Total number of printed pages–7

53 (IE 604) CNSY-II

2014

CONTROL SYSTEM-II

Paper : IE 604

Full Marks : 100

Time : Three hours

The figures in the margin indicate full marks for the questions.

*Answer **any five** questions out of **seven**.*

1. *(a)* The open loop Transfer Function of a system is $G(S) = \frac{5}{S(S+1)(S+2)}$. It is desired to compensate the system so that the stati velocity error constant K_V is 5 sec^{-1}, the phase margin is 40° and Gain margin is at least 10*dB*. 10

(b) A unity feedback system is characterized by the open-loop transfer function

$$G(S)=\frac{K}{S(S+3)(S+9)}$$

Determine –

(i) the value of K if 20% overshoot to a step input is desired.

(ii) the settling time and K_V for the above value of K.

(iii) the cascade compensator for the same overshoot and settling time and $K_V \geq 20$. 10

2. *(a)* Obtain the State Space model of the electrical network shown in *Fig. (2.a)*. Select suitable state variables and output variable. 5

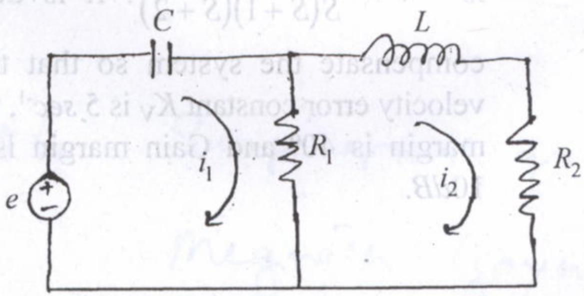

Fig. (2.a)

(*b*) Using Laplace transform method, determine time response of a system having state model as —

$$\dot{x}_1 = x_2 + u(t)$$

$$\dot{x}_2 = -2x_1 + 3x_2$$

where, $u(t) = e^{-t}$ for $t \geq 0$

$= 0$ for $t < 0$

and $x_1(0) = x_2(0) = 0$ 10

(*c*) Comment on the controllability of the system having following co-efficient matrices

$$A = \begin{bmatrix} -1 & -2 & -1 \\ 0 & -1 & 1 \\ 1 & 0 & -1 \end{bmatrix}, \qquad B = \begin{bmatrix} 2 \\ 1 \\ 1 \end{bmatrix}$$

$$C = \begin{bmatrix} 1 & 0 & 1 \end{bmatrix}, \qquad D = 0$$ 5

3. (a) Consider the system given by $\dot{x} = Ax + Bu$.

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -5 & -6 \end{bmatrix}, \quad B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$$

The system uses the state feedback $u = -kx$. The desired closed-loop poles at $S = -2 \pm j4,\ S = -10$.

Determine the state feedback gain matrix. 10

(b) Draw the phase plane portraits of the following system, using isocline method

$\ddot{x} + \dot{x} + 0{\cdot}5x = 0$ 10

4. (a) Find the closed loop transfer function in z domain of the system in *Fig. (4.a)*. 10

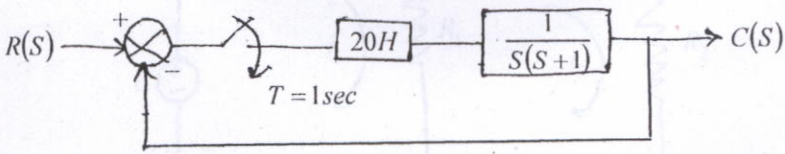

Fig. (4.a)

(b) Determine the pulse Transfer Function of the system given in *Fig. (4.b).* 5

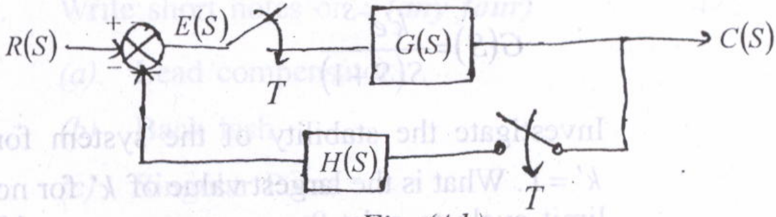

Fig. (4.b)

(c) Obtain the range of the k for stable system.

$$F(z) = z^3 + z^2 + z + k = 0$$ 5

5. (a) Find the describing function for the non-linear system having characteristic as shown in *Fig. (5.a).* 10

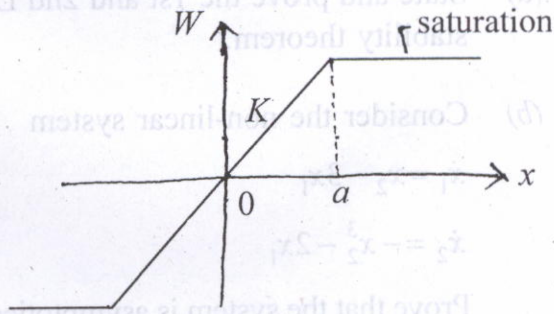

Fig. (5.a)

(b) A two phase servomotor is driven by an amplifier as shown in *Fig. (5.b)*. The transfer function of the motor is

$$G(S) = \frac{k'e^{-S}}{S(S+1)}$$

Investigate the stability of the system for $k' = 1$. What is the largest value of k' for no limit cycle to exist ? 10

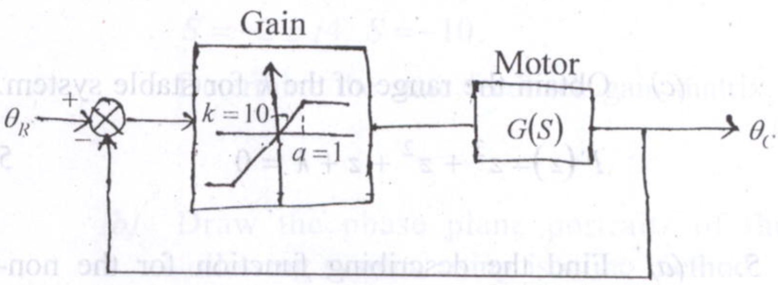

Fig. (5.b)

6. (a) State and prove the 1st and 2nd Lyapunov's stability theorem. 10

(b) Consider the non-linear system 5

$$\dot{x}_1 = x_2 - 3x_1$$

$$\dot{x}_2 = -x_2^3 - 2x_1$$

Prove that the system is asymptotically stable. 5

(c) Explain the limit cycle in the analysis of a non-linear control system. 5

7. Write short notes on : ***(any four)*** 4×5

(a) Lead compensator

(b) Back lash

(c) Singular Point

(d) Isocline method

(e) State Transition Matrix.
