Total number of printed pages–7

53 (IE 503) CNSY-I

2019

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)* Compare Open-loop and Closed-loop Control System. 4

   (b) Distinguish between Linear and Non-Linear Control System. 4

   (c) Distinguish between Time-invariant and Time-varying Control System. 4

Contd.

(d) What is the effect of feedback on : 8

(i) Stability

(ii) External Disturbance

(iii) Sensitivity

(iv) Effect of positive feedback on stability?

2. (a) Explain the various terms used in the formulation of a signal flow graph : 10

(i) Node

(ii) Branch

(iii) Path

(iv) Loop

(v) Loop gain

(vi) Non-touching Loop

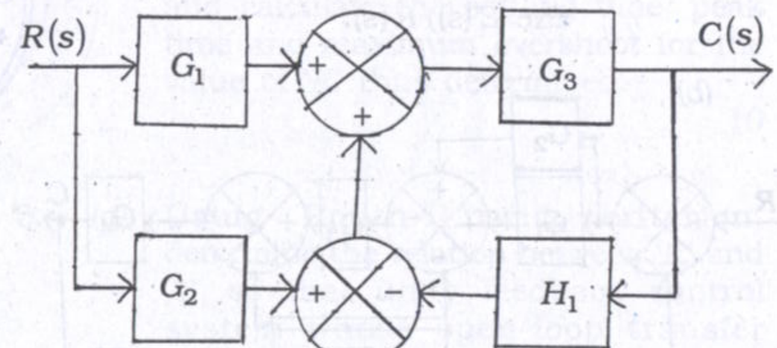
(vii) Sink node

(viii) Input node or Source

(viii) Mason's Gain Formula

(x) Self-loop.

(b) Draw the signal flow graph for a Control System whose block diagram representation is given and determine C/R using Mason's Gain formula. 10



3. (a) Explain the rules for Block Diagram Reduction : 10

(i) Blocks in cascade

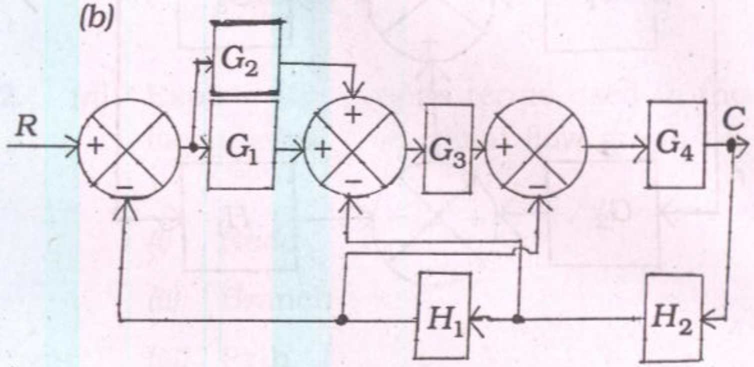
(ii) Blocks in parallel

(iii) Shifting of a summing point before a block to a position after the block

(iv) Elimination of a summing point in a closed-loop system

(v) For a system having $R(s)$: Reference Input signal, $C(s)$: Output signal, $E(s)$: Error signal, $H(s)$: Feedback path transfer function, $G(s)$: Forward path transfer function, evaluate the $E(s)/R(s)$.

(b)



Obtain the overall transfer function for a system represented by the block diagram using the rules of Block Reduction. 10

4. (a) Derive the Time domain response of a second order system for a STEP Input. 10

(b) A closed-loop control system with $H(s) = 0{\cdot}2$ and $G(s) = \dfrac{K}{(s)(s+6)}$, with negative feedback. The system is to have a damping ratio of 0·7. Determine the value of K to satisfy this condition and calculate the settling time, peak time and maximum overshoot for the value of 'K' thus determined. 10

5. (a) Using Routh-Hurwitz criterion, determine the relation between 'K' and 'T' so that unity feedback control system whose open-loop transfer function given below is stable.

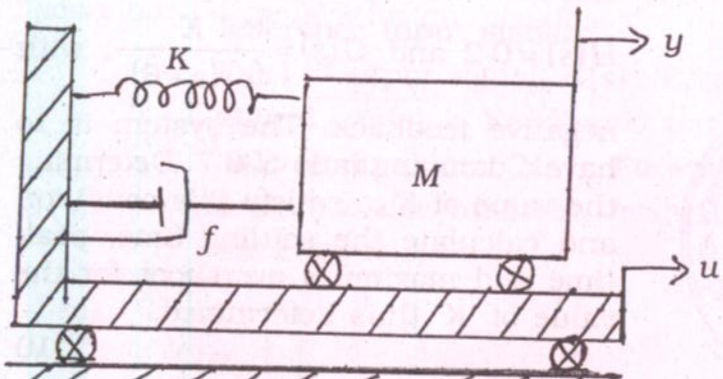
$$G(s) = \frac{K}{(s)[s(s+10)+T]}.$$ 10

(b) Sketch the Root Locus plot for the open-loop transfer function given below : 5

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

Calculate the value of K at break away point. 5

6.



The cart in the above figure is standing still for $t \angle 0$, $u(t)$ is the displacement of the cart and $y(t)$ is the output.

(a) Obtain the mechanical network of the system and the Transfer function of the system $Y(s)/U(s)$.

(b) Name the analogous electrical elements in force-current analogy for the elements of mechanical translational system.

(c) Draw the equivalent electrical circuit for the above cart system.

10+5+5

7. (a) Sketch the Nyquist Plot for a unity feedback control system having given

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

and determine the stability condition. 10

(b) Sketch the Bode Plot for the open-loop transfer function for the unity feedback system given below and assess stability.

$$G(s)=\frac{50}{(s+1)(s+2)}.$$ 10

8. (a) Sketch the direct polar plot for a unity feedback system with open-loop transfer function

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

Also find the frequency at which $|G(j\omega)|=1$ and corresponding phase angle $\angle G(j\omega)$. 10

(b) Derive the transfer function of a field controlled DC servomotor. 10
