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

Question Paper Code : 25075

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2018.

Third Semester

Electronics and Communication Engineering

EC 8391 — CONTROL SYSTEMS ENGINEERING

(Common to Electronics and Telecommunication Engineering)

(Regulations 2017)

Time : Three hours Maximum : 100 marks

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

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define closed-loop control system with a suitable example.

2. Write the force-voltage analogous of a mechanical spring and dash pot.

3. What will be the response of a first-order system with unit step input?

4. Discuss the effect of adding a pole to open loop transfer function of a system.

5. In a Bode plot of a unity feedback control system, the value of phase of $G(j\omega)$ at the gain cross over frequency is $-125°$. What is the phase margin?

6. Differentiate phase lead and phase lag compensator?

7. Find the range of K for stability of a closed loop system with characteristic equation $S^4 + 8S^3 + 36S^2 + 80S + K = 0$ using Routh stability criterion.

8. The Nyquist plot of $G(j\omega)H(j\omega)$ for a closed loop control system, passes through $(-1, j0)$ point in the GH plane. What is the gain margin of the system in dB?

9. List any four advantages of state – variable analysis?

10. Draw the block diagram of state space model.

PART B — (5 × 13 = 65 marks)

11. (a) Write the differential equations governing the behavior of the translational mechanical systems shown in Figure 1 and hence find $X_1(s)$. (13)

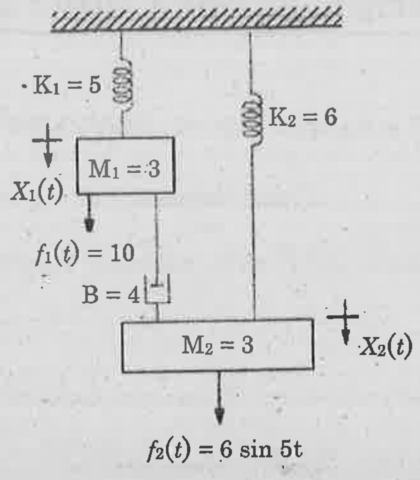


Figure 1

Or

(b) A system is represented by signal flow graph shown in Figure 2, obtain the overall gain of the system using Mason's gain formula. (13)

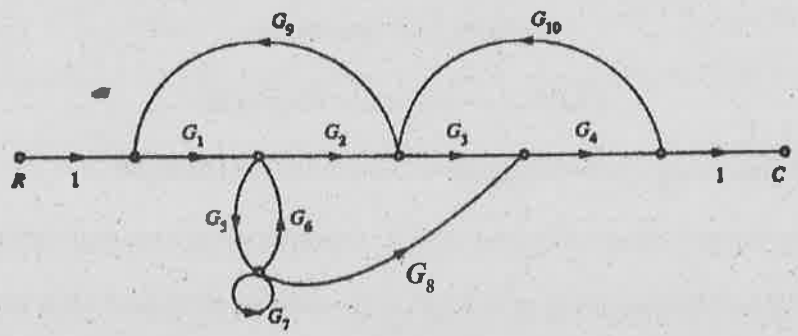


Figure 2

12. (a) (i) Consider the system shown in Figure 3, where damping ratio is 0.6 and natural undamped frequency is 5 rad/sec. Obtain the rise time t_r, peak time t_p, maximum overshoot M_p, and settling time 2% and 5% criterion t_s when the system is subjected to a unit-step input. (6)

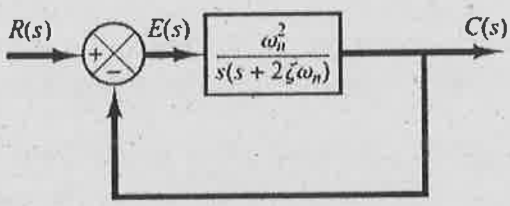


Figure 3

(ii) Derive the expression for peak time and settling time for the underdamped second order system with unit step input. (7)

Or

(b) (i) For a unity feedback system $G(s) = \dfrac{200}{s(s+8)}$ and $r(t) = 2t$ determine steady state error. If it is desired to reduce this existing error by 5% find the new gain of the system. (7)

(ii) Explain in detail about PID controllers used in control systems. (6)

13. (a) The open loop transfer function with unity feedback given by $G(s) = \dfrac{1}{s(1+0.1s)(1+s)}$. From the bode plot, determine the gain crossover frequency, phase crossover frequency, gain margin and phase margin. (13)

Or

(b) The open loop transfer function for a unity feedback system is given by, $G(S) = \dfrac{K}{S(1+0.2S)(1+0.05S)}$. Sketch the polar plot and determine the value of K so that gain margin is 18dB. (13)

14. (a) Sketch the root locus of the system whose transfer function is given by $\dfrac{C(s)}{R(s)} = \dfrac{K}{s(s+4)(s^2+s+1)+K}$. (13)

Or

(b) Sketch the Nyquist plot for the following open loop transfer function is given by $G(s)H(s) = \dfrac{K(1+s)^2}{s^3}$. Determine the range of K for stability. (13)

15. (a) A system is given by

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 2 \end{bmatrix} [u] \text{ with } \begin{bmatrix} x_1(0) \\ x_2(0) \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \end{bmatrix}.$$

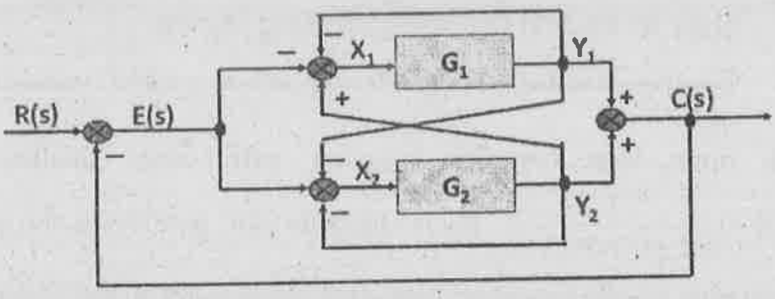
Where u is unit step function. Find the state transition matrix and there from find the state response, i.e.. $x(t)$ for $t > 0$. (13)

Or

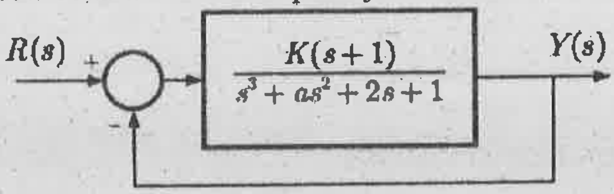
(b) Find the state equation and output equation for the system given by $\dfrac{Y(s)}{R(s)} = \dfrac{s^3+5s^2+6s+1}{s^3+4s^2+3s+3}$. Also check for controllability and observability. (13)

PART C — (1 × 15 = 15 marks)

16. (a) (i) Determine the transfer function C(s)/R(s) for the figure shown below : (7)

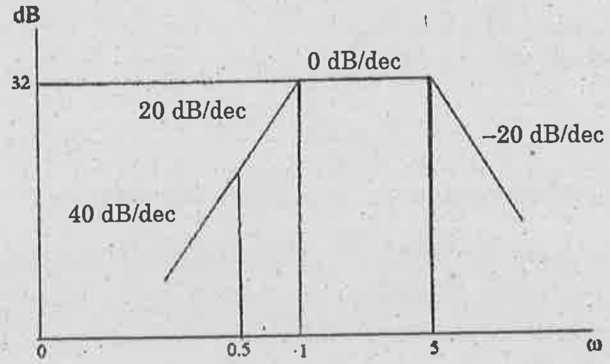


(ii) Determine the positive values of K and a so that the system shown below oscillates at a frequency of 2 rad/sec. (8)

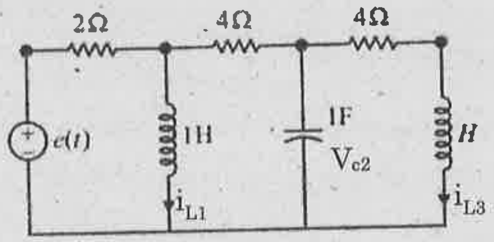


Or

(b) (i) Determine the transfer function of the system for the magnitude plot shown below. (7)



(ii) For the circuit shown in figure, choose state variables x_1, x_2, x_3 to be $i_{L1}(t)$, $V_{c2}(t)$, $i_{L3}(t)$. (8)



Determine the state equation

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = A \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + B[e(t)].$$