Total number of printed pages – 7

B. Tech

CPEE 5302

Fifth 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

   (i) What is Mason's gain formula ?

   (ii) What are the steady state error coefficients for different types of inputs ?

P.T.O.

(iii) Briefly explain the stability of control system with reference to characteristics root locations.

(iv) What are the type and order of a system ?

(v) With an example, explain how positive feedback can make a system unstable ?

(vi) What are the effects of proportional and integral control action ?

(vii) What is a phase-lead compensator, and why is it used ?

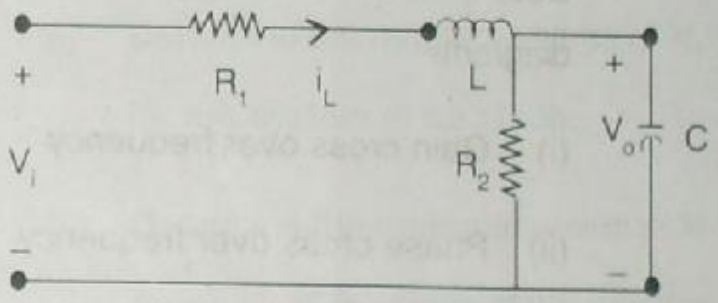
(viii) Briefly explain a method of tuning PID controllers.

(ix) What is the aliasing effect and how can it be avoided ?

(x) Prove the final value theorem in Z-transform.

2. (a) Explain the effects of negative feedback control. 5

(b) Draw the signal flow graph, for the circuit shown below. Determine the overall transfer function, $\frac{V_0(s)}{V_1(s)}$. 5



3. (a) Obtain the rise time, peak time, maximum overshoot, and settling time in the unit step response of a closed loop system given by 4

$$\frac{C(s)}{R(s)} = \frac{36}{s^2+2s+36}.$$

(b) Sketch the root locus of the system with open loop transfer function given by

$$G(s)H(s) = \frac{K(s+2)}{s^2+2s+3}.$$ 6

4. (a) Draw the Bode diagram for

$$G(s) = \frac{100(0.02s+1)}{(s+1)(0.1s+1)(0.01s+1)^2}$$

Determine the following from the Bode diagram.

(i) Gain cross over frequency

(ii) Phase cross over frequency

(iii) Gain margin

(iv) Phase margin.

Is the system stable ? 7

(b) What are the Constant M–, and Constant N–circles ? 3

5. (a) Using Nyquist Criterion determine the stability of the system with

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

(b) The forward path transfer function of a unity feedback system is given by : 5

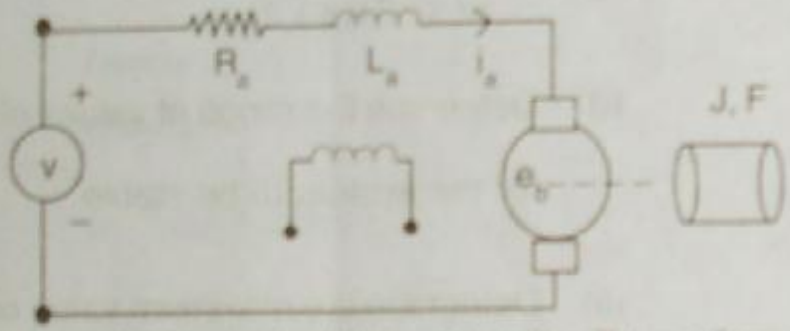
$$G(s) = \frac{K(s+1)}{s(s+2)(s+3)}$$

(i) Determine the range of values of K, for the system to be stable.

(ii) Determine the maximum value of K for which all the poles of the transfer function of the closed loop system are to the left of the line, $\sigma = -0.5$.

6. (a) In the speed controlled DC servo shown below, field flux is constant. Back e.m.f. constant is K_b volts / rad / s. Torque constant is K N.m/A. For the motor and load combination, moment of inertia is J and viscous friction is F N.m/rad/s. Obtain the

state-space representation of the servo system with armature current and speed as state variables. 5



(b) If $Z[x(t)] = X(z)$, obtain the Z-transform of the following functions : 5

(i) $a^k x(t)$ (ii) $e^{-at} x(t)$

(iii) $t\,x(t)$ (iv) t

(v) $k\,a^k x(k)$.

7. (a) Obtain expressions for inverse Z-transform of $X(z) = \dfrac{3z^2 + 2z + 1}{z^2 - 3z + 2}$. 5

(b) The input-output relationship of a sampled data system is described by the difference equation :

$$y(k+2) - 3y(k+1) + 2y(k) = r(k)$$

where, $r(0) = 1$, and $r(k) = 0$ for $k \neq 0$, $y(k) = 0$ for $k \leq 0$. Determine the pulse transfer function, and find the response, $y(kT)$ of the system. 5

8. Write short notes : 10

(a) DC servo motor

(b) Amplidyne

(c) Stepper motor.