53 (IE 503) CNSY–I

2018

CONTROL SYSTEM–I

Paper : IE 503

Full Marks : 100

Time : Three hours

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

*Answer **any five** questions.*

1. *(a)* Given $r(t)$ as input, $g(t)$ as the system gain, $c(t)$ is the output. Using Laplace principle and convolution integral for a LTI system prove that

$$R(s).G(s)=C(s)$$

$$r(t)\rightarrow \boxed{g(t)} \rightarrow c(t)$$

5

(b) Explain the basic rules of block diagram reduction technique. 5

(c) Reduce the block diagram and find the transfer function of *Fig.* 1. 10

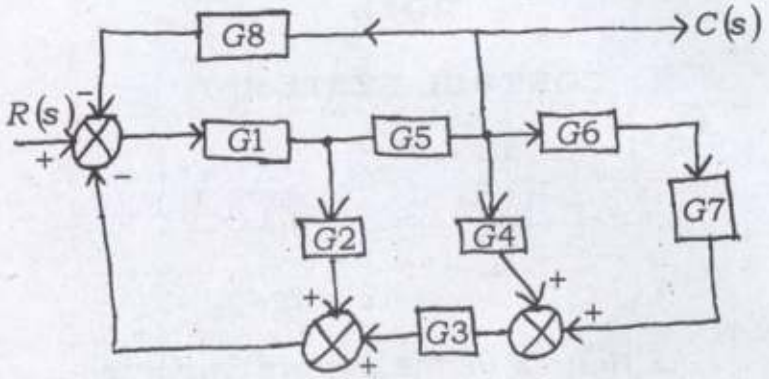

Fig. 1

2. (a) Find the transfer function for the system whose signal-flow graph is shown in *Figure* 2. 10

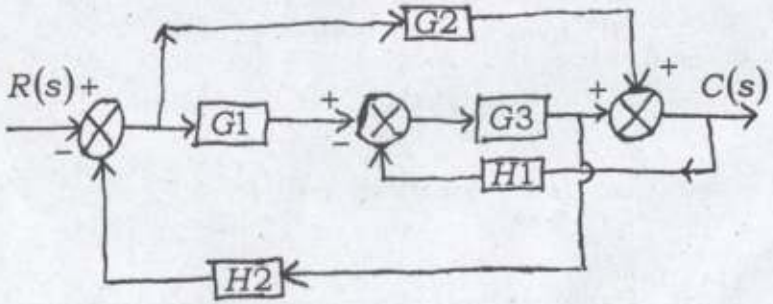

Fig. 2

(b) Obtain the Linear differential equation and its Laplace Transform for the mechanical system in *Fig.* 3 and its Force-voltage analogy. Draw the equivalent electrical circuit.

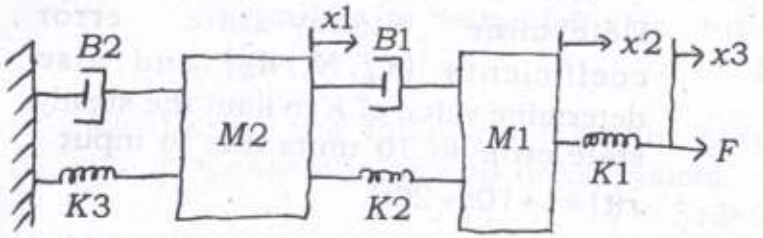

Figure 3

3+3+2=8

(c) Tabulate the equivalence of Rotational Mechanical System Impedances to Electrical Current System Impedances. 2

3. (a) Find out the output response $c(t)$ of the transfer function for step input. Plot the sketch of time response.

$$\frac{C(s)}{R(s)} = \frac{5}{(s+1)}$$

Determine —

(i) Peak time

(ii) Statistic time.

3+2=5

(b) A certain feedback control system is described by the following transfer function — 6+4=10

$$G(s)=\frac{K}{s^2(s+20)(s+30)},\ H(s)=1$$

Determine steady-state error coefficients (K_p, K_v, K_a) and also determine value of K to limit the steady state error to 10 units due to input $r(t)=1+10t+20t^2$

(c) The open-loop transfer function of a unity feedback system is given by

$$G(s)=\frac{K}{s(Ts+1)},$$

K and T are positive constants. By what factor should the amplifier gain K be reduced so that the peak overshoot of unit step response of the system is reduced from 75% to 25% 5

4. (a) Determine the stability of

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

(b) The close-loop transfer function of control system is given by

$$\frac{C(s)}{R(s)}=\frac{K}{s^4+6s^3+30s^2+60s+K}$$

(i) Determine the range of K must lie for the system to be stable. 5

(ii) What should be upper limit of K is all the close loop pole are required to be the left side of the line $(\sigma=-1)$? 5

(c) Derive the following for Unit step response of a second order system. 3+3=6

(i) Output Response ; $c(t)$, for $\zeta=0$

(ii) Delay Time; T_d

5. Sketch the Root loci of unity feedback control system on a graph paper using a suitable scale, whose open loop transfer function is given below — 10+5+5=20

$$G(s)=\frac{K}{(s-1)(s^2+4s+7)}$$

Also determine the following :

(i) The range of gain for stability and the point at which it crosses the imaginary axis

(ii) The value of gain K at the breakaway point.

6. *(a)* For unity feedback control system —

$$G(s) = \frac{800(s+2)}{s^2(s+10)(s+40)}$$ 10

Sketch the Bode plot.

(b) Sketch the Nyquist plot for the transfer function 10

$$G(s)H(s) = \frac{K(1+0.5s)(1+s)}{(1+10s)(s-1)}$$

7. Write short notes on : ***(any four)*** 4×5=20

(i) Amplidyne

(ii) Synchros

(iii) Field control DC motor

(iv) Potentiometer

(v) Armature control DC motor

(vi) Polar Plot

(vii) Advantages and limitations of Frequency Response Analysis.
