Total number of printed pages: **3** **Programme(UG)/5th Semester/UIE502**

2024

CONTROL SYSTEM

Full Marks : 100

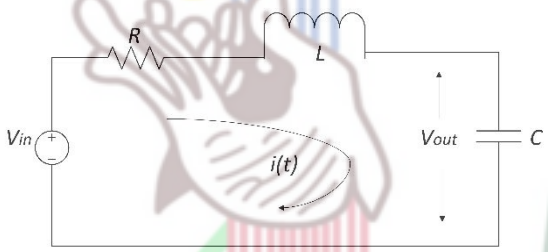
Time : Three hours

The figures in the margin indicate full marks for the questions.

*Answer **any five** questions.*

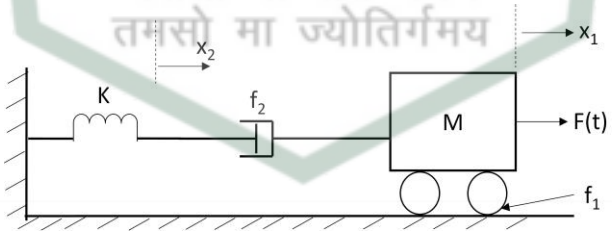
1. a) Write the definition of open loop control system and closed loop control system. How they differ from each other. 5

   b) What is transfer function? Obtain the transfer function of the following system. 2+3



   c) Define analogous system with suitable examples. Obtain the analogous electrical circuits based on 2+4+4

   a) Force-current analogy b) Force-voltage analogy.

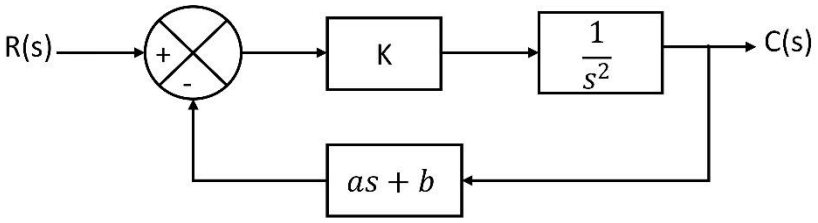


2. a) What are steady state errors and error constants? Discuss the effect of type and order of a system to obtain those values. 3+2

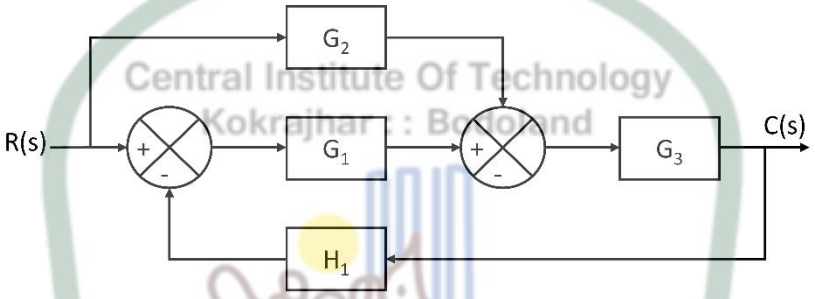
   b) Obtain the time response expression of a second order control system subjected to unit step input. 5

   c) Write short notes on: i) Standards test signals, ii) Transient response specifications 5+5

3. a) The block diagram of a simple servomechanism is shown in the following figure. Determine the value of 'a' and 'b' to provide an overshoot of 16% with time constant of 0.1 sec for a unit step input. Find also the damping ratio when K = 40. 5



b) Simplify the block diagram shown in following figure and find the overall transfer function. 5

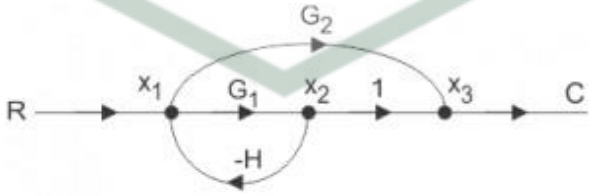


c) What is meant by stability of a system? Explain the effect of position of the roots of the characteristics equation in the S-plane and the stability of a system using graphical representation. 10

4. a) By means of the Routh criterion, determine the stability of the system represented by the following characteristics equation. 5

$$s^6 + 3s^5 + 5s^4 + 9s^3 + 8s^2 + 6s + 4 = 0$$

b) What is Mason's gain formula? Determine the overall transfer function of the following SFG using Mason's gain formula. 2+3



c) The open-loop transfer function of a control system is given by: 10

$$G(s)H(s) = \frac{K}{s(s+6)(s^2+4s+13)}$$

Sketch the root locus and determine the stability condition.

5. a) Sketch the bode plot for the open loop transfer function,- 14

$G(s)H(s)=\dfrac{2000}{s(s+2)(s+100)}$. Obtain gain and phase cross over frequency from the plot. Also comment on the system stability.

b) What is a lead compensator? Determine the transfer function of a lead compensator that will provide phase lead of 45˚ and gain equal to 10dB at the angular frequency ω=8 rad/sec. 2+4

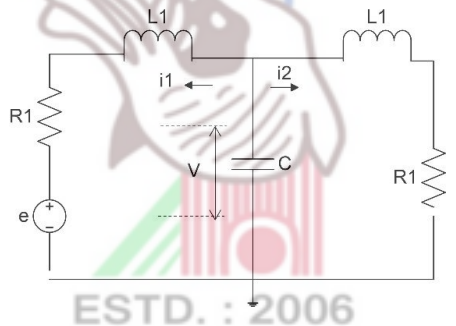
6. a) Consider an open loop unstable system with the transfer function 10

$G(s)H(s)=\dfrac{(s+2)}{(s+1)(s-1)}$. Determine system stability when the feedback path is closed using Nyquist stability criterion.

b) Determine the transfer function of the state model. 5

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}-3 & 1\\ -4 & 0\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}+\begin{bmatrix}1\\ 0\end{bmatrix}u(t) \text{ and } y(t)=\begin{bmatrix}1 & 1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}$$

c) Determine the state model for the electrical circuit shown below. 5



7. a) Check the observability of the system. 5

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\\ \dot{x}_3\end{bmatrix}=\begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ -6 & -11 & -6\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix}+\begin{bmatrix}0\\ 0\\ 1\end{bmatrix}u \text{ and } y=\begin{bmatrix}20 & 9 & 1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix}$$

b) Write short notes (any three) 5 × 3

i) Lag compensation technique

ii) Controllability of a system

iii) Properties of the nonlinear elements

iv) Describing function of saturation nonlinearity