53 (IE 503) CNSY-I

2016

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 out of **Seven**.*

1. *(a)* Write the differential equations for the mechanical system shown in *Fig.*(1.*a*). Also obtain the analogous electrical circuits based on force-current analogy.

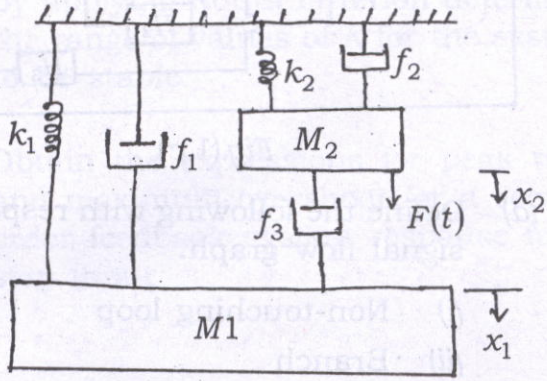

Fig.(1.*a*) 5

(b) A unity feedback system is characterised by an open loop transfer function

$$G(s) = \frac{K}{s(s+2)(0{\cdot}5s+1)}$$

Determine the error at steady state for input, $r(t) = 3t$ and $K = 4$.

Also find K for $e_{ss} = 0{\cdot}4$. 5

(c) Reduce the block diagram shown in *Fig.*(1.c) and obtain the overall transfer function. 10

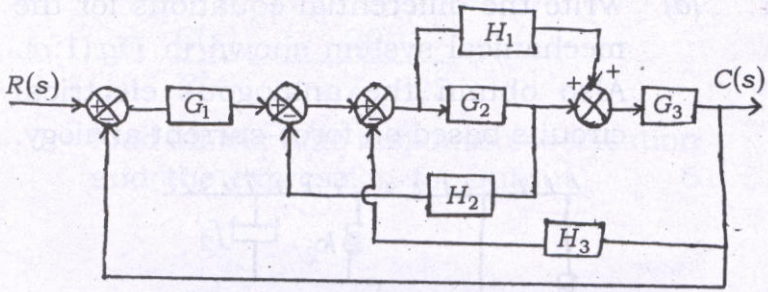

Fig.(1.c)

2. (a) Define the following with respect to the signal flow graph.

(i) Non-touching loop

(ii) Branch 2+2

(b) Consider the signal flow graph of *Fig.*(2.*b*). Obtain the overall transfer function $C(s)/R(s)$ using Mason's gain formula. 6

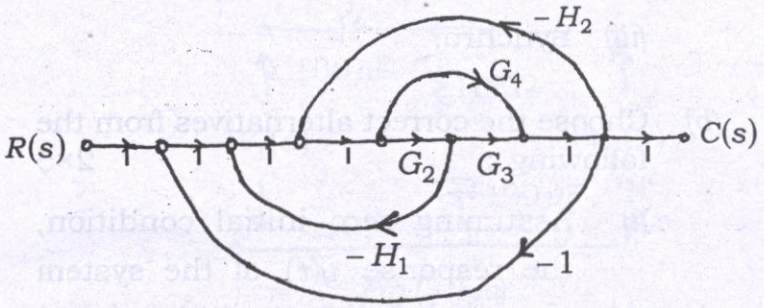

Fig.(2.*b*)

(c) The characteristics equation of a feedback control system is given by

$$s^4 + 20Ks^3 + 5s^2 + 10s + 15 = 0$$

By applying Routh criterion determine the range of values of K for the system to be stable. 5

(d) Obtain the expressions for peak time and maximum overshoot for a second order feedback system response for a step input. 5

3. *(a)* Write short notes on : ***(any two)*** 2×5

(i) Brushless DC motor

(ii) Armature control PMDC motor

(iii) Synchro.

(b) Choose the correct alternatives from the following : 2×5

(i) Assuming zero initial condition, the response $y(t)$ of the system given below to a unit step input $u(t)$ is

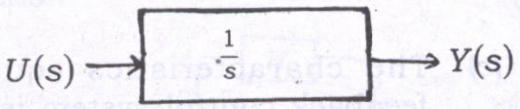

Fig.(3.*b.i*)

(A) $u(t)$

(B) $tu(t)$

(C) $\frac{t^2}{2}u(t)$

(D) $e^{-t}u(t)$

(ii) The transfer function $\frac{V_2(s)}{V_1(s)}$ of the circuit shown below is

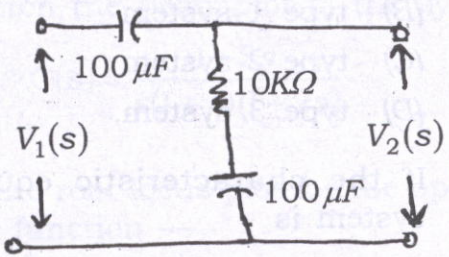

Fig.(3.*b.ii*)

(A) $\frac{0{\cdot}5s+1}{s+1}$

(B) $\frac{3s+6}{s+2}$

(C) $\frac{s+2}{s+1}$

(D) $\frac{s+1}{s+2}$

(iii) The steady state error of a feedback control system with an acceleration input becomes finite in a ....

(A) type 0 system

(B) type 1 system

(C) type 2 system

(D) type 3 system.

(iv) If the characteristic equation of a system is

$s^2 + 4s + 10 = 0$, the system is

(A) undamped

(B) over damped

(C) Critically-damped

(D) Under damped.

(v) For the transfer function $\frac{K}{(s+1)(s+2)(s+3)}$, the root locus break away point will be ————————.

(A) between 0 and –1,

(B) between –1 and –2

(C) between –2 and –3

(D) beyond –3.

4. *(a)* Discuss the effect of a P-D control action in the transient characteristics of a unity feedback system. 10

(b) Sketch the polar plot of the system

$$G(s)=\frac{1+3s}{s(1+s)(1+2s)}$$ 10

5. Sketch the root locus plot for the open loop transfer function —

$$G(s)=\frac{K\left(s^2+4\right)}{s(s+2)}$$

Calculate the value of K at,

(i) break away point

(ii) $s=-0{\cdot}69+j0{\cdot}9$

(iii) marginal stability. 14+2+2+2

6. Sketch the asymtotic Bode plot for the transfer function given below —

$$G(s)H(s)=\frac{10}{s(1+0{\cdot}5s)(1+0{\cdot}01s)}$$

From the Bode plot determine

(i) the phase cross over frequency

(ii) the gain cross over frequency

(iii) the gain margin

(iv) the phase margin

(v) is the system stable ? 10+10

7. (a) Plot the Nyquist plot to determine the phase crossover frequency and gain margin for

$$G(s)H(s) = \frac{K}{s(0{\cdot}4s+1)(0{\cdot}2s+1)}$$

10+2+2

(b) The overall transfer function of a system is given by

$$\frac{C(s)}{R(s)} = \frac{20}{s^2+7s+25}$$

Find all the time response specification and the expression for output. 6