Reg. No. :

Question Paper Code : 40438

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2021.

Third/Fourth and Fifth Semester

Electronics and Communication Engineering

EC 8391 – CONTROL SYSTEMS ENGINEERING

(Common to : Electronics and Telecommunication Engineering/ Mechatronics Engineering/Medical Electronics)

(Regulations 2017)

(Provide Semilog sheet, Polar sheet and ordinary graph sheet)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Write any two limitations of transfer function approach.

2. Find the number of forward paths and independent loops for the signal flow graph shown in the Fig. 1

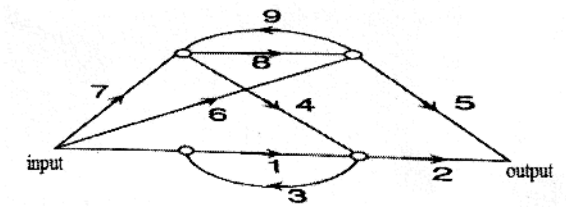

Fig. 1

3. A control system is defined by the following differential mathematical relationship $9\frac{d^2x}{dt^2}+16\frac{dx}{dt}+5x=12(1-e^{-2t})$. Find response of the system at $t \to \infty$.

4. The compensator has the transfer function $G_c(s)=\frac{10(1+0.04S)}{(1+0.01S)}$. Determine the maximum phase angle lead provided by this compensator.

5. The system with the open loop transfer function G(s)H(s) = $\frac{1}{s(s^2+s+1)}$ Determine the gain margin.

6. Differentiate phase lead and phase lag compensator?

7. A certain closed loop system with unity feedback has the following transfer function given by $G(s)H(s) = \dfrac{K}{s(s+2)(s+4)}$ with the gain set at the ultimate value. Determine the oscillation frequency of the system.

8. What is the necessary condition for stability.

9. Write any two properties of state transition matrix.

10. Draw the block diagram of the system described by the state model

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & a_2 & a_3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u \text{ and } y = x_1 .$$

PART B — (5 × 13 = 65 marks)

11. (a) (i) Find the transfer function $V_0(s)/V_1(s)$ for the Circuit shown in Fig. 2. (7)

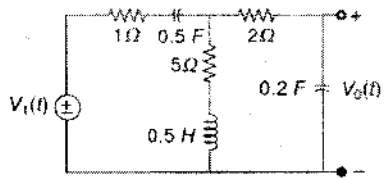

Fig. 2

(ii) Explain the working of AC servomotor in control systems. (6)

Or

(b) Reduce the block diagram shown in Fig. 3 to find the transfer function C(s)/R(s) and verify it using Mason's gain formula. (13)

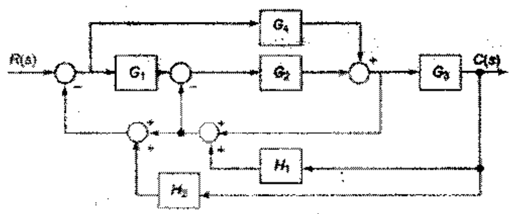

Fig. 3

12. (a) (i) The block diagram of a servomechanism is shown in Fig 4. Determine the values of 'K' and 'a' so that the maximum overshoot in unit-step response is 50% and the peak time is 5 seconds. (7)

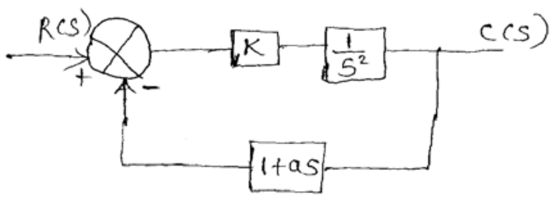

Fig 4

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(ii) The open loop transfer function of a unity feedback system is given by $G(s) = \frac{K}{S(\tau S+1)}$ By what factor should the amplifier gain K be multiplied so that the damping ratio is increased from 0.25 to 0.75? (6)

Or

(b) For the system shown in Fig 5, determine the percentage of peak overshoot and settling time when it is excited by unit step input. If for the same system, PD controller having constant T_d = 1/30 is used in forward path, determine new values of damping ratio. peak overshoot and settling time. (13)

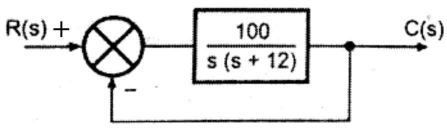

Fig. 5

13. (a) The open loop transfer function of a unity feedback system is given by $G(s) = \frac{1}{s(0.5s+1)^2}$. Sketch the polar plot and determine the gain and phase margin. (13)

Or

(b) Design a lead compensation such that the closed loop system shown in Fig. 6 satisfies the following specifications : static velocity error constant is $24s^{-1}$, phase margin is 55° and gain ≥ 13dB. (13)

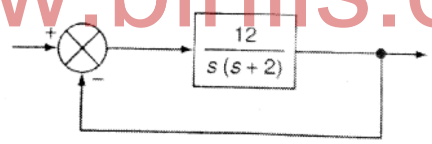

Fig. 6

14. (a) Sketch the root locus for the unity feedback system whose open loop transfer function is $G(s)H(s) = \frac{16.5K(s+1.5)}{s^2(s^2+5s+25)}$ (13)

Or

(b) Draw the Nyquist plot for a system with open loop transfer function $G(s)H(s) = \frac{10K(s+0.6)}{s^2(s+2)(s+10)}$ Using Nyquist stability criterion determine stability with K=1, K=10 and K=100. (13)

15. (a) (i) Determine the state model of armature control DC motor and draw the block diagram representation. (7)

(ii) Derive Jordan's canonical form for the following transfer function $\frac{Y(s)}{U(s)} = \frac{6}{(s+1)^2(s+2)}$. (6)

Or

(b) (i) What is observability and controllability? How do you verify whether the system is observable and controllable? (8)

(ii) Determine e^{At} where $A = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$ using similarity transformation method. (5)

PART C — (1 × 15 = 15 marks)

16. (a) (i) For the system shown in Fig. 7, the steady state error component due to unit step disturbance is 0.000012 and steady state error component due to unit ramp input is 0.003. The values of K_1 and K_2 are respectively. (7)

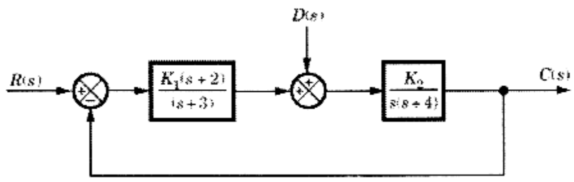

Fig. 7

(ii) Determine the transfer function of the system for the magnitude plot shown in Fig. 8. (8)

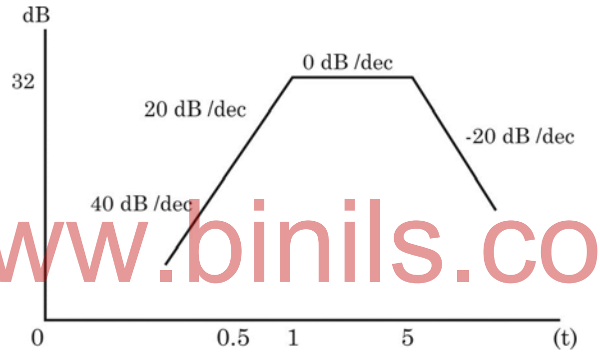

Fig. 8

Or

(b) An aeroplane with an autopilot in the longitudinal mode has a simplified open loop transfer function $G(s)H(s) = \frac{K(s+1)}{s(s-1)(s^2+4x+16)}$. This system which involves an open loop pole in the right half s-plane may be conditionally stable. Sketch the root-locus plot and determine the range of K for stability. (15)