Roll No											

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING
MID TERM EXAMINATION - OCT 2023

Semester : Semester V - 2021
Course Code : ECE3007
Course Name : Sem V - ECE3007 - Control Systems
Program : B.TECH

Date : 30-OCT-2023
Time : 2:00PM - 3:30PM
Max Marks : 50
Weightage : 25%

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 2 = 10M)**

1. The following paragraph is from the textbook "Control Systems Engineering", Seventh Edition, Norman S Nise, Wiley International.

"Control systems are an integral part of modern society. Numerous applications are all around us: The rockets fire, and the space shuttle lifts off to earth orbit; in splashing cooling water, a metallic part is automatically machined; a self-guided vehicle delivering material to workstations in an aerospace assembly plant glides along the floor seeking its destination. These are just a few examples of the automatically controlled systems that we can create."

In your own words define what a control system is and its broad classification.

(CO1) [Knowledge]

2. Consider an inductor with an inductance of 0.25 H with no initial current flowing through it. Suppose a current of $i(t)$ is flowing through the inductor. The voltage across the inductor can be written as _____ and the s – domain equivalent of the inductor is _____

(CO1) [Knowledge]

3. Mr. Kiran is experimenting with a system with a transfer function given by $H(s) = \frac{2s}{s+3}$. He wants to develop a relation between the input to the system, $r(t)$ and its corresponding output $c(t)$. Help him by deducing the relation.

(CO1) [Knowledge]

4. Mr. Rinto is analyzing a system which is described by the set of equations

$x_1 = 3r - 2c$

$c = 2r + 4x_1$

If r denotes the input to the system and c denotes the corresponding output, draw the signal flow graph of the system.

(CO1) [Knowledge]

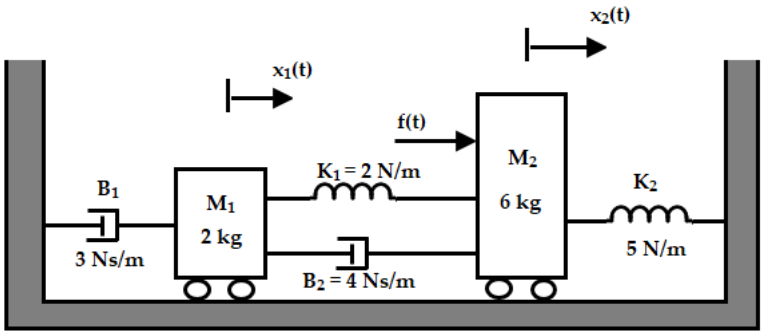
5. Mr. Suraj was experimenting with a first order system and he noticed that the final steady state value is 20 units. He also noticed that it took 2 seconds for the system to reach 12.64 units. Deduce the rise time of the system.

(CO2) [Knowledge]

PART B

ANSWER ALL THE QUESTIONS **(2 X 10 = 20M)**

6. Suppose you are a control system design engineer in Indian Space Research Organization. You are asked to find the displacement of the mass M_1 of the mechanical system shown below when a unit step input is applied as force to the mass M_2. To carry out this, he needs to find the transfer function relating the displacement of mass M_1 with respect to the force applied. For this you have to draw the free body diagram of both the masses. Prepare the differential equations representing the systems. Employ these differential equations, to solve for the transfer function $\frac{X_1(s)}{F(s)}$



(CO1) [Comprehension]

7. Dr. Pritam was analyzing a system described by the transfer function

$$H(s) = \frac{K}{s + \alpha}$$

He made the following two observations about the system when he applied a unit step signal as the input to the system.
Observation 1: The steady state final value is 2 units.
Observation 2: The system took 1 second to settle.
Determine the value of K and α. [4 Marks]
Now Dr. Pritam wanted to study the system when the input is applied to the system

$r(t) = 3tu(t) + 4u(t) + 6\delta(t)$

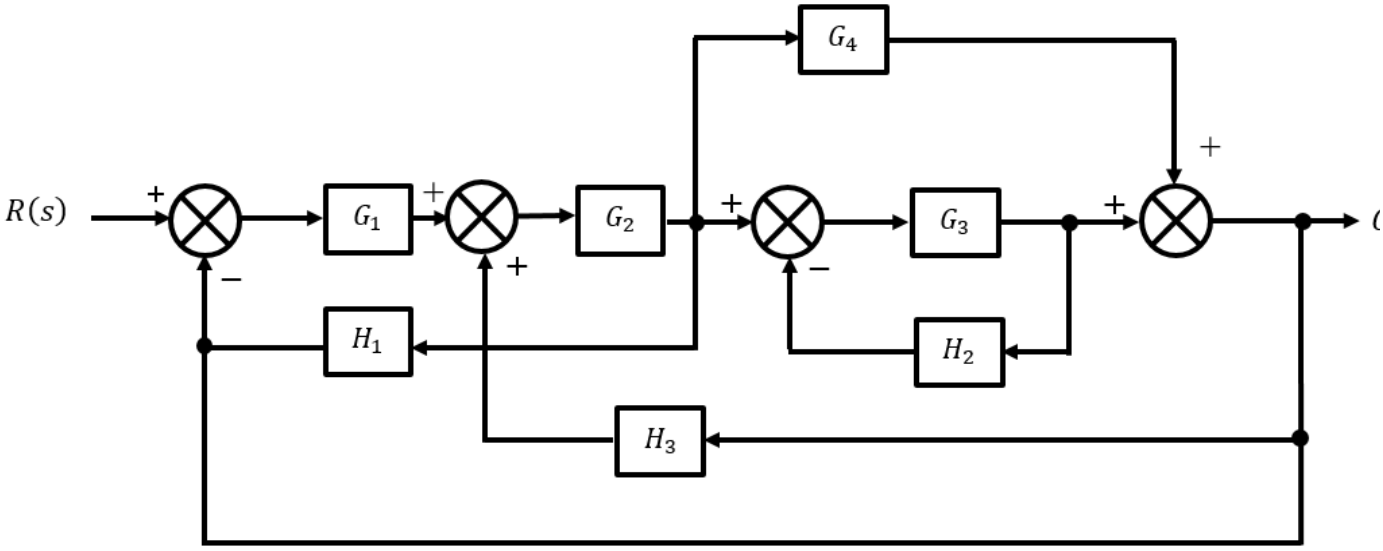
Predict the output of the system to the mentioned input. [6 Marks]

(CO2) [Comprehension]

PART C

ANSWER THE FOLLOWING QUESTION **(1 X 20 = 20M)**

8. Block diagram reduction is an essential method, which can be used to represent a complex system using a single block. If the block diagram is converted into a Signal Flow Graph which is the graphical representation of the complete block diagram, it becomes easy to find the closed loop transfer function using Mason's Gain Formula. Consider the following block diagram



Mr. Kiran wants to do some analysis of the block diagram to check what will be the output if a certain input is given. For that he is planning to do a transfer function modelling so that he can use MATLAB to model the system.

(a) Use block diagram reduction rule to find the closed loop transfer function

(b) Now verify your answer using Mason's Gain Formula so that Mr. Kiran can be sure of the answer he got in part (a)

(CO1) [Application]