53 (IE 503) CNSY–I

2013

(May)

CONTROL SYSTEM – I

(THEORY)

Paper : IE 503

Full Marks : 100

Pass Marks : 30

Time : Three hours

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

*Answer **any five** questions out of seven.*

1. *(a)* What is transfer function ?
Write the differential equations governing the behavour of the mechanical system shown in *Fig.* (1.*a*). Also obtain the analogous electrical circuits based on

(i) force–current analogy and

(ii) force–voltage analogy.

Also find the transfer function $X_1(s)/F(s)$.

Contd.

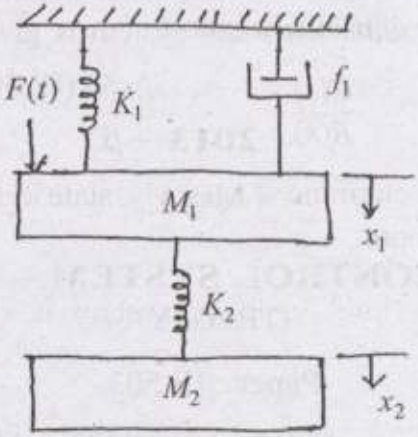

Fig.(1.*a*)

2+3+3+2

(b) Obtain the transfer function of the control system whose block diagram is shown in *Fig.*(1.*b*) by

(i) block diagram reduction technique

(ii) signal flow graph method. 10

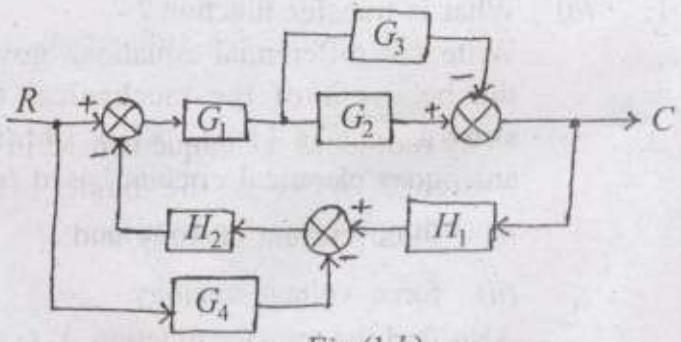

Fig.(1.*b*)

2. *(a)* The closed loop transfer function of a unity feedback control system is given below

$$\frac{C(s)}{R(s)} = \frac{ks+\beta}{s^2+\alpha s+\beta}$$

Determine the steady state error for ramp input. 5

(b) A unit feedback system is characterised by an open loop transfer function $G(s) = \frac{k}{s(s+10)}$. Determine the gain k, so that the system will have a damping ratio of $0 \cdot 7$. For this value of k determine the settling time, peak overshoot and time to reach peak overshoot for a unit step input. 8

(c) What is Routh stability criterion ? Determine the range of values of k for the system to be stable

$$s^4 + 4s^3 + 13s^2 + 36s + k = 0 \qquad 2+5$$

3. *(a)* Why root locus technique is used in control system ? What is the basic principle regarding ploting the root-locus ? 2+3

(b) Sketch the root locus plot for the open loop transfer function

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

Calculate the value of k at,

i) break away point and

ii) $S = -0 \cdot 69 + j0 \cdot 9$. 15

4. Sketch the asymtotic Bode plot for the transfer function given below

$$G(s)H(s) = \frac{2(s+0 \cdot 25)}{s^2(s+1)(s+0 \cdot 5)}$$

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.

Is the system stable ? 20

5. Sketch the Nyquist plot having the open-loop transfer function of unity feedback control system as $G(s) = \frac{k}{s(s+1)^2}$ and determine

i) the limiting value of k for closed loop stability.

ii) the gain and phase margin of $k = 0 \cdot 5$. 20

6. *(a)* What is the difference between the polar plot and Nyquist plot ? Which one is used for checking stability of the system ? Give examples. 5

(b) Sketch the polar plot of the system given by

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

(c) State the Nyquist stability criterion. 5

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

(a) Synchro error detector

(b) DC servomotor

(c) Derivative control effect

(d) Tacho generators

(e) Armature control PMDC motor.
