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

Ph.D. Preliminary Examination in Control Systems

Spring 2013

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

Do not use cell phone during the examination.
(Calculator will be provided upon request)

Note: Each problem is worth 20 points.

Name: ________________________ **Date: March 22, 2013**

1. (a) Sketch the root locus diagram for a feedback system having an open-loop transfer function of

$$G_o(s) = \frac{K}{s(s+1)}$$

(b) Sketch the root locus diagram of the feedback system now being compensated with the introduction into the forward path a lead compensator with transfer function of

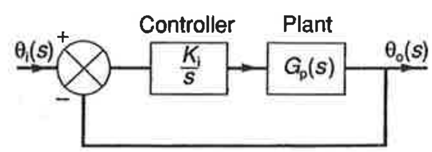
$$G_c(s) = \frac{s+2}{s+8}$$

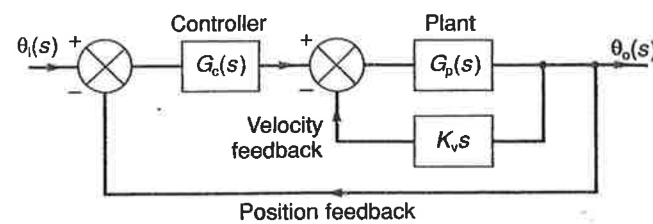
(c) Explain the effect of the lead compensator on the root locus diagram in (a) and on the relative stability of the system.

2. A closed-loop system has a proportional controller of gain K_p, a plant of transfer function

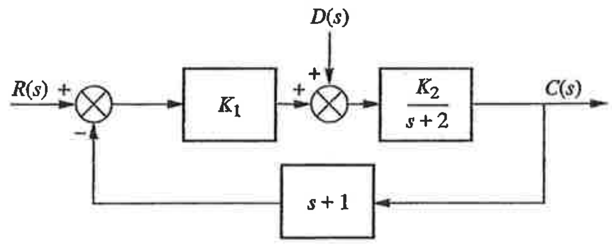
$$G_p(s) = \frac{1}{s(s+1)}$$

and unity position feedback. (a) What proportional gain K_p is required for the natural angular frequency to be 2 rad/s? (b) What is the damping ratio at that frequency? (c) If velocity feedback was introduced, as shown in the figure below, what would the velocity gain K_v need to be for the damping ratio to be doubled for the same angular frequency?



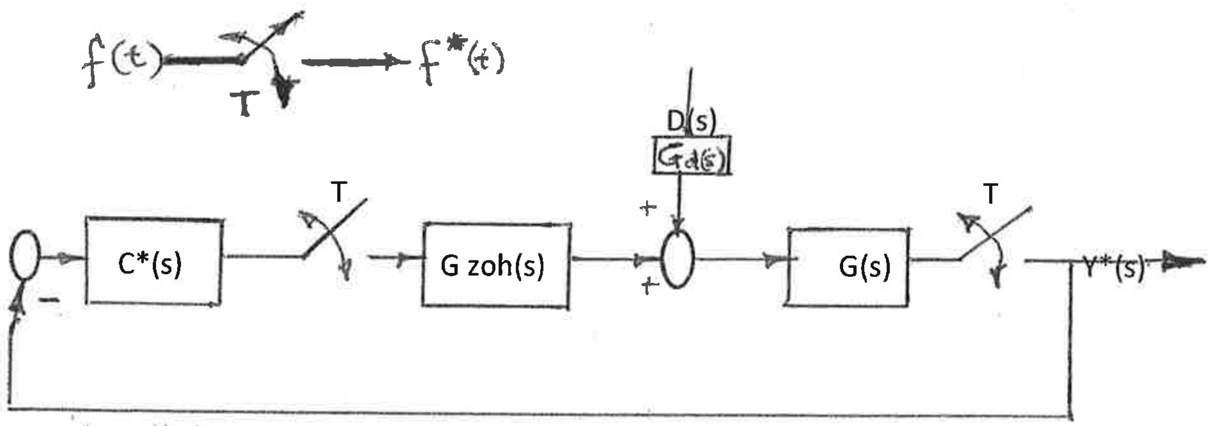


3. For the system shown below, find the sensitivity of the steady-state error for changes in K_1 and K_2 when $K_1 = 100$ and $K_2 = 0.1$. Assume step inputs for both the input and the disturbance.



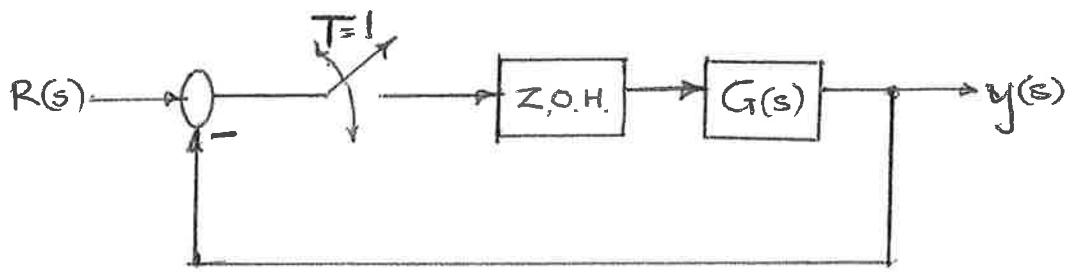
#4.(a)

The block diagram of a digital system with an analog disturbance is shown in the figure below. **Given that G(s) = K1 /(s +1), Gd(s) = 1/s , and C(s) =K2 where K1 and K2 are gain constants,** find the steady state output response to a unit impulse disturbance, assume the sampling time T=.01s .



#4. (b)

A digital cruise control system is shown in the figure below. Find the range of values for the gain K so the system is stable given **G(s) = K / (s +3).**



#5.

A sample-and-hold device samples every 0.2 seconds and feeds into a process with transfer function G(s) = 4/ {s(s+2)} as shown in the figure below.

(i) Obtain a state space representation for G(s) in the form

$$\dot{x} = Ax + Bu$$

$$y = Cx$$

(ii) Find the expression for the transition matrix ϕ (t) for the system in (i).

(iii) Find the digital state space representation for the system.

(iv) Determine the input sequence u(0), u(1) that will transfer the system from state (x1=0, x2=0) to the state (x1= 1, x2=0).