Code : 03712

B.Tech 7th Semester Exam., 2015

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. Fill in the blanks (any *seven*) : 2×7=14

(a) If the impulse response of a system is $5e^{-10t}$, its step response is _____.

(b) The transfer function of a control system is given as $T(s) = \frac{K}{s^2 + 4s + K}$, where K is the gain of the system in rad/amp. For this system to be critically damped, the value of K should be _____.

(c) The open-loop transfer function of a feedback control system is $\frac{K}{s(s^2 + 3s + 6)}$. The breakaway points of root locus is at _____.

(d) The transient response of a system is improved by _____ compensator.

(e) A linear system follows _____ and _____ principle.

(f) The system is described by characteristic equation

$$Q(s) = s^5 + 2s^4 + 3s^3 + 4s^2 + 3s + K$$

according to Routh-Hurwitz criteria, the values of K _____ for system to be stable.

(g) The damping ratio of a system is 0·6 and the natural frequency of oscillation is 8 rad/sec, the rise time is _____.

(h) The Laplace transform of a transportation lag of 5 seconds is _____.

(i) The phase angle of the system $G(s) = \frac{s+5}{s^2 + 4s + 9}$ varies between _____ and _____.

(j) A linear system, initially at rest, is subject to an input signal $r(t) = 1 - e^{-t}$ $(t \geq 0)$. The response of the system for $t > 0$ is given by $c(t) = 1 - e^{-2t}$. The transfer function of the system is _____.

2. (a) What is a potentiometer? What are the differences between AC and DC potentiometers? What are the applications of potentiometers? 7

(b) What is servomechanism? Explain. 7

3. A unity feedback control system has open-loop transfer function $G(s) = \frac{10}{s(s+2)}$.

Find the rise time, % overshoot, peak time and settling time for a step input of 12 volts. 14

4. For the following transfer functions, determine type and order of the system :

(a) $G(s)\,H(s) = \frac{K}{s(s+1)(s^2+6s+8)}$

(b) $G(s)\,H(s) = \frac{20(s+2)}{s^2(s+3)(s+0\cdot5)}$

Calculate the error coefficient and steady-state error in each case. 7+7=14

5. (a) Define the following terms : 6

Breakaway point, centroid, root locus

(b) Sketch the root locus for the unity feedback system whose open-loop TF is

$$G(s)\,H(s) = \frac{K(s+1\cdot5)}{s(s+1)(s+5)}$$ 8

6. For the function

$$G(s)\,H(s) = \frac{5(1+2s)}{(1+4s)(1+0\cdot25s)}$$

draw the Bode plot. 14

7. (a) What do you mean by Nyquist criterion? 5

(b) Consider a unity feedback system has open-loop transfer function

$$G(s) = \frac{50}{s(s+4)(s-1)}$$

Comment on stability of the system using Nyquist stability criterion. 9

8. A unity feedback system has open-loop transfer function

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

(Continued)

is to be compensated to meet the following specifications : settling time, $t_s = 10$ sec and peak overshoot, $M_p = 25\%$ and position error constant, $K_v = 5$. Design a suitable compensator. 14

9. Write short notes on : 3½×4=14

(a) M and N circle

(b) Correlation between time domain and frequency domain specifications

(c) Systems with transport lag

(d) Linearization of nonlinear systems

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