

(3 Hours)

[Total Marks : 80]

- N. B. :** (1) Questions No. 1 is compulsory.
 (2) Attempt any **three** questions from remaining **five** question.
 (3) Assume suitable data if needed.



1. Attempt the following :-

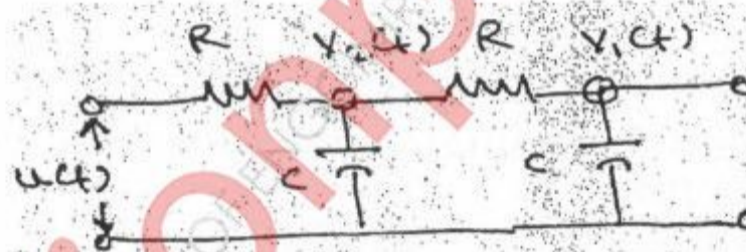
- Why there is a need of compensation? Compare cascade compensation with feedback compensation.
- Explain the advantages of modern control system with traditional control system.
- State the properties of state transition matrix also state the properties of jordan matrix.
- Derive transfer function of a state model. Also draw the block diagram representation of a state model.

2. (a) Construct state models of the following system :-

(i) $\frac{(s+1)}{s^2+5s+6}$ use phase variable method. 3

(ii) $\ddot{y} + 6\dot{y} + 11y = u$ use canonical method. 3

(iii)



Assume :
 $R = 1 \text{ M } \Omega$
 $C = 1 \mu \text{ F}$

4

(b) Obtain the response of the system which is represented by the following state equation. 10

$$\dot{X} = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} X + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u$$

Assume initial state vector $x(0) = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$

3. (a) For the unit feedback controls system with PID controller is used to control the system. The plant transfer function is :- 10

$$G(s) = \frac{k}{(s+1)(s+5)}$$

Determine PID controller. Also obtain the PID compensater block $G_c(s)$.

[TURN OVER]

- (b) Check the following systems are completely controllable and observable :- 10

$$(i) \dot{X} = \begin{bmatrix} 0 & 0 & 0 \\ 1 & 0 & -3 \\ 0 & 1 & -4 \end{bmatrix} X + \begin{bmatrix} 40 \\ 10 \\ 0 \end{bmatrix} u$$

$$y = [0 \quad 0 \quad 1] X$$

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

$$y = [1 \quad -1] X$$

4. (a) A control system is represented by its open loop transfer function as : 10

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

Design lead compensator to meet the following specifications.
Peak overshoot = 20%
Setting time = 5 sec.

- (b) Consider a plant transfer function 10

$$G(s) = \frac{k}{(s+1)(s+5)}$$

Design state feedback gain matrix to meet the following specifications where:-
Damping ratio = 0.707
Settling time = 4.5 sec.

5. (a) Explain the design steps of lag-lead compensator using root locus. 10
(b) For a unity feedback system 10

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

Design a suitable compensator with the following specifications :-
 $K_v = 12 / \text{sec}$
Phase margin $\phi_m = 40^\circ$

6. (a) Design an observer for the plant :- 10

$$G(s) = \frac{10(s+2)}{s(s+4)(s+6)}$$

Desired observer poles are : -4.5, -4.5

- (b) Explain the design steps of lead compensator using Bode plot. 10