Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 50484

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2023.

Third/Fourth/Fifth Semester

EC 8391 – CONTROL SYSTEMS ENGINEERING

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

(Regulations 2017)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Why positive feedback is not used in closed loop system?

2. Represent the electrical circuit show in Figure. 1 by block diagram.

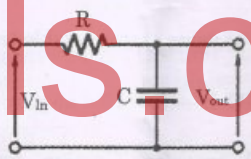

Figure. 1

3. In the system shown in the Figure. 2, determine the values of K and a to obtain a steady-state error of 0.5 for a unit step input?

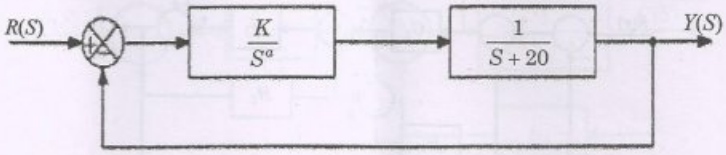

Figure. 2

4. A second order system has the transfer function $G(S)=\frac{1}{(S+1)(S+2)}$. With a PD controller (K_p+SK_d) the closed loop system with a unity feedback has a second order characteristic polynomial with $\varsigma=0.75$ and $\omega_n=3\ rad/sec$. Determine the values of K_p and K_d.

5. Define octave and decade. How they are related to each other.

6. What is the effect on polar plot, (a) if a pole is added to the transfer function, and (b) if a zero is added to the transfer function?

7. Consider a closed loop transfer function $T(S)=\frac{S^2+5S+10}{S^5+6S^3+2S^2+5}$. Determine number of poles in the right half-plane, left half-plane and on the imaginary axis.

8. For the pole plot shown in Figure. 3, which pole (x, y, z or k) will have fastest decrease in exponential transient response? Justify it.

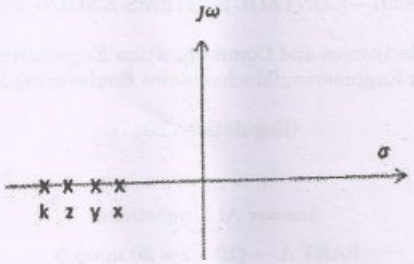

Figure. 3

9. Define State vectors.

10. List any two advantages of using state variable techniques.

PART B — (5 × 13 = 65 marks)

11. (a) Determine overall transfer function by block diagram reduction technique shown in Figure. 4 and verify it by using signal flow graph.

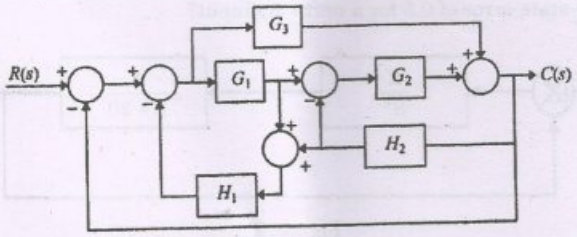

Figure. 4

Or

(b) (i) Determine transfer function $\frac{X_1(S)}{F(S)}$ for the translational mechanical system shown in Figure. 5. (8)

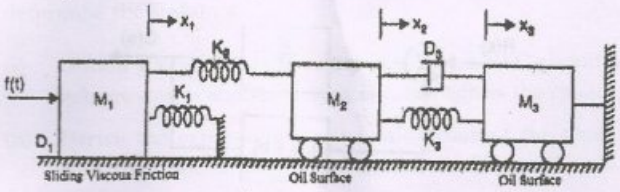

Figure. 5

(ii) Determine the transfer function of the electrical network shown in Figure. 6. (5)

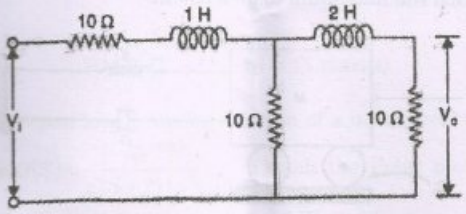

Figure. 6

12. (a) (i) Derive an expression for the unit step response for a closed loop transfer function of a unity feedback control system $\frac{C(S)}{R(S)} = \frac{(S+1)+3e^{-4s}}{(S+2)(S+3)}$. (9)

(ii) The block diagram of certain control system is shown in Figure. 7. Calculate damping ratio and natural frequency of oscillation when $K = 0$. Also compute K when damping ratio is 0.6. (4)

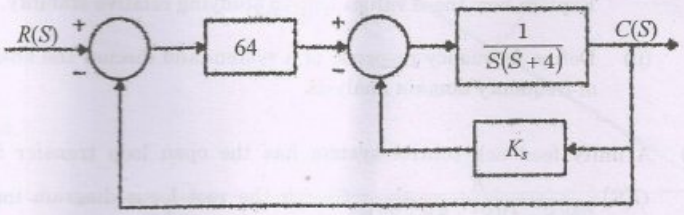

Figure. 7

Or

(b) (i) For the system shown in Figure. 8 taking $K = 10$, determine the values of 'a' and 'b' so that overshoot is 16% and time constant is 0.1sec in its response to unit step input.

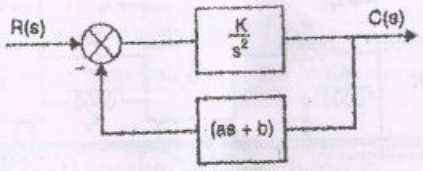

Figure. 8

(ii) For the system shown in Figure.9, determine the final displacement of mass, maximum displacement of the mass and time required to reach the maximum displacement.

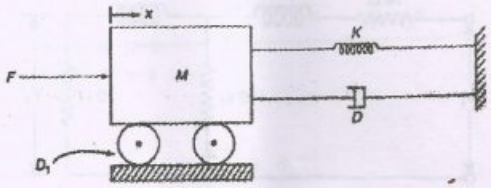

Figure. 9

13. (a) Draw the circuit diagram of lead compensator and derive its transfer function. Also, explain the design procedure for lead compensation in frequency domain.

Or

(b) (i) Illustrate the procedure to plot magnitude and phase in bode plot. Explain how these values help in studying relative stability. (9)

(ii) Define frequency response of a system and discuss the advantages of frequency domain analysis. (4)

14. (a) A unity feedback control system has the open loop transfer function $G(S) = \frac{K}{S(S+4)(S^2+8S+32)}$. Sketch the root locus diagram indicating clearly the break points, angle of departure or arrival, asymptotes, centroid, ω at the imaginary axis intersection and their values of k.

Or

(b) A unity feedback control system has an open loop transfer function given by $G(S)=H(S)=\frac{100}{S(S+5)(S+2)}$. Draw the Nyquist diagram and determine the stability.

15. (a) (i) Obtain the state space model of a series RLC circuit excited by a voltage source and the output is taken across the capacitor C. (7)

(ii) Derive the expression for the calculation of the transfer function from the state variables for the analysis of system? (6)

Or

(b) (i) Determine the state model of armature controlled DC motor. (9)

(ii) Explain any two methods of evaluation of state transition matrix. (4)

PART C — (1 × 15 = 15 marks)

16. (a) (i) The open loop transfer function of a unity feedback system is given by, $G(S)=\frac{Ke^{-0.2S}}{S(S+2)(S+8)}$. Sketch the Polar plot and determine K such that (1) Gain margin is 10dB (2) Phase margin is 45°. (12)

(ii) Determine the transfer function of the system from the data given on the Bode diagram shown in Figure 10. (3)

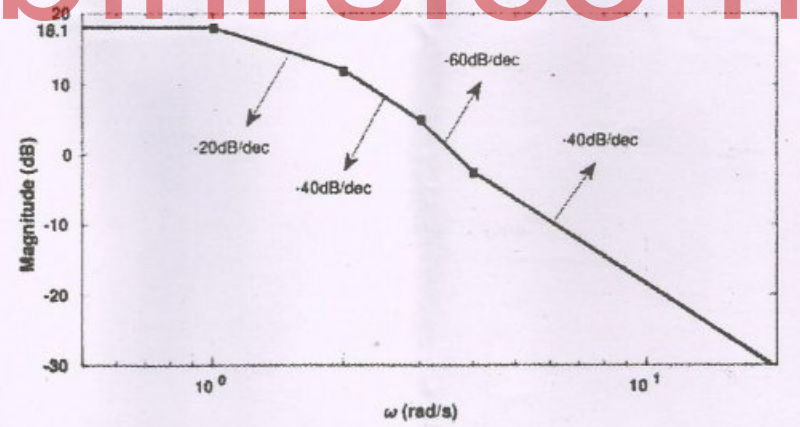

Figure: 10

Or

(b) Consider a unity feedback system with open loop transfer function $G(S)=\frac{75}{(S+1)(S+3)(S+8)}$. Design a PID controller to satisfy the following specifications.

(i) Steady state error for unit ramp should be less than 0.08 (5)

(ii) Damping ratio is 0.8 (5)

(iii) Natural frequency of oscillation in 2.5 rad/sec. (5)
