Total number of printed pages – 6

B. Tech

CPEE 5302

Sixth Semester Examination-2007

CONTROL SYSTEM ENGINEERING

Full Marks – 70

Time – 3 Hours

*Answer Question No. 1 which is compulsory and any **five** from the rest.*

The figures in the right-hand margin indicate marks.

1. Answer the following questions : 2×10

   (a) Determine the break away point of the system whose open loop transfer function is $G(s) = \frac{K}{s(s+3)^2}$.

(b) Find how many unstable roots are there for $f(s) = s^5 + 4s^4 + 8s^3 + 9s^2 + 6s + 2$

(c) What is inverse polar plot ?

(d) Draw a schematic diagram for a typical position control system.

(e) What is the difference between a servo and regulatory control system ?

(f) What are the frequency domain specifications ?

(g) What is the significance of the system time constant ?

(h) Distinguish between absolute stability, conditional stability and relative stability.

(i) How can you say about the phase margin and gain margin from the bode plot of a system ?

(j) How Routh criterion is helpful in finding relative stability ?

2. (a) An R-L-C circuit is an example of second order function. If R = 1 Ω, L = 1 H and C =1 F. Find the step response for a step voltage of 1 V connected as input. Output is across R. 6

(b) A control system is represented by following characteristic equation.

$$q(s) = s^4 + 2s^3 + 3s^2 + s + 5.$$

Check the stability by Hurwitz criterion. 4

3. (a) The open loop transfer function of a unit feedback system is given by $G(s) = \frac{K}{s(1+Ts)}$ where K and T are positive constants. By what factor should be the amplifier gain be reduced so that peak overshoot of the unit feed back system is reduced from 75% to 25%. 7

(b) A system is described by

$$\frac{d^2y}{dt^2} + 8\frac{dy}{dt} + 25u(t) = 50x(t)$$

Evaluate the response and maximum output for a step of 2.5 units. 3

4. If the open loop transfer function is $G(s) = \frac{K}{s(s+1)(s+\beta)}$, where K and β are varying, find the root contour of the feedback system. 10

5. Draw the Bode plot for the following open loop transfer function. Indicate the gain and phase margin. 10

$$G(s) = \frac{2500(s+10)}{s(s+2)(s^2+30s+2500)}.$$

6. (a) Sketch the polar plot of transportation lag. 4

(b) The open loop transfer function of a unit feedback system is :

$$G(s) = \frac{(4s+1)}{s^2(s+1)(2s+1)}.$$

Check the stability of the system. 6

7. For a unit feedback control system the open loop transfer function is – 10

$$G(s) = \frac{K(s+2)}{s(s^3+7s^2+12s)}$$

(i) State the type and order of the system.

(ii) Find K_p, K_v, and K_a.

(iii) Find e_{ss} due to step, ramp and parabolic inputs.

(iv) Find ess due to an input described by

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

8. A two-phase servo-motor has the following specifications : starting torque (T_{st}) = 0.166 N-m,

supply voltage (V_c) = 115 volts, no-load speed (N_0) = 2900 rpm, moment of inertia (J) = 10^{-5} kg-m^2. Friction is neglected – 10

(a) Find the transfer function,

(b) Draw the torque-speed characteristics for the control winding voltage of 57 volts

(c) How the speed will vary when the control winding voltage undergoes a unit step change ?

(d) What will be the steady state speed ?