Printed Pages—5 **EIC501**

(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 2121 **Roll No.**

B. Tech.

(SEM. V) ODD SEMESTER THEORY EXAMINATION 2010-11

CONTROL SYSTEMS—I

Time : 3 Hours *Total Marks : 100*

Note : Attempt **all** the questions.

1. Attempt any **four** parts of the following : **(5×4=20)**

(a) What do you mean by feedback control system ? Distinguish between an open-loop system and closed-loop system.

(b) Discuss the effect of feedback on stability, noise and over-all gain of system.

(c) Find the transfer function for the system whose block diagram representation is shown in figure 1.

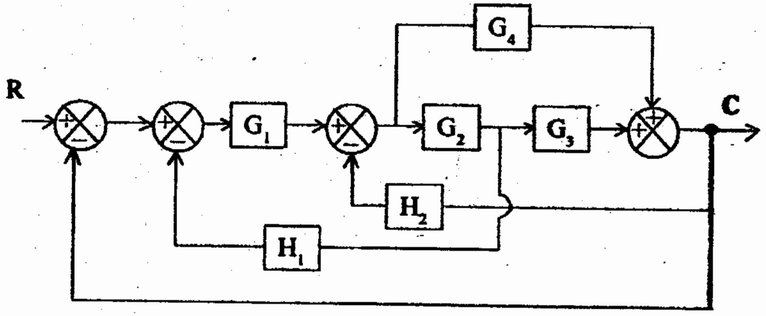

Fig. 1

(d) Draw the electrical analogy, using force current (f-i) analogy, of the mechanical system given in figure 2.

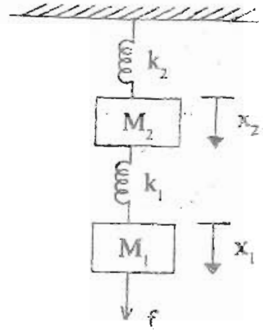

Fig. 2, Mechanical System

(e) Find the transfer function of the signal flow graph given in figure 3.

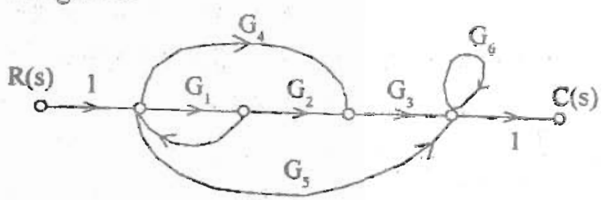

Fig. 3

(f) Define the following :

(i) Node (ii) Loop

(iii) Loop gain (iv) Path

(v) Forward path gain

2. Attempt any **two** parts of the following : **(10×2=20)**

(a) Write the state variables in matrix form for the circuit given in figure 4.

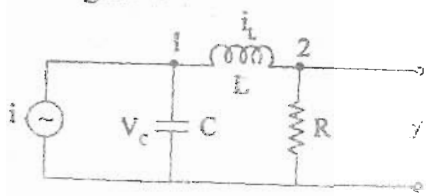

Fig. 4

(b) Realise State model by cascade decomposition of the following transfer function :

$$\frac{Z(s)}{V(s)} = \frac{5(s+1)(s+2)}{(s+4)(s+5)}.$$

(c) Define State variable and explain its importance and use in mathematical modelling of system. Also define state transition matrix and discuss its properties.

3. Attempt any **four** parts of the following : **(5×4=20)**

(a) A unity feedback servo driven instrument has open loop transfer function $G(s) = \frac{10}{s(s+2)}$. Find the following :

(i) The time domain response for a unit step input.

(ii) The natural frequency of oscillation.

(b) Define the following :

(i) Rise time

(ii) Delay time

(iii) Peak overshoot

(iv) Steady state error

(v) Time constant.

(c) Determine the step, ramp and parabolic error constants for the following feedback control systems. The open-loop transfer function is given below :

$$G(s) = \frac{120}{s(s^2+10s+110)}.$$

(d) A unity feedback system has $G(s) = \frac{180}{s(s+6)}$ and $r(t) = 4t$.

Determine (i) the steady state error, (ii) the value of K to reduce the error by 6%.

(e) Derive the expression for peak time (τp) for the second order control system.

(f) With example discuss its time response of first order system.

4. Attempt any two parts of the following : (10×2=20)

(a) Examine the stability of the system having characteristic equation $s^5 + s^4 + 3s^3 + 2s^2 + 4s + 8 = 0$. Also state Routh's stability criterion.

(b) Find the characteristic equation of the system shown in figure 5.

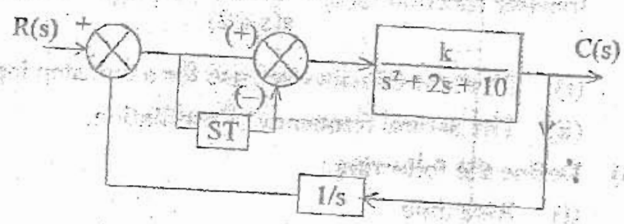

Fig. 5

(c) Discuss the concept of stability for bounded-input, bounded-output, continuous data systems. Also explain the concept of relative stability.

5. Attempt any four parts of the following : (5×4=20)

(a) Sketch the Nyquist plot for a system with the open-loop transfer function :

$$G(s)\,H(s) = \frac{k(1+0{\cdot}5s)(s+1)}{(1+10s)(s-1)}$$

determine the range of values of K for which the system is stable.

(b) Establish correlation between frequency domain response and time domain response.

(c) A unity feedback control system has $G(s) = \frac{400(s+2)}{s^2(s+5)(s+10)}$.

Draw the Bode plot.

(d) Determine the frequency domain specifications for a second-order system with unity feedback and

$$G(s) = \frac{225}{s(s+6)}.$$

(e) A unity feedback control system has :

$$G(s) = \frac{k}{s(s+4)(s+10)}.$$

Draw the Bode plot. Find K when PM = 30°.

(f) Discuss Nyquist stability criterion.