TE-II / Control System design / INST

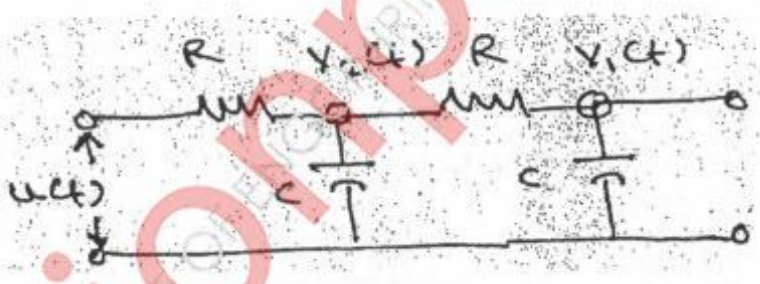
04-12-14

QP Code : 14939

(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 :– **20**
   (a) Why there is a need of compensation? Compare cascade compensation with feedback compensation.
   (b) Explain the advantages of modern control system with traditional control system.
   (c) State the properties of state transition matrix also state the properties of jordon matrix.
   (d) 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) $\dddot{y}+6\ddot{y}+11\dot{y}+6y=u$ use canonical method. **3**
   (iii) 

   Assume :
   $R = 1\ M\Omega$
   $C = 1\ \mu F$ **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 Gc(s).

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(b) Check the fllowing 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 compensater 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 / sec
Phase margin $\varphi_m = 40°$

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) Exlain the design steps of lead compensator using Bode plot. 10
