Code : 031712

B.Tech. 7th Semester Exam., 2014

LINEAR CONTROL THEORY

Time : 3 hours *Full Marks* : 70

Instructions :

(i) All questions carry equal marks.

*(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*) :

(a) The Laplace transform of $e^{-2t}\sin 2t$ is ——.

(b) Unit impulse response of a system in Laplace transform gives ——.

(c) For dynamic equation

$$2\frac{d^2y}{dt^2}+4\frac{dy}{dt}+8y=8$$

the damping coefficient is ——.

(d) The characteristic equation of a feedback control system is

$$2s^4+s^3+3s^2+5s+10=0$$

then number of roots in the right half of *s*-plane is ——.

(e) For the transfer function

$$G(s)H(s)=\frac{1+s}{s(s+0\cdot 5s)}$$

the corner frequency will be —— and ——.

(f) The gain of a system is 10 at some frequency in terms of DB it is equal to ——.

(g) The loop transfer function of a feedback control system is given by

$$G(s)H(s)=\frac{k}{s(s+2)(s^2+2s+2)}$$

then number of asymptotes of its root locus will be ——.

(h) For an overdamped system, damping factor is ——.

(i) For Nyquist plot we use —— loop transfer function.

(j) By using —— compensator transient response of system will improve.

2. For a unity feedback system

$$G(s) = \frac{36}{s(s+0\cdot72)}$$

determine the characteristic equation and hence calculate *(a)* damping ratio, *(b)* peak time, *(c)* settling time, *(d)* peak overshoot and *(e)* number of cycle completed before output settle for unit step input.

3. For a unity feedback system having

$$G(s) = \frac{5(s+1)}{s^2(s+3)(s+10)}$$

determine type of system, error coefficient and the steady-state error for input

$$r(t) = 1 + 3t + \frac{t^2}{2}$$

4. *(a)* What are *M*-circles and *N*-circles? Explain in brief.

(b) Given that $M_r = 2$ and $\omega_r = 5$. Determine the steady-state error for a unit ramp for a unity feedback system with a closed loop transfer function of second-order system.

5. For each of the characteristic equation of feedback control system given, determine the range of k for stability. Determine the value of k so that the system is marginally stable and find

the frequency of sustained oscillation :

(i) $s^4 + 25s^3 + 15s^2 + 20s + k = 0$

(ii) $s^4 + ks^3 + s^2 + s + 1 = 0$

(iii) $s^3 + 3ks^2 + (k+2)s + 4 = 0$

(iv) $s^4 + ks^3 + 5s^2 + 10s + 10k = 0$

6. Draw the root locus of the system whose open loop transfer function is

$$G(s)H(s) = \frac{k}{s(s+3)(s^2+3s+11\cdot25)}$$

7. *(a)* Define the following terms :

(i) Resonant frequency

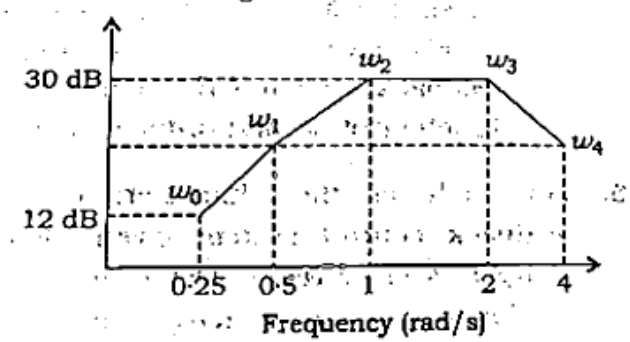
(ii) Resonant peak

(iii) Cut-off frequency

(iv) Bandwidth

(v) Cut-off rate

(b) Find the transfer function of the Bode plot shown in the figure below :



8. Plot the Nyquist diagram for the system having the open-loop transfer function

$$G(s)\,H(s) = \frac{2(s+0\cdot1)(s+0\cdot6)(s^2+s+1)}{s^3(s-0\cdot2)(s+1)}$$

and hence determine the stability of closed loop system.

9. Write short notes on the following :

(a) Relative stability using Routh criteria

(b) All pass and minimum phase system

(c) Lag compensator

(d) Linearization of system

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