(vi) For a system the open loop transfer function is given by $G(s)\mathrm{H(s)} = \frac{k(s+2)}{s^2(s+4)}$. The centroid is located at
(a) -1 (b) -3 (c) -4 (d) 0.

(vii) A system having a transfer function $G(s) = \frac{(1+5s)}{(1+50s)}$ is a
(a) lag compensator (b) lead compensator
(c) lag-lead compensator (d) lead-lag compensator.

(viii) The relative stability of a system is given by
(a) gain margin alone
(b) phase margin alone
(c) both gain margin and phase margin
(d) cannot be determined from gain margin or phase margin.

(ix) By the use of PI control for a second order system, the steady state error
(a) increases (b) decreases
(c) remains unaltered (d) cannot be determined.

(x) If a system is described by, $A = \begin{bmatrix} -0.5 & 0 \\ 0 & -2 \end{bmatrix}, B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$ then
(a) system is controllable
(b) system is uncontrollable
(c) system is undefined
(d) cannot comment on controllability.

Group – B

2. Determine the transfer function of the system shown in Fig. (1) using block diagram reduction techniques. Apply Mason's gain formula to verify the results.

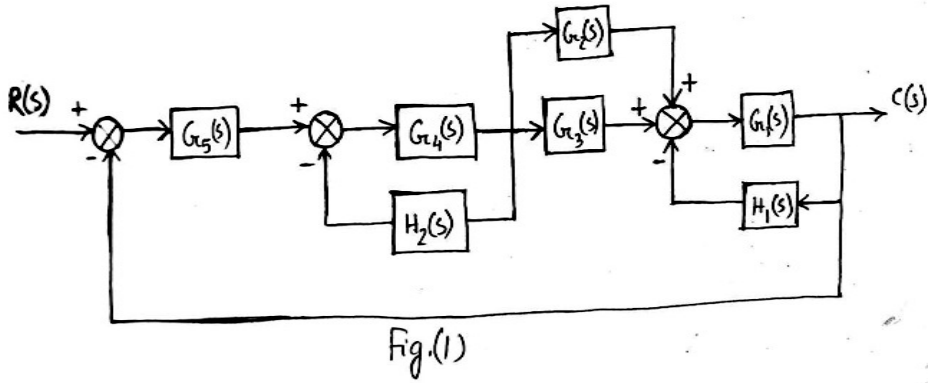

Fig.(1)

(6 + 6) = 12

3. Write short notes on **any three** of the followings:-
(i) Potentiometer
(ii) Tacho generator
(iii) Synchro
(iv) Gyroscop.

(3 × 4) = 12

Group – C

4. (a) The open loop transfer function of a unity negative feedback system is given by $G(s) = \frac{K}{s(\tau s+1)}$. Where K and τ are positive constants. By what factor should the gain be reduced so that the peak overshoot of unit step response for the closed loop system is reduced from 75% to 25%.

(b) Determine the values of 'k' and 'b' so that the system whose open loop transfer function is given by $G(s)H(s) = \frac{k(s+1)}{s^3+bs^2+3s+1}$ oscillates at a frequency of 2 rad/sec.

7 + 5 = 12

5. (a) What do you mean by Root Locus of a system?

(b) Sketch the root locus of a unity negative feedback system whose open loop transfer function is given by

$$G(s)H(s) = \frac{K(s+1)(s+2)}{(s+0.1)(s-1)}$$

2 + 10 = 12

Group – D

6. (a) Draw the polar plot of a system having a transfer function

$$G(s) = \frac{10}{s(s+2)}$$

(b) The open loop transfer function of a unity negative feedback system is given by

$$G(s)H(s) = \frac{40}{s(s+2)(s+4)}$$

Draw the Nyquist diagram and comment on stability of the closed loop system.

2 + 10 = 12

7. The open loop transfer function of a unity negative feedback system is $G(s)H(s) = \frac{200(s+10)}{s(s+5)(s+20)}$. Draw the Bode plot. Hence find gain margin, phase margin, gain cross over frequency and phase cross over frequency of the system. Comment on stability of the system.

(9 + 2 + 1) = 12

Group – E

8. (a) Discuss the effect on the performance of a second order system, when controlled using P-control, PD-control and PI-control action.

   (b) Find the observable canonical form of the system whose transfer function is

$$H(s) = \frac{s^2 + 4s + 3}{s^4 + 2s^3 + 9s^2 + 6s + 2}$$

6 + 6 = 12

9. (a) A system is described by
$\dot{X} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} X + \begin{bmatrix} 0 \\ 1 \end{bmatrix} U$ and $y = [1 \quad 0]X$
Check the controllability and observability of the system.

   (b) A system is described by,
$\dot{X} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix} X + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u$
and $y = [1 \quad 0 \quad 0]X$
Using state feedback control, place the poles of the closed loop system in desired locations, $s = -2 \pm j2\sqrt{3}$ and $s = -10$. Determine the state feedback gain matrix.

4 + 8 = 12

CONTROL SYSTEM
(ELEC 3203)

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 transfer function of a system is $T(s) = \frac{K}{s^3(1+Ts)}$. The type and order of the system are respectively
   (a) 4 and 3 (b) 3 and 4 (c) 3 and 3 (d) 4 and 4.

   (ii) The output of a linear system for a unit step input is given by t^2e^{-t}. The transfer function is given by
   (a) $\frac{s}{(s+1)^3}$ (b) $\frac{2s}{(s+1)^3}$ (c) $\frac{1}{s^2(s+1)}$ (d) $\frac{2}{s(s+1)^2}$

   (iii) Which of the following has a closed loop configuration?
   (a) Field controlled D.C servo motor
   (b) Armature controlled D.C servo motor
   (c) Both (a) and (b)
   (d) D.C series motor.

   (iv) The characteristic equation of a system is $s^2 + 8s + 16 = 0$. Hence the values of natural frequency of oscillation and damping ratio are respectively
   (a) 4 rad/sec and 1 (b) 2 rad/sec and 0.5
   (c) 3 rad/sec and 1.2 (d) 40 rad/sec and 10.

   (v) The first column of the Routh's table contains the following integers 2, 4, -5, -3, 2. The system is
   (a) Stable (b) Marginally stable
   (c) Unstable (d) Stability cannot be determined.