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 $G(s) = \frac{K}{s^2(s+2s^2)}$. 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 a unit impulse input is given by $e^{-t}\cos(t)$. The transfer function is given by

(a) $\frac{1}{(s+1)^2+1}$ (b) $\frac{s+1}{s^2+2s+2}$
(c) $\frac{1}{s^2+2s+2}$ (d) $\frac{s}{(s+1)^2+2}$

(iii) A system has a single pole at origin. Its impulse response will be

(a) constant amplitude (b) ramp
(c) decaying exponential (d) oscillatory

(iv) The characteristics equation of a system is $s^2 + 6s + 36 = 0$. The natural frequency of oscillation and damping ratio of the system will be

(a) 5 rad/sec and 0.5 (b) 6 rad/sec and 3
(c) 5 rad/sec and 0.6 (d) 6 rad/sec and 0.5

(v) The steady state error of a type-1 system due to unit ramp input is

(a) zero (b) ∞
(c) constant (d) -∞

(vi) An example of bounded input signal is

(a) $e^{-4t}u(t)$ (b) $e^{4t}u(t)$
(c) $tu(t)$ (d) $e^{4t}\sin(t)\,u(t)$

(vii) For a system, the open loop transfer function is given by $G(s)H(s) = \frac{k}{(s^2+1)}$. The angle of departure from the complex poles are

(a) 0° (b) $\pm 90^\circ$ (c) $\pm 180^\circ$ (d) $\pm 45^\circ$

(viii) The minimum phase-shift that can be provided by a lag compensator with transfer function $G_c(s) = \frac{1+2s}{1+6s}$ is

(a) -45° (b) 45° (c) 30° (d) -30°

(ix) State variable analysis has several advantages over transfer function approach as

(a) It is applicable for linear and non-linear and variant and time-invariant system
(b) It is for the analysis of MIMO system
(c) It takes initial conditions of the system into account
(d) All of the above

(x) The Eigen values of the matrix $A = \begin{bmatrix} 1 & 3 \\ 3 & 1 \end{bmatrix}$ are

(a) - 2 and 4 (b) -4 and 4
(c) -2 and -4 (d) 2 and -2

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.

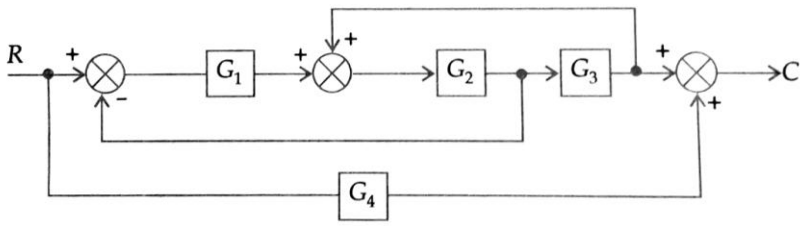

Fig. 1

6 + 6 = 12

3. Write short notes on **any three** of the followings: **(3 × 4) = 12**

(i) Actuator
(ii) Servomotor
(iii) Potentiometer
(iv) Synchro.

Group – C

4. (a) Determine the value of 'K' and 'a' such that the system has a damping ratio of 0.7 and an undamped natural frequency of 4 rad/sec for the system shown in Fig.(4a). Hence find out the rise time of the system.

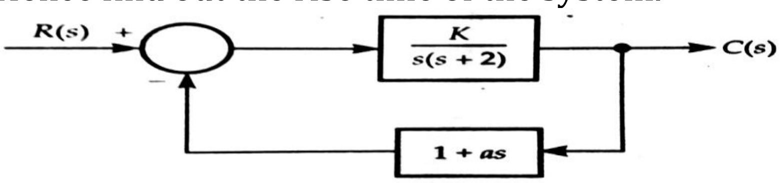

Fig. 4a

(b) State Routh Stability Criterion.

(c) 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 $G(s) = \frac{K}{(s+2)(s+4)(s^2+6s+25)}$.

(2 + 10) = 12

Group – D

6. (a) What is principle of argument?

(b) The open loop transfer of a unity negative feedback system is $G(s)H(s) = \frac{120}{s(s+4)(s+6)}$. 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 $G(s)H(s) = \frac{10}{s(s+1)(1+0.02s)}$. 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 lag compensator? Obtain the transfer function of a lag compensator and draw the pole-zero diagrams.

(b) Find the observable canonical form of the system whose transfer function is $G(s) = \frac{2s^3+7s^2+12s+8}{s^3+6s^2+11s+9}$

6 + 6 = 12

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

$$\dot{X} = \begin{bmatrix} -2 & 2 & 0 \\ 0 & -1 & 1 \\ 0 & 0 & -3 \end{bmatrix} X + \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix} u \text{ and } y = \begin{bmatrix} 1 & 0 & 2 \end{bmatrix} X$$

Check the controllability of the system.

(b) A system is described by,

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

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/MjI2MjE5NDQ2MDMy/a/MzY0MzE0Njc3MjYx/details