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 definitions of the following with suitable examples. 2×3

   i) Physical system

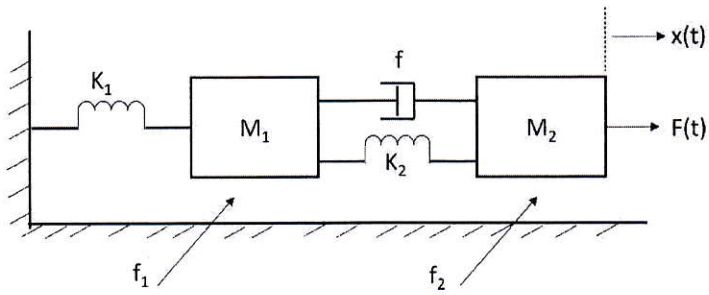
   ii) Open loop system

   iii) Transfer Function

   b) Obtain analogous relationships between mechanical (translational + rotational) 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 constants. 3

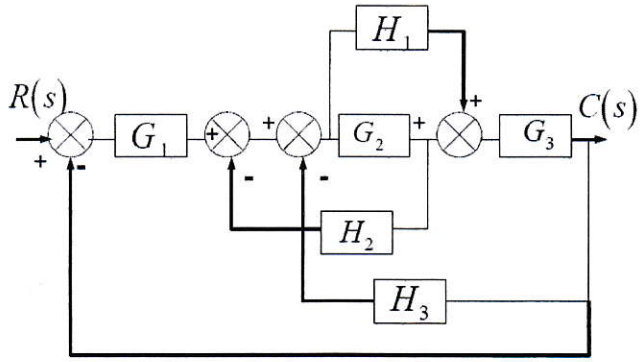
   b) For a unity feedback system having open loop transfer function as 3+4

   G(s) = K(s+2)/s2 (s2 + 7s+ 12), determine i) Error constants, ii) Steady state error for parabolic input.

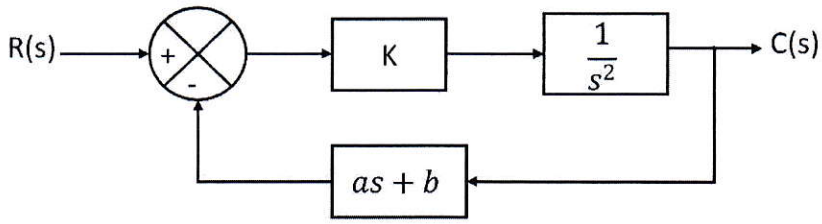
   c) Obtain the time response expression of a second order control system subjected to unit step input. 10

3. a) Write reduction rules to simplify a complex block diagram using block diagram algebra. 6

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



c) 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



4. a) Define 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) The open-loop transfer function of a control system is given by: 15

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

Sketch the root locus and determine the stability condition.

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

a) Steady state response specifications

b) Lag-Lead 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 10

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

b) Sketch the bode plot for the open loop transfer function, 10

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

i) Phase cross over frequency

ii) Gain cross over frequency

iii) Gain margin

iv) Phase margin