53 (IE 503) CNSY-I

2014

CONTROL SYSTEM-I

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)* For the system represented by the following equations, find the transfer function $\frac{X(S)}{F(S)}$ by signal flowgraph technique 5

$$x = x_1 + \beta_3 u$$

$$\dot{x}_1 = -\alpha_1 x_1 + x_2 + \beta_2 u$$

$$\dot{x}_2 = -\alpha_2 x_1 + \beta_1 u$$

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

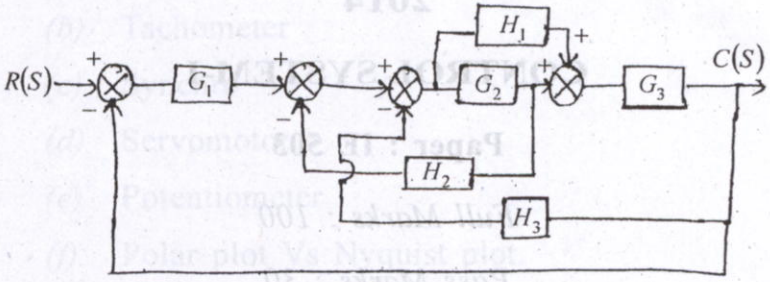

Fig. (1.b)

(c) Obtain the transfer function of the mechanical system shown in *Fig.(1.c).* 5

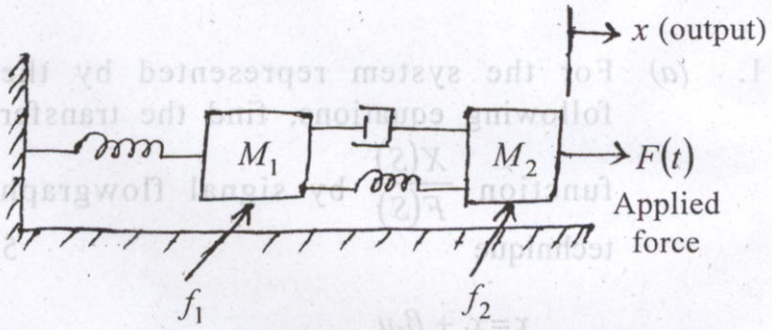

Fig. (1.c)

2. *(a)* A positional servomechanism is characterised by an open loop transfer function

$G(S)=\frac{K}{S(S+\alpha)}$, where K and α are positive constants, for an unity feedback. Find the values of K and α for a damping co-efficient value of 0·6 and damped frequency of 8 *rad/sec*. Also find the peak value of the response when the system is excited by a step of 2 *volts*. 10

(b) Using Routh's criterion, check the stability of the system equation of 5

$$S^6+2S^5+8S^4+12S^3+20S^2+16S+16=0$$

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

3. *(a)* Sketch the polar plot of the system given by

$$G(S)=\frac{10}{S(S+1)(S+5)}$$ 10

(b) The open loop transfer function of a servo system with unity feedback is

$$G(S)=\frac{10}{S(0{\cdot}1S+1)}$$

Evaluate the static error-coefficient (Ka, Ku, Ka) for the system. Obtain the steady state error of the system when subjected to an input given by the polynomial $r(t)=a_0+a_1t+\frac{a_2}{2}t^2$ 10

4. (a) Sketch the root locus plot for the open loop transfer function

$$G(S)H(S)=\frac{K(S^2+4)}{S(S+2)}$$

Calculate the value of K at breakaway point. 15

(b) Why root locus technique is required in control system engineering ?

What are the basic conditions to sketch the root locus ? 5

5. *(a)* 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

6. *(a)* State the Nyquist stability criterion and explain with example. 5

(b) Draw the Nyquist plot for the system whose open loop transfer function is

$$G(S)H(S)=\frac{6S+1}{S^2(S+1)(3S+1)}$$ 15

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

(a) Proportional and Integral action

(b) Tachometer

(c) Synchro

(d) Servomotor

(e) Potentiometer

(f) Polar plot Vs Nyquist plot.
