

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) : $2 \times 7 = 14$

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

$\rightarrow cL$

(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 _____

(2)

(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 _____.

(3)

- (i) 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 :

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

$$(b) G(s) H(s) = \frac{20(s+2)}{s^2(s+3)(s+0.5)}$$

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

(4)

5. (a) Define the following terms :

Breakaway point, centroid, root locus

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

$$G(s) H(s) = \frac{K(s+1 \cdot 5)}{s(s+1)(s+5)}$$

6. For the function

$$G(s) H(s) = \frac{5(1+2s)}{(1+4s)(1+0.25s)}$$

draw the Bode plot.

6

8

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.

5

9

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

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

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(Continued)

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

14

9. Write short notes on : $3\frac{1}{2} \times 4 = 14$

(a) M and N circle

(b) Correlation between time domain and frequency domain specifications

(c) Systems with transport lag

(d) Linearization of nonlinear systems

