

6E3109

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B. Tech. VI Semester (Main/Back) Exam. May/June 2013

ELECTRICAL ENGINEERING # 6EEO

MODERN CONTROL THEORY

Time : 3 Hours

Min. Passing Marks : 24

Maximum Marks : 80

Instruction to Candidates :

Attempt any five questions, selecting one question from each unit. All questions carry equal marks. (Schematic diagrams must be shown wherever necessary. Any data you feel missing suitably be assumed and stated clearly. Units of quantities used/calculated must be stated clearly.)

Unit-I

1. Define the following
 - (i) Linearity [3]
 - (ii) Relaxedness [3]
 - (iii) Time Invariance [3]
 - (iv) Causality [3]
 - (v) Linear vector space linear independence [4]

OR

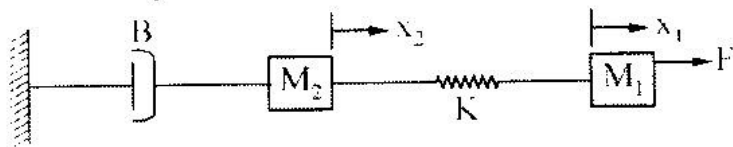
- (a) Derive the solution of homogeneous state equation. [8]
- (b) Consider the homogeneous equation. $\Delta X = 0$

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

Find the linearly independent solution of this equation. [8]

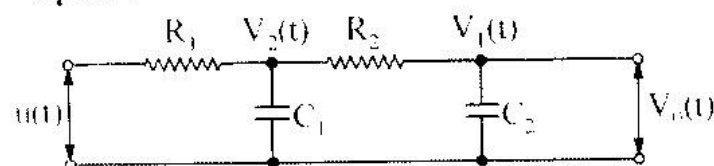
Unit-II

2. (a) What are the advantages and disadvantages of state space analysis. [8]
- (b) Draw the free body diagram and write the differential equation of the mechanical system shown in figure 1. [8]



OR

- (a) What are state variables? Give the advantages of modern control theory over conventional control theory. [8]
- (b) For the system shown in figure 2, choose the state variable as $v_1(t)$ and $v_2(t)$ and write down the state equation. [8]



Unit-III

3. (a) Explain the procedure to convert a given state model into signal flow graph. [8]
- (b) Obtain the transfer function if state model is given by.

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$

$$Y = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} \quad [8]$$

OR

- (a) Explain cascade and parallel decomposition in brief. [6]
- (b) Construct the state model in Jordan's canonical form for a system whose transfer is given by

$$\frac{Y(s)}{X(s)} = \frac{10}{(s+1)^2(s+2)} \quad [10]$$

Unit-IV

4. (a) Define diagonalization. Explain its importance in modern control theory. [8]
- (b) Define the following: [8]
 - (i) Eigen values (ii) Eigen vectors
 - (iii) State of a system (iv) State transition matrix

OR

- (a) State the duality between controllability and observability. [8]
- (b) Consider the state equation.

$$\begin{bmatrix} \dot{x}_1(t) \\ \dot{x}_2(t) \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} \begin{bmatrix} x_1(t) \\ x_2(t) \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t)$$

Obtain the state transition matrix. [8]

Unit-V

5. (a) What are the properties of z-transform? Find the relationship between z and s domain. [8]
- (b) Find the z-transform of $\{u_n\}$ where

$$\{u_n\} = \begin{cases} 4^n & \text{if } n < 0 \\ 3^n & \text{if } n \geq 0 \end{cases} \quad [8]$$

OR

- (a) What is sampling process? Write short note on digital PID controller. [8]
- (b) Find the z-transform of the following

$$(i) \frac{a}{(s-a)^2} \quad (ii) e^{-at} \sin \omega t$$

by using the property of z-transform. [8]