

Control System - I

P. Pages : 4

Time : Three Hours



TKN/KS/16/7481

Max. Marks : 80

- Notes :
1. All questions carry marks as indicated.
 2. Solve Question 1 OR Questions No. 2.
 3. Solve Question 3 OR Questions No. 4.
 4. Solve Question 5 OR Questions No. 6.
 5. Solve Question 7 OR Questions No. 8.
 6. Solve Question 9 OR Questions No. 10.
 7. Solve Question 11 OR Questions No. 12.
 8. Due credit will be given to neatness and adequate dimensions.
 9. Assume suitable data whenever necessary.
 10. Illustrate your answers whenever necessary with the help of neat sketches.
 11. Use of non programmable calculator is permitted.

1. a) Draw signal flow graph for a system whose block diagram is shown in fig. 1(a). Specify : 9
- i) Forward paths
 - ii) Individual loops
 - iii) Non touching loops
 - iv) Overall transfer function from signal flow graph

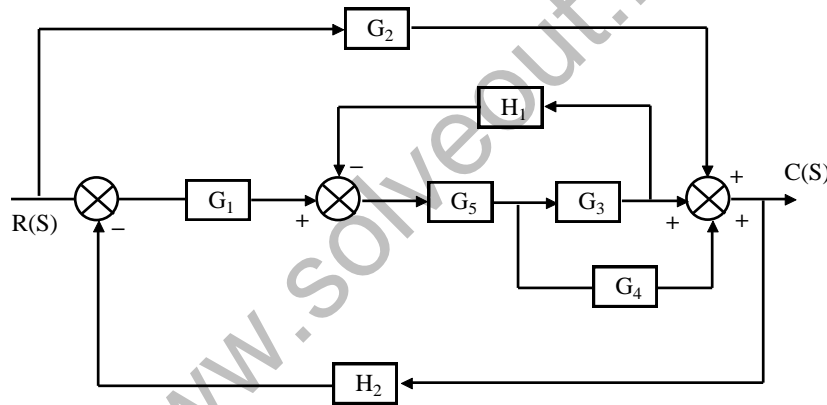


Fig.1 (a)

- b) Compare open loop and closed loop system with one example of each. 5

OR

2. a) Determine the transfer function $\frac{C(S)}{R(S)}$ of fig. 2 (a) using block diagram reduction techniques. 8

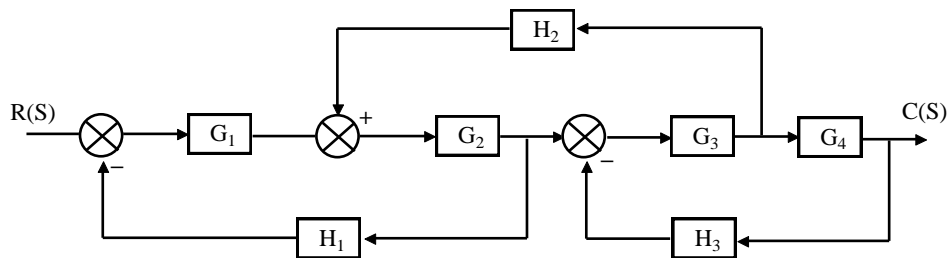


Fig. 2 (a)

- b) Find the transfer function for the electrical network of fig. 2(b) by drawing signal flow graph. 6

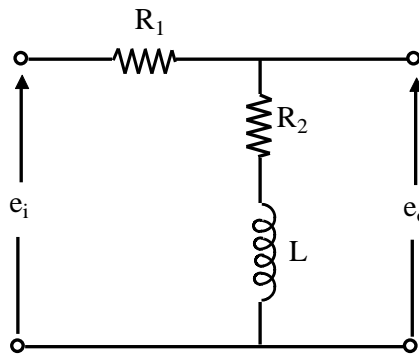


Fig. 2 (b)

3. a) For the system shown in fig. 3 (a) find the sensitivities at $\omega = 1$ rad/sec. 7
 i) S_a^T ii) S_b^T iii) S_k^T
 Assume $k = 10$, $a = 2$, $b = 1$.

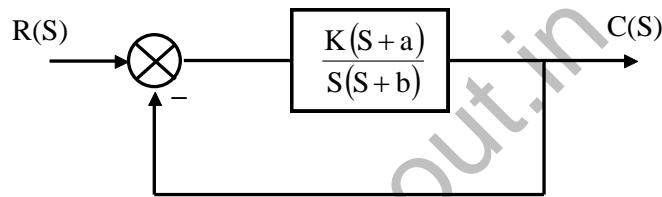


Fig. 3 (a)

- b) Derive the transfer function of a field controlled D. C. servomotor. 6

OR

4. a) Write a short note on synchro transmitter receiver pair with schematic diagram. 7
 b) Explain the use of feedback in reducing the sensitivity to parameter variation and in improving the dynamic response of the system. 6
5. a) For a feed-back control system having open loop transfer function 6

$$G(S) = \frac{K}{S(S+0.15)} \text{ and } H(S) = 0.1$$
 i) Find the value of K for the system to have damping ratio of 0.5.
 ii) For this value of K , find the closed loop transfer function
 iii) For this value of K , find an expression for the output response for a unit step input.
- b) Discuss in detail about root variation due to change in damping ratio for a second order system. 5

c) Show that circuit shown in fig. 5 (c) represents standard second order system.

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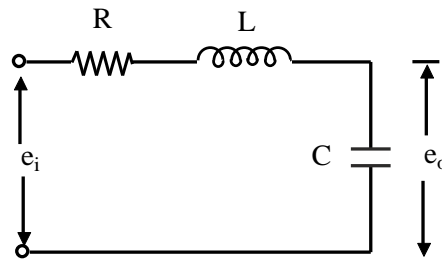


Fig. 5 (c)

OR

6. a) Discuss the effect on performance of second order system due to
i) Derivative control. ii) Integral control. 6

b) A unity feedback control system has open loop transfer function 7

$$G(S) = \frac{K(T_1S+1)}{S(T_2S+1)(T_3S+1)}$$

- i) Prove that for a unit step input steady state error is zero.
ii) For a unit ramp input find the value of K to be set so that steady state error does not exceed 0.25.

7. a) Define the term stability applied to control systems. Discuss the difference between absolute and relative stability. 5

b) Find the value of K by Routh's criterion for the unity feed-back system with open loop transfer function is stable $G(S) = \frac{K}{S(S^2 + 4S + 5)(S + 2)}$ 5

c) State true or false and rectify if necessary "A system having repeated roots of characteristic equation on imaginary axis is stable". 3

OR

8. Sketch the complete root loci of the closed loop system having the open loop transfer function $G(S)H(S) = \frac{K}{S(S+4)(S+4+j4)(S+4-j4)}$ 13

Hence find the value of K for damping ratio $\xi = \frac{1}{\sqrt{2}}$.

9. For a unity feedback system with open loop transfer function :

$$G(S) = \frac{50}{S(1+0.25S)(1+0.1S)}$$

7

a) Sketch BODE PLOT.

b) Gain cross over frequency. 1

- c) Phase cross over frequency. 1
- d) Gain margin and phase margin. 2
- e) Stability of the system. 2

OR

10. a) The forward path transfer function of a unity feed-back system is 7

$$G(S) = \frac{100}{S(S+6.54)}$$

Find the resonant peak, resonant frequency and bandwidth of the closed loop system.

- b) Sketch the polar plot of 6

$$G(S) = \frac{12}{S(S+1)(S+2)} \text{ and } H(S) = 1.$$

Hence discuss the stability of the system.

11. a) For the given transfer function obtain the state model and draw the block diagram. 7

$$\frac{Y(S)}{U(S)} = \frac{K}{S^3 + a_3S^2 + a_2S + a_1}$$

- b) Find the state model in canonical form of a system whose transfer function is - 7

$$\frac{Y(S)}{U(S)} = \frac{S+1}{(S+2)(S+3)(S+5)}$$

OR

12. a) The system is represented by state and output equation as : 10

$$\frac{dx_1}{dt} = -9x_1 - 4x_2 + u$$

$$\frac{dx_2}{dt} = 6x_1 + 8x_2 + 2u$$

$$y = x_1 + x_2$$

Determine the transfer function of the system.

- b) Define : 4

- i) State. ii) State variable.
- iii) State vector. iv) State space.
