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

2023

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 definitions of the following with suitable examples. 2×3

   i) System

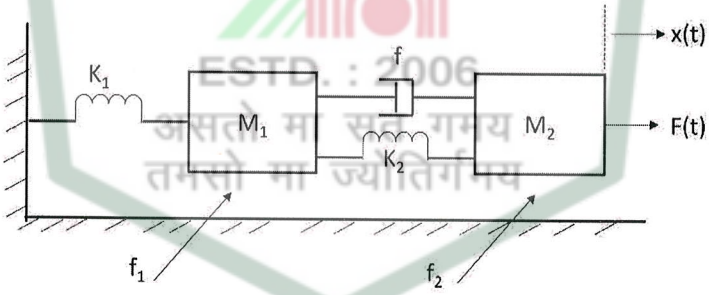
   ii) Controlled system

   iii) Transfer Function

   b) What is analogous system? Obtain analogous relationships among mechanical and electrical system. 6

   c) Obtain the analogous electrical circuits based on 4+4

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



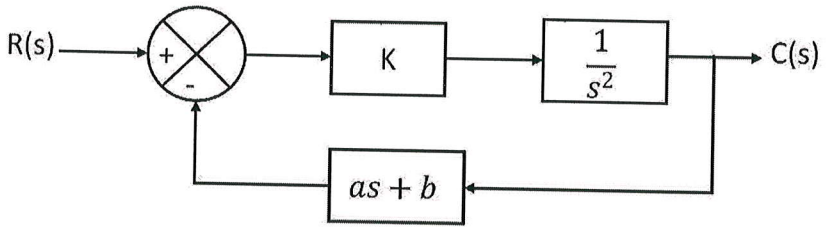
2. a) Define the three steady state error for a control system. 2

   b) For a unity feedback system having open loop transfer function as 1+3+4

   $G(s) = K(s+2)/s2\ (s2 + 7s+ 12)$, determine i) Type of the system, ii) Error constants, iii) Steady state error for parabolic input.

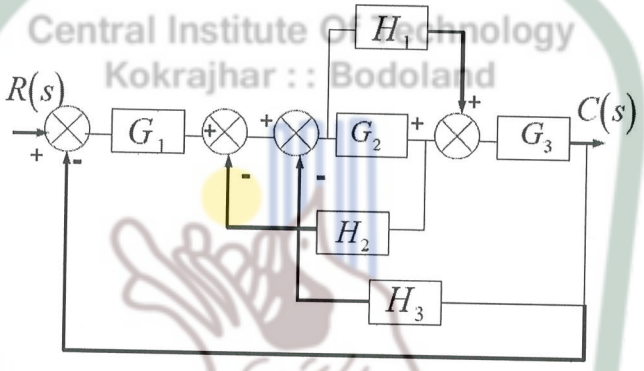
   c) Obtain the time response expression of a first order control system subjected to unit step and unit ramp input. 5+5

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. 6



b) Write the rules for simplification of the block diagram algebra. 6

c) Simplify the block diagram and find the overall transfer function. 8



4. a) State the Routh stability criterion. Using the Routh's stability criterion, calculate the range of 'K' for which the following system become stable for unity feedback. 2+4

$$G(s) = \frac{K(s+13)}{s(s+3)(s+7)}$$

b) What is Mason's gain formula? Represent the following set of equations by a signal flow graph and determine the overall transfer function using Mason's gain formula. 4+5

$$x = x_1 + \alpha_3 u$$

$$\dot{x}_1 = -\beta_1 x_1 + x_2 + \alpha_2 u$$

$$\dot{x}_2 = -\beta_2 x_1 + \alpha_1 u$$

c) Explain the concept of stability of a control system. 5

5. a) Why root locus plot is necessary in control system? Discuss two basic conditions for plotting a root locus. 5

b) A unity feedback control system has an open-loop transfer function $G(s)H(s)=\frac{K(s+1)}{s^2+0.4s+0.4}$. Sketch the root locus plot of the system. Determine the value of K at $s=-2$. Comment on the stability and time response of the system. 15

6. Write short notes on any four from the following topics. 5x4=20

a) Transient Response Specifications

b) Lag compensator

c) State model of linear system

d) Observability of a system

e) State transition matrix

7. a) Consider an open loop unstable system with the transfer function $G(s)H(s)=\frac{(s+2)}{(s+1)(s-1)}$. Determine system stability when the feedback path is closed using Nyquist stability criterion. 10

b) Sketch the asymptotic Bode plot for the following transfer function 10

$$G(s)H(s)=\frac{2(s+0.25)}{s^2(s+1)(s+0.5)}.$$

From the Bode plot determine

i) Phase cross over frequency

ii) Gain cross over frequency

iii) Gain margin

iv) Phase margin