Code : 031712/031812

B.Tech 7th Semester Special Exam., 2020

LINEAR CONTROL THEORY

Time : 3 hours *Full Marks* : 70

Instructions :

(i) The marks are indicated in the right-hand margin.

*(ii) There are **NINE** questions in this paper.*

*(iii) Attempt **FIVE** questions in all.*

*(iv) Question No. **1** is compulsory.*

1. Answer the following questions (any *seven*) : 2×7=14

(a) Write the different types of DC servomotors.

(b) Why is frequency domain compensation normally carried out using the Bode plots?

(c) What is dominant pole?

(d) What are the effects adding open-loop poles and zero on the nature of the root locus and on system?

(e) What will be stability of the system when the roots of characteristic equation are lying on imaginary axis?

(f) What is a control system?

(g) Find the unit impulse response of system $H(s) = \frac{5s}{s+2}$ with zero initial conditions.

(h) Compare open- and closed-loop in control system.

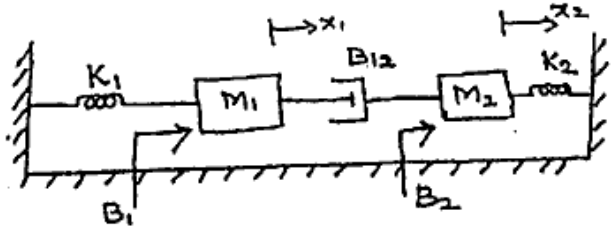
(i) For the system described by

$$\frac{C(s)}{R(s)} = \frac{16}{s^2 + 8s + 16}$$

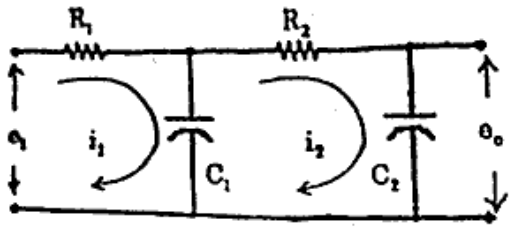
find the nature of the time response.

(j) What is a lag-lead compensator?

2. (a) Write the differential equations governing the mechanical translational system shown in the figure below and determine the transfer function : 8



(b) Construct a block diagram for the simple electrical network shown in the figure below. And, obtain the signal flow graph and the transfer function $\frac{E_o(s)}{E_i(s)}$. 6



3. (a) Draw the root locus for a system given by

$$G(s) = \frac{K(s+1)}{s(s^2+5s+20)}$$ 4

(b) A single loop negative feedback system has a loop transfer function

$$G_c(s)G(s) = \frac{K(s+6)^2}{s(s^2+1)(s+4)}$$

Sketch the root locus as a function of K. Find the range of K for which the system is stable, K for which purely imaginary roots exit and find the roots. 10

4. (a) A unity feedback system has the forward transfer function

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

when the input $r(t) = 1 + 6t$. Determine the minimum value of K so that the steady error is less than 0·1. 9

(b) Derive the transfer function of a PID controller. 5

5. (a) Derive the time response of un-damped and critically-damped second-order system for unit step input. 9

(b) A unity feedback control system has an open loop transfer function

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

Find the rise time, peak time, percentage overshoot and settling time for step input of 12 units. 5

6. (a) Plot the Bode plot for the following transfer function and determine the phase and gain cross over frequencies

$$G(s) = \frac{10}{s(1+0\cdot4s)(1+0\cdot1s)}$$ 7

(b) The open-loop function of a unity feedback system is given by

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

Sketch the polar plot and determine the gain and phase margin. 7

7. (a) State and explain Nyquist stability criteria. 5

(b) Determine the stability of closed-loop system by Nyquist stability criterion, whose open-loop transfer function is given by

$$G(s)H(s) = \frac{s+2}{(s+1)(s-1)}$$ 9

8. (a) Using Routh criterion, determine the stability of a system representing the characteristic equation

$$s^4 + 8s^3 + 18s^2 + 16s + 5 = 0$$

Comment on location of the roots of the characteristic equation. 5

(b) Write down the procedure for designing lag compensator using Bode plot. 9

9. (a) Obtain the closed-loop stability for the transfer function

$$G(s)H(s) = \frac{8s}{(s-1)(s-2)}$$

(Use Nyquist criterion). 9

(b) Why are constant M circles and constant N circles required? Write some properties of constant M circles and constant N circles. 5

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