Total number of printed pages–5

53 (IE 604) CNSY

2019

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.*

1. *(a)* Draw and explain the Bode plot for a phase lag network. 5

   (b) Design a suitable lag compensating network for $G(s)=\frac{K}{s(s+1)(s+20)}$ to fulfill the following specifications: Velocity error Constant, $K_v = 20\,sec^{-1}$, Phase margin $(\text{PM}) \geq 35°$. Assume the margin of safety = 5°. 15

Contd.

2. (a) Explain the phase plane technique. 10

(b) How time can be determined from the phase plane trajectory? 10

3. (a) Define : (i) non-liner system and (ii) the describing function. 6

(b) What are the common types of non-linearities? 2

(c) Determine the describing function of the following non-linearity (shown in *Fig. Q3c*). 12

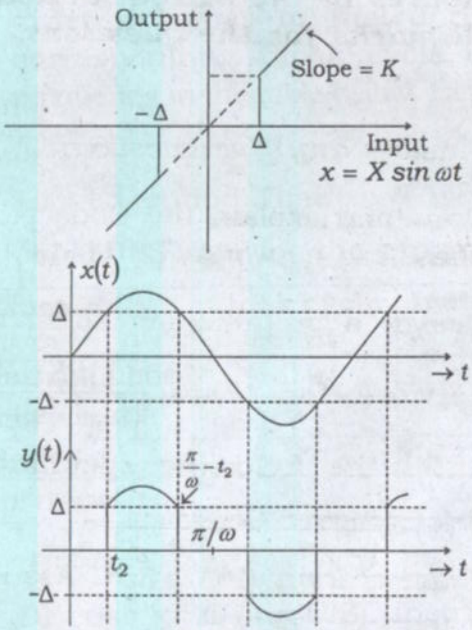

Fig. Q3c

4. (a) Define state variable, state vector and state space. 6

(b) What are the advantages of state space technique? 4

(c) A system is described by the differential equation $\frac{d^3y}{dt^3}+5\frac{d^2y}{dt^2}+7\frac{dy}{dt}+9y$

$$=11\,u_1(t)+13\,u_2(t)$$

where $y(t)$ is the output and $u_1(t), u_2(t)$ are the inputs to the system. Obtain the state space representation of the system. 10

5. (a) State and prove Final value theorem (FVT) for Z-transformation. 10

(b) Find the Final value of $f(k)$ using FVT for a given function

$$F(z)=\frac{1}{1-z^{-1}}-\frac{1}{1-e^{-aT}z^{-1}}$$ 5

(c) Solve the differential equation using Z-transform method :

$$x(k+2)+3x(k+1)+2x(k)=0$$

Assume, $x(0)=0$ and $x(1)=1$. 5

6. (a) A control system is described by the following matrices :

$$A=\begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ 0 & -2 & -3\end{bmatrix}, B=\begin{bmatrix}0\\0\\1\end{bmatrix} \text{ and } C=[1 \ \ 2 \ \ 0]$$

Determine the transfer function of the system. 10

(b) A Single-input single-output (SISO) system is represented as 10

$$\dot{x}(t)=\begin{bmatrix}-2 & 0 & 0\\ 0 & -3 & 0\\ 0 & 0 & -4\end{bmatrix}x(t)+\begin{bmatrix}1\\1\\0\end{bmatrix}u(t)$$

and $y(t)=[1 \ 0 \ 2]x(t)$.

Test the Controllability and Observability of this system.

7. (a) What is transfer matrix and state transition matrix ? 10

(b) Compute state transition matrix when 10

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

8. Write short note on ***any two*** of the following : 2×10=20

(a) Design procedures for phase lead compensation

(b) Properties of state transition matrix

(c) Stability analysis from the phase plane trajectory

(d) Asymptotic stability and limit cycle.