Dr Ram Naresh Mahto 28/11/2023 146

Roll No....................

National Institute of Technology, Hamirpur (H.P.) B

Examination: B.Tech. End Semester Examination, November-2023

Branch : Open Elective | Semester : Vth

Course : Elements of Control Systems | Code : EE-371

Time: 03:00 Hours | **Maximum Marks: 50**

Instruction: Attempt all the questions.

Q. 1. Explain the relative merits and demerits of open and closed loop systems. Also explain the DC servomotor in detail with suitable examples. **[05]**

Q. 2. Draw the mechanical network (or nodal diagram) and write the nodal equations for the system shown in Fig. 1 and also draw the electrical current analog. **[05]**

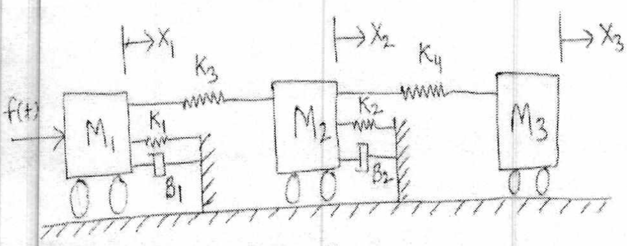

Figure 1.

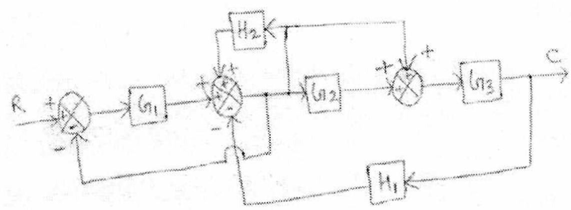

Figure 2.

Q. 3. A unity feedback system is characterized by an open-loop transfer function $G(s) = \frac{K}{s(s+10)}$. Determine the gain K so that the system will have a damping ratio of 0.5. For this value of K, determine settling time, peak overshoot and time to peak overshoot for a unit step input. **[05]**

Q. 4. Find the transfer function for the block diagram shown in Fig. 2 using block diagram reduction technique. **[05]**

Q. 5. Using Routh's stability criterion, ascertain stability for the following characteristic equation: $P(s) = s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16 = 0$ **[05]**

Q. 6. Plot the root locus pattern of a system whose forward path transfer function is $G(s) = \frac{K}{s(s+2)(s+3)}$. **[05]**

Q. 7. Sketch the Bode plot for a unity feedback system characterized by the open-loop transfer function $G(s) = \frac{K(1+0.2s)(1+0.025s)}{s^3(1+0.001s)(1+0.005s)}$, show that the system is conditionally stable and find the range of values of K for which the system is stable. Also find: (i) Gain Margin (GM), and (ii) Phase Margin (PM). **[05]**

Q. 8. Explain: (a) State, (b) State Variables, (c) State Vector, (d) State Space, and (e) State models and state space representation of linear continuous time systems with exaples. **[05]**

Q. 9. Find the state transition matrix ($\phi(t)$) for **[05]**

$$\dot{x} = \begin{bmatrix} -2 & 1 & 0 \\ 0 & -2 & 1 \\ 0 & 0 & -2 \end{bmatrix} x$$

Q. 10. Determine the state Controllability and Observability of the system described by **[05]**

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

****** All the Best ******