CONTROL SYSTEM
(ELEC 3103)

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 $G(s) = \frac{K}{s^2(s+2s^2)}$. The type and order of the system are
(a) 4 and 3 (b) 4 and 2
(c) 2 and 4 (d) 3 and 4.

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

(iii) A system has dual pole at origin. Its impulse response will be
(a) constant amplitude (b) ramp
(c) decaying exponential (d) oscillatory.

(iv) Consider a unity feedback control system with open-loop transfer function $G(s)H(s) = \frac{K(s+1)}{s(s+2)(s+3)}$. The steady state error of the system due to a unit step input is
(a) 0 (b) infinite
(c) *K/6* (d) *6/K*.

(v) The radius of Nyquist contour is
(a) 25 (b) 1
(c) 0 (d) ∞.

(vi) For a system having a transfer function $G(s) = \frac{K}{s(s^2+6s+10)}$ the angle of asymptotes will be
(a) 60°, 180°, 120° (b) 60°, 180°, 300°
(c) 60°, 180°, 200° (d) 60°, 150°, 300°.

(vii) If the phase margin of a unity feedback control system is zero, then the Nyquist plot of the system passes through
(a) the origin in GH plane
(b) left hand side of (-1,*j*0) point in the GH plane
(c) exactly on (-1,*j*0) point in the GH plane
(d) in between origin and (-1,*j*0) point in the GH plane.

(viii) A system having a transfer function $G(s) = \frac{(1+2s)}{(1+40s)}$ is a
(a) lag compensator (b lead compensator
(c) lag-lead compensator (d) lead-lag compensator.

(ix) By the use of PI control to a second order system the steady state error
(a) increases (b) decreases
(c) remains unaltered (d) can't be determined.

(x) If a system is described by, $A = \begin{bmatrix} 0 & 1 \\ -4 & -5 \end{bmatrix}$, $B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$ then the roots of the characteristics equations are
(a) $s = -1$ and $s = -4$ (b) $s = -1$ and $s = -5$
(c) $s = -4$ and $s = -5$ (d) $s = 0$ and $s = -1$.

Group – B

2. Find the transfer function of the system shown in Fig. (1) using block diagram reduction techniques. Apply Mason's gain formula to verify the result. Consider R as input and C as output of the system.

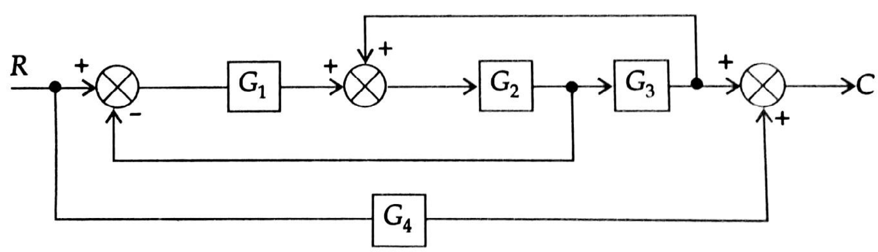

Fig. (1)

6 + 6 = 12

3. Write short notes on **any three** of the followings: **(4 × 3) = 12**
(i) Potentiometer
(ii) Synchro
(iii) Tacho generator
(iv) Gyroscope

Group – C

4. (a) Determine the value of 'K' and 'a' such that the system has a damping ratio of 0.8 and an undamped natural frequency of 4 rad/sec for the system shown in Fig.(4a). Hence find out the peak time of the system.

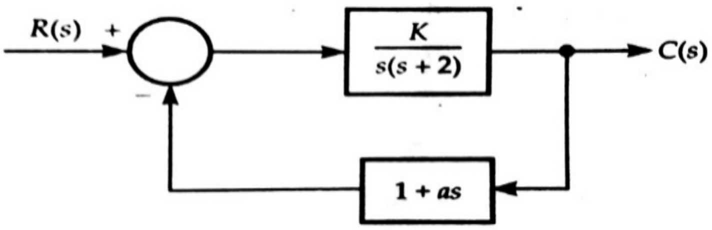

Fig.(4a)

(b) State Routh Stability Criterion. The open loop transfer function of a negative unity feedback control system is given by $G(s)H(s) = \frac{K}{s(s^2+8s+32)}$. Determine (i) the range of K (K>0) for which the system is stable, (ii) the value of K for which system is marginally stable, (iii) frequency of sustained oscillation.

(2 + 2 + 1) + (2 + 5) = 12

5. (a) What do you mean by the term 'angle of departure' and 'angle of arrival?

(b) Sketch the complete root locus of the system whose open loop transfer function is given by

$$G(s) = \frac{K}{s(s+2)(s^2+6s+25)}.$$

2 + 10 = 12

Group – D

6. (a) What is principle of argument?

(b) The open loop transfer of a unity negative feedback system is $G(s)H(s) = \frac{240}{s(s+4)(s+6)}$. Draw the Nyquist diagram and comment on stability of the closed loop system.

2 + 10 = 12

7. The open loop transfer of a unity negative feedback system is $G(s)H(s) = \frac{100}{s(s+2)(s+10)}$. Draw the Bode plot. Hence find gain margin, phase margin, gain cross over and phase cross over frequency of the system. Comment on stability of the system.

7 + 4 + 1 = 12

Group – E

8. (a) What is lead compensator? Obtain the transfer function of a lead compensator and draw its pole-zero diagrams.

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

$$G(s) = \frac{s^3 + 2s^2 + 4s + 1}{s^4 + 4s^3 + 6s^2 + 8s + 4}$$

6 + 6 = 12

9. (a) Consider a system having state and output equations as follows.

$$\dot{X} = \begin{bmatrix} -4 & 2 & 0 \\ 0 & -4 & 1 \\ 0 & 0 & -1 \end{bmatrix} X + \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix} u \quad \text{and} \quad y = \begin{bmatrix} 2 & 0 & 1 \end{bmatrix} X$$

Check whether the system is completely state observable or not.

(b) A system is described by,

$$\dot{X} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -5 & -6 \end{bmatrix} X + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u \quad \text{and} \quad y = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} X$$

Using state feedback control, place the pole of the close loop system to a desired locations$s = -2 \pm j4$ and $s = -10$. Determine the state feedback gain matrix.

5 + 7 = 12

Department & Section	Submission Link
EE	https://classroom.google.com/c/MTIxOTAzMDMzNDIx/a/MjcxNTM4ODQ5Njgx/details