53 (IE 604) CNSY-II

2018

CONTROL SYSTEM–II

Paper : IE 604

Full Marks : 100

Time : Three hours

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

Symbols have their usual significance.

Answer ***any five*** *questions.*

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

   b) Design a suitable lead compensation network for $G(s)=\frac{K}{s^2(s+5)}$ to fulfill the following specifications : Velocity error constant, $K_v = 15\,sec^{-1}$, phase margin (PM) $\geq 35°$.
   Assume the margin of safety = 35°.
   15

2. *a)* Define the describing function. 4

b) Determine the describing function for a practical relay in the control system. 12

c) What will be value of the describing function for an ideal relay ? 4

3. *a)* Explain the phase plane technique. 10

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

4. *a)* State and prove *(i)* Initial Value Theorem (IVT) and Final Value Theorem (FVT) for Z-transformation. 10

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

$$F(z)=\frac{0.792z^2}{(z-1)\left(z^2-0.416z+0.208\right)}$$

5

c) Using inverse Z-transformation, find $x(k)$ when $X(Z)=\frac{11z^2-7z}{z^2-1.3z+4}$ for $k=0, 1, 2, 3, \ldots$ 5

5. 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

$$\frac{d^3y}{dt^3}+6\frac{d^2y}{dt^2}+11\frac{dy}{dt}+10y=8u(t)$$

where $y(t)$ is the output and $u(t)$ is the input to the system. Obtain the state space representation of the system. 10

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

b) Compute state transition matrix when

$$A=\begin{bmatrix}-1 & 1\\ 0 & 2\end{bmatrix}.$$ 10

7. 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

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

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

Test the controllability and observability of this SISO system. 10

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

a) Phase lead-lag networks

b) Stability analysis with describing function

c) Stability analysis from the phase plane trajectory

d) Asymptotic stability and limit cycle

e) Kalman's test for controllability and observability.
