(vii) For a gain constant K, the phase-lead compensator
(a) reduces the slope of the magnitude curve in the entire range of frequency domain
(b) decreases the gain cross-over frequency
(c) reduces the phase margin
(d) reduces the resonance peak Mp.

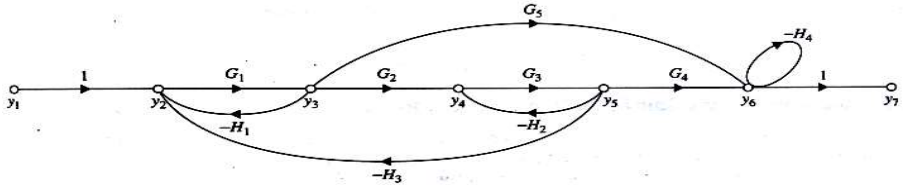
(viii) In closed loop control system, with positive value of feedback gain the overall gain of the system will
(a) decrease (b) increase
(c) be unaffected (d) be any of the above.

(ix) In case of type-1 system steady state acceleration error is
(a) unity (b) infinity (c) zero (d) 10.

(x) The system $\dot{x} = Ax + Bu$ with $A = \begin{bmatrix} -1 & 2 \\ 0 & 2 \end{bmatrix}$, $B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$ is
(a) observable and controllable
(b) observable but uncontrollable
(c) unobservable but controllable
(d) unobservable and uncontrollable.

Group – B

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

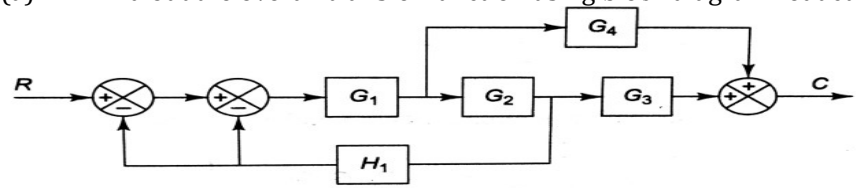


(b) Show force voltage analogy by comparing an electrical RLC circuit and a mechanical translational system.

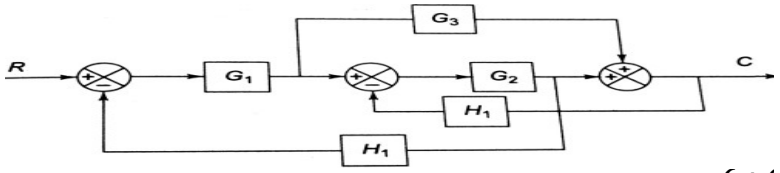
(c) List the advantages of negative feedback in a system.

6 + 4 + 2 = 12

3. (a) Find out the overall transfer function using block diagram reduction:



(b) Draw the Signal Flow Graph of the following block diagram an the overall transfer function using Mason's Gain Formula.



6 + 6

Group – C

4. (a) Using the Routh Hurwitz stability criterion, determine the max feedback gain K for which the closed loop system will be stable OLTF is

$$G(s)H(s) = \frac{5(1-0.2s)}{s^2 + 3.2s + 4}$$

Also find the frequency of oscillation.

(b) A unity feedback system OLTF is given by $G(s) = \frac{10}{s^2 + 11s + 10}$ out the position, velocity and acceleration error for this system.

(c) Comment how the location of the poles of a second order s varies with variation of damping ratio.

8 + 2 + 2

5. (a) Derive the expressions for Rise time for the unit step respons second order system.

(b) For a unity negative feedback system having transfer fur $\frac{K(s+5)}{s(s+6)(s+7)(s+8)}$ evaluate the value of gain K, such tha system has 10% steady-state error for a unit ramp input.

(c) Using Routh-Hurwitz criterion, find the range of K for stabi unity negative feedback having open loop transfer functi $G(s) = \frac{K}{s(s+1)(s+2)}$.

3 + 5 + 4

Group – D

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

7. (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

Group – E

8. (a) Obtain the characteristic equation and the poles for the control system having state space model as

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}-4 & -1\\ 2 & -1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}+\begin{bmatrix}3\\ 2\end{bmatrix}[u(t)];\ Y=\begin{bmatrix}1 & 0\end{bmatrix}X$$

   Also check for controllability.

   (b) Obtain the state transition matrix $\phi(t)$ from non-homogeneous state equation of a linear time invariant control system.

8 + 4 = 12

9. Write short notes on any three: **(4 × 3) = 12**
   (i) PID Controller
   (ii) Compensation techniques
   (iii) Polar plot
   (iv) Time domain specifications
   (v) Eigen value.

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) The Routh-Hurwitz criterion gives
   (a) relative stability (b) absolute stability
   (c) gain margin (d) phase margin.

   (ii) 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.

   (iii) 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.

   (iv) The response of an undamped second order system is
   (a) constant (b) ramp
   (c) decaying exponential (d) oscillatory.

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

   (vi) An open loop system represented by the transfer function, $G(s)=\frac{(s-1)}{(s+2)(s+3)}$ is
   (a) Stable and of the minimum phase type
   (b) Stable and of the non–minimum phase type
   (c) Unstable and of the minimum phase type
   (d) Unstable and of non–minimum phase type.