53 (IE 503) CNSY-I

2017

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

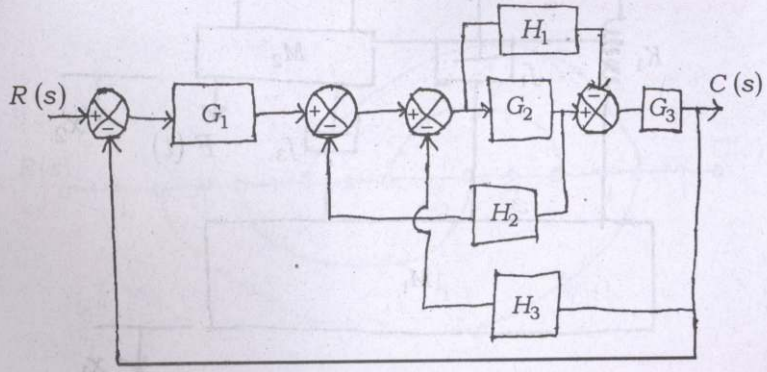

Fig. (1a)

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

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

Determine the error at steady state for input, $r(t) = 5t$ and $K = 10$.

Also find K for $e_{ss} = 0{\cdot}2$. 5

7. (c) Write the differential equations for the mechanical system shown in *Fig. (1c)*. Also obtain the analogous electrical circuit based on force-current analogy. 5

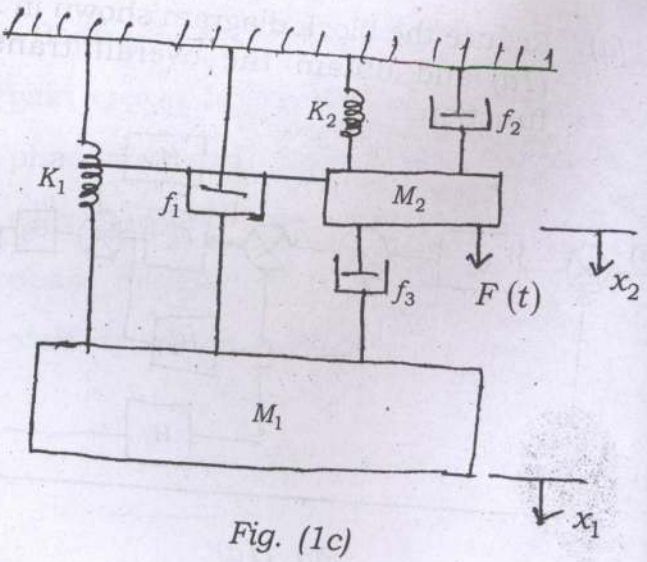

Fig. (1c)

2. *(a)* Define the following : 2+2

(i) Non-touching loop of a signal flow graph.

(ii) Take off point of a block diagram.

(b) 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

(c) Consider the signal flow graph of *Fig. (2c)*. Obtain the overall transfer function $\frac{C(s)}{R(s)}$ using Mason's gain formula. 6

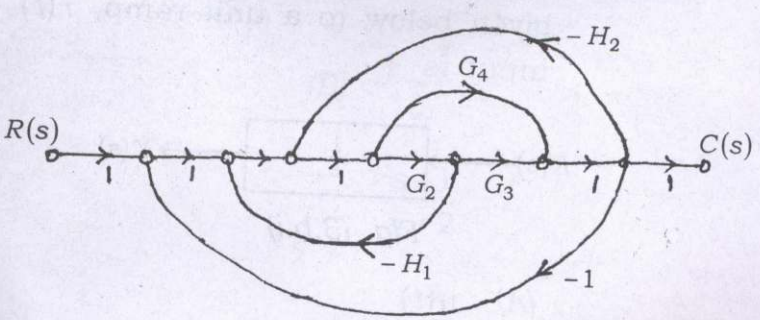

Fig. (2c)

(d) Define the following : 5

(i) Peak overshoot

(ii) Rise time w.r.t. a second order unit steps input system.

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

(i) Synchro

(ii) P–D control action

(iii) Servomotor.

(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 ramp, $r(t)$ input is

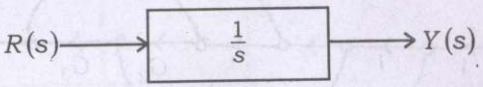

Fig. (3.b.i)

(A) $u(t)$

(B) $tu(t)$

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

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

(ii) The transfer function $V_2(s)/V_1(s)$ of the circuit shown below is

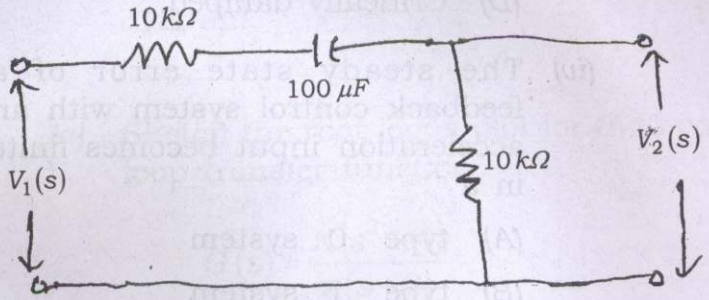

Fig. (3.b.ii)

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

(B) $\frac{s+1}{10^4}$

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

(D) $\frac{10^4}{s+1}$

(iii) If the characteristics equation of a system is, $s^2+4s+10=0$, the system is

(A) undamped

(B) Over damped

(C) Under damped

(D) Critically damped.

(iv) 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

(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)* Sketch the polar plot of the system :

$$G(s) = \frac{10}{s(1+s)(\cdot 5+2s)}$$ 10

(b) Discuss the effect of the PMDC motor with armature control. Draw the necessary transfer function and block diagram. 10

5. *(a)* 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. *(a)* Plot the Nyquist plot to determine the phase margin and gain margin for

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

10+4

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

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

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

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

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

From the Bode plot determine

(i) the gain crossover frequency

(ii) the phase crossover frequency

(iii) the gain margin

(iv) the phase margin

(v) the stability of the system.

10+10