6E3109

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

ELECTRICAL ENGINEERING # 6EE1

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.
AX = 0

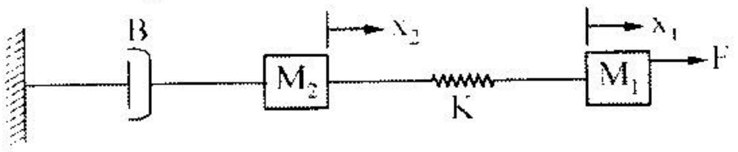
$$\text{Where } A = \begin{bmatrix} 0 & 1 & 1 & 2 & -1 \\ 1 & 2 & 3 & 4 & -1 \\ 2 & 0 & 2 & 0 & 2 \end{bmatrix}$$

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

Unit-'II'

2. (*a*) What are the advantages and disadvantages of state space analysis. [8]

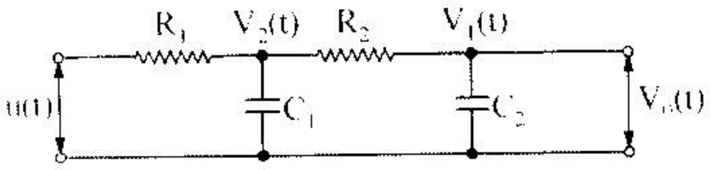
(*b*) Draw the free body diagram and write the differential equation of the mechanical system shown in figure 1. [8]



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.

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

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

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

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

OR

(*a*) What is sampling process? Write short note on digital PID controller. [8]

(*b*) Find the z-transform of the following

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

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