts on the dish and creates a disturbance torque, Td.

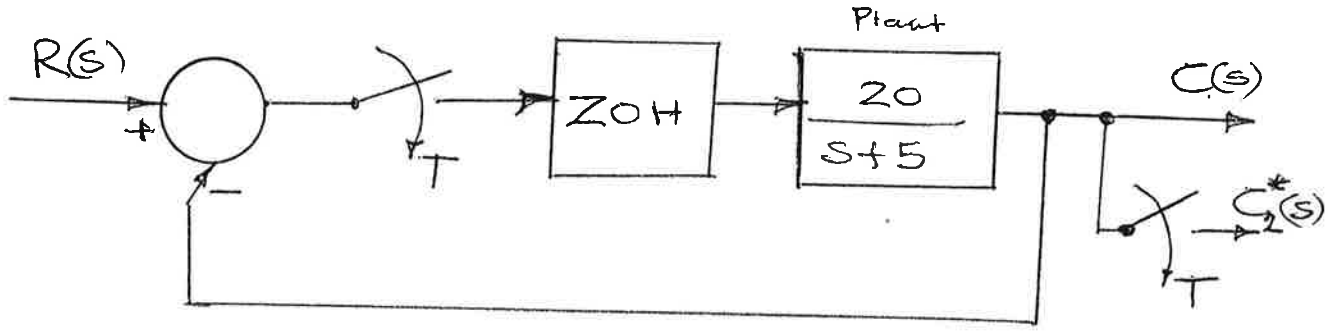


(i) Find the transfer function relating Po and Td.

(ii) Determine the angular displacement of the dish for a wind torque of 175 N-m assume K=100.

(iii) What value of K is required to reduce the dish positioning error to less than 1%

5. A sampled data control system is shown below. For this system



(i) Find the discrete transfer function G(Z).

(ii) Determine the range of the sampling interval, T, that will make the system stable.

(iii) For T=0.1s, and the input r(t) a unit step, find $C_2(kT)$ for K =0, 1, 2.