CONTROL SYSTEMS
(ECEN 3102)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) Given $G(s)=\frac{k}{s^2(s+5)(s+4)}$, the type and order of the system is
(a) 3 and 3 (b) 3 and 0 (c) 2 and 4 (d) 3 and 1.

(ii) If the maximum overshoot is 100% the damping ratio is
(a)1 (b)0 (c)0.5 (d) Infinite.

(iii) For the system $G(s)=\frac{16}{s^2+8s+16}$, the nature of the time response will be
(a) overdamped (b) underdamped
(c) critically damped (d) undamped.

(iv) Type of a transfer function denotes the number of
(a) poles at origin (b) zeros at origin
(c) poles at infinity (d) finite poles.

(v) The response of an undamped second order system is
(a) Constant (b) Ramp
(c) Decaying exponential (d) Oscillatory.

(vi) The Routh-Hurwitz criterion gives
(a) Relative stability (b) Absolute stability
(c) Gain margin (d) Phase margin.

(vii) The phase margin of a system is used to specify
(a) Time response (b) Frequency response
(c) Absolute stability (d) Relative stability.

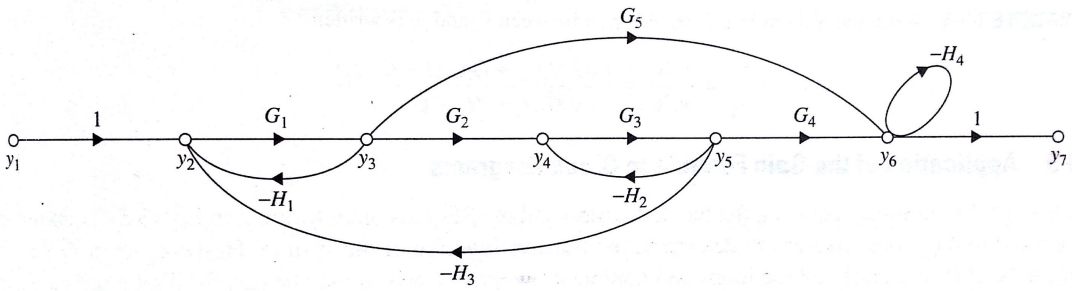
(viii) The position error for a unity feedback system having open loop transfer function as $G(s)=\frac{10}{s(s+10)}$ is
(a) 10 (b) Infinity (c)1 (d)0.

(ix) The characteristic equation of a unity feedback system is given by $s^3+s^2+4s+4=0$. The system has
(a) One pole in the RHS of s plane
(b) No poles in the RHS of s plane
(c) Exhibits oscillatory nature
(d) Both (b) and (c).

(x) Given $G(s)H(s)=\frac{K}{s(s+1)(s+3)}$. The point of intersection of the asymptotes of the root loci with the real axis is
(a) -4 (b) 1.33 (c) -1.33 (d) 4.

Group – B

2. (a) Find out the overall transfer function using Mason's Gain formula.

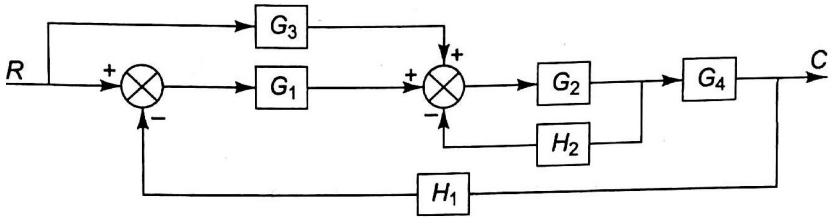


(b) Show force voltage analogy by comparing an electrical RLC circuit and a mechanical translational system.

(c) List the advantages of negative feedback in a system.

6 + 4 + 2 = 12

3. (a) Determine the transfer function of the system using block diagram reduction technique.



(b) Define the following and give examples:
(i) Linear system
(ii)Time invariant system

6 + (3 + 3) = 12

Group – C

4. (a) Determine the peak overshoot value and rise time for a unity negative feedback system whose open loop transfer function is given by

$$G(s) = \frac{16}{s^2 + 4s + 16}$$

Also determine the steady state error of the system for unit step input.

(b) The characteristic equation of a control system is

$$s(s^2 + 5s + 20) + k(s + 2) = 0$$

Using Routh's criterion determine the range of k for which the system will be stable.

(5 + 2) + 5 = 12

5. Sketch the complete root-locus for the open-loop transfer function, given below. Also determine at what value of K system becomes unstable?

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

12

Group – D

6. (a) The open loop transfer function of a unity feedback system is given by $G(s) = \frac{5}{s(s+1)(s+2)}$. Draw the Nyquist plot and hence comment on its stability.

(b) Define relative stability.

10 + 2 = 12

7. Draw the Bode plot of the system having open loop transfer function $G(s) = \frac{200(s+10)}{s(s+5)(s+20)}$.

12

Group – E

8. (a) A system is represented by the following state and output equation:

$$\dot{X} = \begin{bmatrix} -3 & -2 \\ -1 & -2 \end{bmatrix} X + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u(t)$$

$$Y = \begin{bmatrix} 1 & 2 \end{bmatrix} X$$

Find the poles of the system.

(b) Find the transfer function of the system that is represented as

$$\dot{X} = \begin{bmatrix} -5 & -1 \\ 3 & -1 \end{bmatrix} X + \begin{bmatrix} 2 \\ 5 \end{bmatrix} u(t)$$

$$Y = \begin{bmatrix} 1 & 2 \end{bmatrix} X$$

(c) Define Controllability and Observability of a system.

4 + 5 + 3 = 12

9. Write short notes on any three:
   (i) Gain margin and Phase margin
   (ii) PID controller
   (iii) Time domain specifications of a second order system
   (iv) Steady state error
   (v) Effect of damping factor on time response of second order system

$3 \times 4 = 12$

Department & Section	Submission Link
ECE	https://classroom.google.com/c/Mjc0NTMxNDE3NzMy/a/Mjc0NzI3NTgxMjQ5/details