Roll No											

PRESIDENCY UNIVERSITY
BENGALURU

SET A

SCHOOL OF ENGINEERING
END TERM EXAMINATION - JAN 2024

Semester : Semester III - 2022
Course Code : EEE3052
Course Name : Control Systems for Robotic Applications
Program : B.Tech.

Date : 09-JAN-2024
Time : 9:30AM - 12:30 PM
Max Marks : 100
Weightage : 50%

Instructions:
(i) Read all questions carefully and answer accordingly.
(ii) Question paper consists of 3 parts.
(iii) Scientific and non-programmable calculator are permitted.
(iv) Do not write any information on the question paper other than Roll Number.

PART A

ANSWER ALL THE QUESTIONS **5 X 2M = 10M**

1. Stability is the most desired property in designing of control systems. Describe the terms absolute stability and relative stability.

(CO1) [Knowledge]

2. Define the terms Poles and Zeros of a transfer function

(CO2) [Knowledge]

3. Explain the correlation between state model and transfer function

(CO3) [Knowledge]

4. List the difference between state feedback and output feedback

(CO4) [Knowledge]

5. Draw the block diagram representation of a PI controller

(CO4) [Knowledge]

PART B

ANSWER ALL THE QUESTIONS **5 X 10M = 50M**

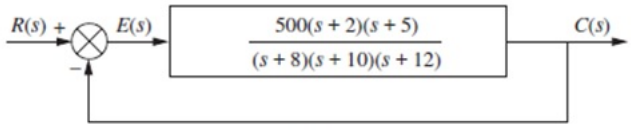
6. Rotational mechanical systems move about a fixed axis. A disc of moment of inertia J is rotated with an applied torque of T Nm. The disc is fixed at one end using an elastic shaft. Assuming the disc can be modelled using moment of inertia J, Damper B and spring constant K, obtain its mathematical model.

(CO1) [Comprehension]

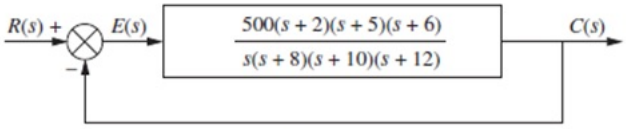
7. Identify the test signals which give constant steady state error with type 0, type 1 and type 2 signals . Write down the expression for their steady state errors.

(CO2) [Comprehension]

8. Steady-state error is a property of the input/output response for a linear system and defined as the difference between the desired value and the actual value of a system output in the limit as time goes to infinity. The magnitudes of the steady-state errors due to these individual inputs are indicative of the goodness of the system. For the feedback control systems given below, identify the type of input signal which gives rise to a constant steady state error and evaluate the expected steady state error values.



(a)



(b)

(CO2) [Comprehension]

9. The state model of a robotic arm which uses PI controller is given below. It is required to check its stability using classical methods like Root Locus method, Bode plots etc. Obtain the transfer function of this system so that stability analysis can be done with the classical methods.

$$\dot{X} = \begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -1 & -1 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 \\ 0 \end{bmatrix} [u]$$

$$Y = [0 \quad 1] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

(CO3) [Comprehension]

10. A robot developed for pick and place operation in an automobile industry should have the ability to move around in its entire configuration space by controlling the input and the state variables of the robot is measurable or observable. Use a suitable test to ensure the same for the state model given below

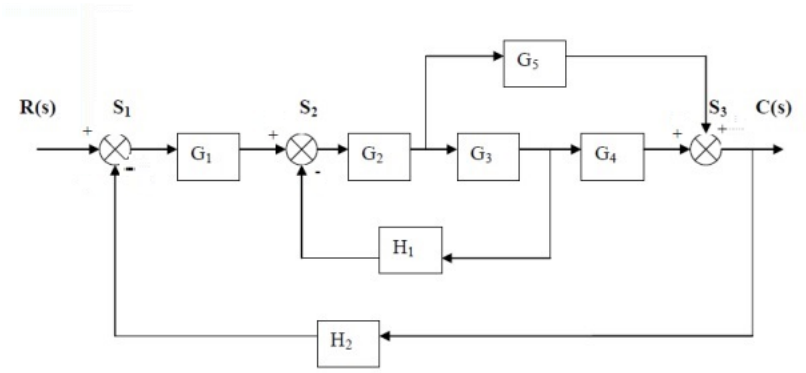
$$\dot{X} = AX + BU$$
$$Y = CX$$
$$A = \begin{bmatrix} 0 & 1 \\ -1 & -2 \end{bmatrix};\ B = \begin{bmatrix} 0 \\ 1 \end{bmatrix};\ C = [1 \quad 1]$$

(CO3) [Comprehension]

PART C

ANSWER ALL THE QUESTIONS **2 X 20M = 40M**

11. Using Block diagram reduction techniques reduce the block diagram given below and obtain the transfer function.



(CO1) [Application]

12. For the open loop system whose transfer function is given below

$$G(s) = \frac{450(s+8)(s+12)(s+15)}{s(s+38)(s^2+2s+28)}$$

1. Identify the type and order.
2. Find the location of poles and zeros
3. Determine the static error constants for step, ramp and parabolic (acceleration) inputs
4. Determine the steady state errors for unit step, unit ramp and unit parabolic (acceleration) inputs when applied separately.

(CO2) [Application]