Total number of printed pages–4

53 (IE 604) CNSY–II

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2021

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 lead network. 8

   (b) Design a suitable lead 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°. 12

Contd.

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

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

3. *(a)* Define : 7

(i) Non-linear system;

(ii) The describing function.

(b) What are the common types of non-linearities? 3

(c) Determine the describing function for a practical relay. 10

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 —

$$\frac{d^3y}{dt^3}+5\frac{d^2y}{dt^2}+7\frac{dy}{dt}+9y=11u_1(t)+13u_2(t)$$

where, $y(t)$ is the output and $u_1(t)$,

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$u_2(t)$ are the inputs to the system. Obtain the state space representation of the system. 10

5. *(a)* State and prove the Final value theorem (FVT) for Z-transformation. 8

(b) Find the final value of $f(k)$ using FVT for a given function : 6

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

(c) Solve the following difference equation using Z-transform method : 6

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

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

6. *(a)* A contral system is described by the following matrices : 10

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

Determine the transfer function of the system.

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(b) A single input–single output (SISO) system is represented as : 10

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

and $y(t)=\begin{bmatrix}1 & 0 & 2\end{bmatrix}x(t)$.

Test the controllability and observability of this SISO system.

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

(b) Compute the state transition matrix when

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

8. Write short notes on : ***(any two)*** 10×2=20

(i) Design procedures for phase lag compensation

(ii) Properties of state transition matrix

(iii) Stability analysis from the phase plane trajectory.

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