Total No. of printed pages = 5

19/4th Sem/DIE 404

2022

CONTROL SYSTEMS

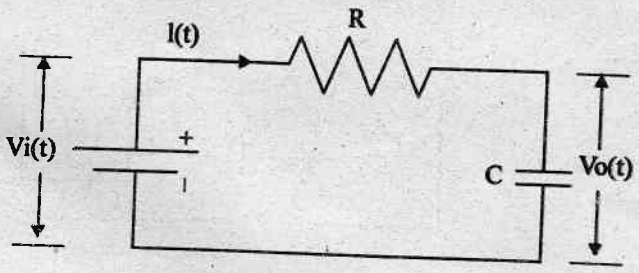
Full Marks – 100

Time – Three hours

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

Answer any *five* questions.

1. (a) What is meant by transfer function of a system ? Find out the transfer function of the following system as shown in the following figure : 5



[Turn over

(b) Write the differences between Open-loop and Closed-loop control system. 5

(c) What is Signal Flow Graph (SFG) ? Prepare a SFG from the set of linear equations. 2+8=10

$x_2 = a_{12}x_1 + a_{32}x_3$

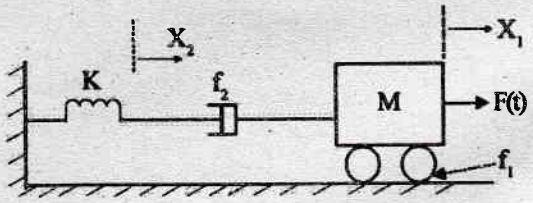
$x_3 = a_{13}x_1 + a_{23}x_2 + a_{33}x_3$

$x_4 = a_{24}x_2 + a_{34}x_3$.

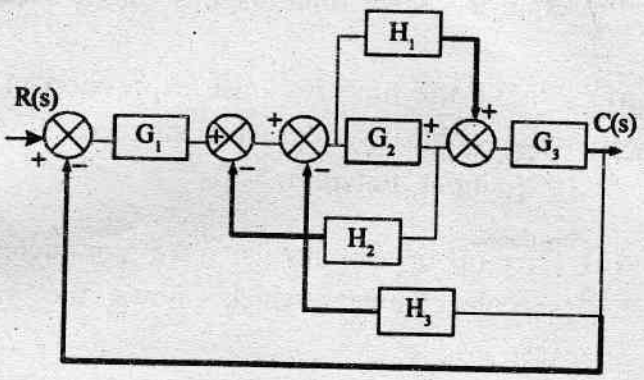
2. (a) Describe the concept of analogous system with examples. Write the differential equations to govern the behaviour of the mechanical system as shown in following figure. Also obtain the analogous electrical circuits based on : 5+5=10

(i) Force-current analogy

(ii) Force-voltage analogy



(b) Determine the overall transfer function of the following block diagram : 10

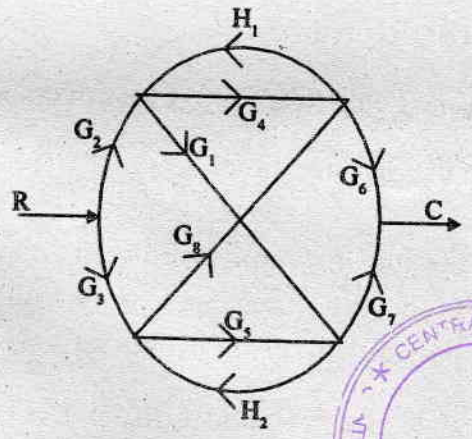


3. (a) Define the following with suitable examples : 2×2=4

(i) Linear and Non-linear system

(ii) SISO and MIMO system.

(b) What is Mason's gain formula ? Obtain the overall transfer function from the following signal flow graph : 2+8=10



(c) Define three test input signals that are used in control system time response analysis. 6

4. (a) Derive the time response expression of first order control system when subjected to a unit step input function. 5

(b) Certain measurements were conducted on servomechanism which shows the system response as 5

$c(t) = 1 + 0.2e^{-60t} - 1.2e^{-10t}$.

when subjected to unit step input. Find the expression for closed loop transfer function.

(c) What is transient response? Define the transient response specifications of a second order system : 2+8=10

(i) Rise time

(ii) Peak time and Peak overshoot

(iii) Settling time.

5. (a) Define the term stability in control system. Find out the system stability for the polynomial using Routh criterion. 4+6=10

$s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16 = 0$.

(b) What are order and type of a system ? Find out the steady state errors for a type 1 system. 4+6=10

6. Why root locus plot is required in control system ? Draw the root locus plot for the unity feedback open loop transfer function given by : 5+15=20

$$G(s) = \frac{K}{s(s+1)(s+3)}.$$

7. (a) Sketch the bode plot for the open loop transfer function : 15

$$G(s)H(s) = \frac{4s+1}{s^2(s+1)(2s+1)}.$$

(b) Write short note on Polar plot. 5