=/INST/Sem-V-CBSGS/Control System Design/Nov-16

QP Code : 597702

(3 Hours) **[Total Marks : 80**

N.B. : (1) Question No. **1** is compulsory
(2) Attempt **any three** questions out of remaining **five** questions.
(3) Assume suitable data if necessary.

1. Attempt the following :- **20**
   (a) What are the advantages of modern control system over conventional control system.
   (b) What is compensator? Explain cascade and feedback compensation with neat diagram.
   (c) Derive the transfer function for electrical lead compensator.
   (d) Define state, state variable, state vector and state model of a system. Also draw block diagram of state model.

2. (a) Consider a unity feedback control system with open loop transfer function. **10**

$$G(s) = \frac{k}{s(s+50)}$$

Design a PI controller to meet following specifications.
% Mp = 20%, Ts = 2 sec.

(b) Derive the transfer function of electrical lag-lead compensator also draw the pole-zero plot. for the same. **10**

3. (a) Construct state models for the following. **10**

(1) $$T(s) = \frac{s^3 + 2s^2 + 4s + 6}{s(s+1)(s+2)}$$

(2) $$\dddot{Y} + 6\ddot{Y} + 11\dot{Y} + 6Y = 6U$$

(3) $$\frac{d^3y}{dt^3} + 3\frac{d^2y}{dt^2} + 2\frac{dy}{dt} = u$$

(b) Diagonalise the following matrix 10

$$A=\begin{bmatrix}4 & 1 & -2\\ 1 & 0 & 2\\ 1 & -1 & 3\end{bmatrix}$$

4. (a) An open loop transfer function is 10

$$G(s)=\frac{k}{s(s+1)(s+4)}$$

the system is to be compensated to meet the following specifications.
Damping ratio = 0.5
Ts = 10 sec
Kv ≥ 5 /sec

(b) A dynamic system is described by the state variable equation 10

$$\dot{x}=\begin{bmatrix}0 & 1\\ 0 & -2\end{bmatrix}x \quad \text{and } y=[3 \quad -1]\,x$$

initial conditions are $\begin{bmatrix}0\\ 2\end{bmatrix}$. Obtain state transition matrix also determine homogeneous response of the system.

5. (a) Explain the design procedure for lag compensator using Bode plot. 10

(b) $$A=\begin{bmatrix}0 & 0 & 0\\ 0 & -1 & 1\\ 0 & -1 & -10\end{bmatrix}, B=\begin{bmatrix}0\\ 0\\ -10\end{bmatrix}$$ 10

Desired poles are,

$S=-1\pm j\sqrt{3}\ , -10$

Determine the state feedback gain matrix of the above system.

6. (a) A System whose open loop transfer function 10

$$G(S)=\frac{k}{S(s+1)(s+4)}$$

The system is to be compensated to meet following specifications,

Damping ratio = 0.4
Ts = 10 sec
Kv $\geq$ 5/sec
phase margin (ϕ_m)=43°

(b) Check controllability and observability of the following systems. 10

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

$$y = [1 \quad 0]\, x$$

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

$$y = [10 \quad 0 \quad 0]x$$
