

Code : 031712

B.Tech 7th Semester Examination, 2016

Linear Control Theory

Time : 3 hours

Full Marks : 70

Instructions :

- (i) There are Nine Questions in this Paper.
- (ii) Attempt Five questions in all.
- (iii) Question No. 1 is Compulsory.
- (iv) The marks are indicated in the right-hand margin.

1.

$2 \times 7 = 14$

(a) Find the value of K if a point $-3 \pm j8$ lies on the root locus

$$\text{of the system } G(s)H(s) = \frac{K}{s(s+6)}$$

(b) A unity feedback system has the plant transfer function

$G(s) = \frac{1}{(s+1)(2s+1)}$. Find the frequency at which the plant has a phase lag of 90° .

P.T.O.

(c) A linear 2nd order system with transfer function

$G(s) = \frac{49}{s^2 + 16s + 49}$ is initially at rest and is subjected to a step input signal. Find the peak overshoot of the response of the system.

(d) For the transfer function $G(s) = \frac{I}{s(s+1)(s+0.5)}$, find the phase cross over frequency.

(e) A unity feedback system has the open loop transfer function $G(s) = \frac{1}{(s-1)(s+2)(s+3)}$. How many times the Nyquist plot of G will encircle the origin.

(f) The open loop transfer function of a system is $G(s) = \frac{1-x}{s(s+2)}$. If the system is operated in a closed loop with unity feedback, comment on stability of the closed loop system.

(g) Find the position and velocity error coefficients for the system of transfer function

$$G(s) = \frac{50}{(1+0.1s)(1+2s)}$$

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(h) The characteristic equation of a control system is given by $2s^3 + s^4 + 4s^3 + 2s^2 + 2s + 1 = 0$ comment on stability of the system.

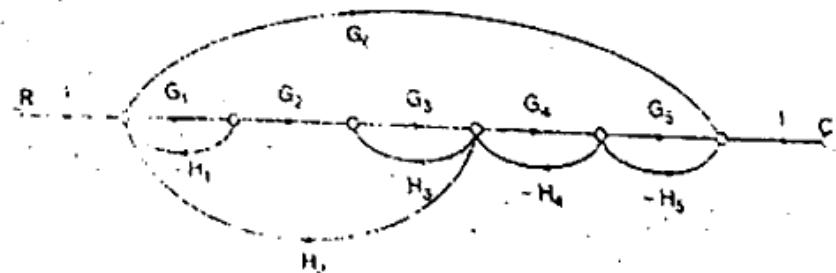
(i) The open loop transfer function of a unity feedback control system is given by $G(s) = \frac{K}{(s+p)^3}; p > 0$.

Find the value of 'K' for the damping ratio to be 0.5 corresponding to the dominant closed loop complex conjugate pair.

(j) The unit step response of a linear time invariant system is $y(t) = 5e^{-10t}u(t)$, where $u(t)$ is the unit step function. If the output of the system corresponding to an unit impulse input $\delta(t)$ is $h(t)$, find $h(t)$.

2 (a) For the given signal flow graph, using Mason's Gain formula, find the ratio C/R.

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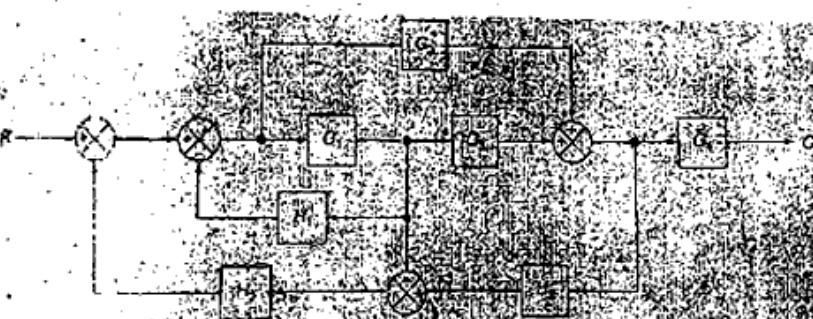
P.T.O.

(b) The open loop transfer function with unity feedback is given by $G(s) = \frac{108}{s^2(s+4)(s^2+3s+12)}$. Find the static error coefficients and steady state error of the system when subjected to an input given by $r(t) = 2+5t+2t^2$.

3 (a) Obtain the simplified block diagram for the following and determine the transfer function.

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(b) Derive output response of critically damped 2nd order system with unit step input through generalized output expression.

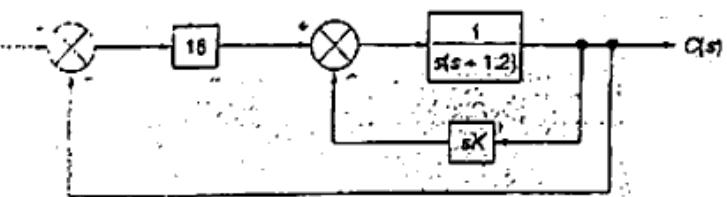
6

4 (a) Consider unity feedback system is as below

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and Calculate K when $\zeta = 0.56$. Determine (i) Peak time (ii) Peak Overshoot (iii) Settling Time and (iv) Damped natural frequency.

- (b) Discuss steady state error of closed loop 2nd order system along with cascade PD controller for ramp input. 6

5. (a) For $G(s)H(s) = \frac{K}{(s^2 + 6s + 25)(s + 2)(s + 4)}$, by Routh criterion, discuss stability of closed loop system as a function of K . Further, find value of K for the sustained oscillations in closed loop system and obtain corresponding frequencies. 8

- (b) Derive peak time and peak overshoot 6

6. (a) Sketch root locus on graph paper for $G(s)H(s) = \frac{K}{s(s+2)(s^2 + 2s + 5)}$, and find K for $\zeta = 0.5$ 8

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P.T.O.

- (b) Discuss angle and magnitude criterion. 6
7. (a) Draw Bode plot on semilog paper for open loop transfer function

$G(s)H(s) = \frac{512(s+3)}{s(s^2 + 16s + 256)}$. Further, obtain gain margin, phase margin phase crossover frequency and gain crossover frequency. 8

- (b) Discuss gain margin, phase margin, phase cross over and gain crossover frequency. 6

8. (a) State and Develop Nyquist Criterion for closed loop system stability. 4

- (b) For $G(s)H(s) = \frac{10(1+0.5s)}{s^2(1+0.1s)(1+0.03s)}$, draw the Nyquist plot and discuss stability. 10

9. (a) The open loop transfer function with unity feedback is given by $G(s) = \frac{K}{s^2(1+0.25s)}$. Design a Lead compensator so that acceleration error constant and phase margin may be obtained as 10 and 35° respectively. 10

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(b) Discuss lead and lag compensator along with their requirements.

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