UNIT-2

(Lecture-3)

Vector matrix representation of state equation

In vector-matrix form

$$\dot{x} = Ax + Bu \qquad (1)$$

where

$$\dot{x} = \begin{bmatrix} dq/dt \\ di/dt \end{bmatrix} \quad A = \begin{bmatrix} 0 & 1 \\ -1/LC & -R/L \end{bmatrix}$$

$$x = \begin{bmatrix} q \\ i \end{bmatrix} \qquad B = \begin{bmatrix} 0 \\ 1/L \end{bmatrix} \qquad u = v(t)$$

$$y = Cx + Du \qquad (2)$$

where

$$y = v_L(t) \qquad C = \begin{bmatrix} -1/C & -R \end{bmatrix} \qquad D = 1$$

General State Representation

$$\dot{x} = Ax + Bu$$ State equation

$$y = Cx + Du$$ output equation

x = state vector

$\dot{x}$ = derivative of the state vector with respect to time

y = output vector

u = input or control vector

A = system matrix

B = input matrix

C = output matrix

D = feedforward matrix

Some definitions

- **System variable : any variable that responds to an input or initial conditions in a system**
- **State variables : the smallest set of linearly independent system variables such that the values of the members of the set at time t_0 along with known forcing functions completely determine the value of all system variables for all $t \geq t_0$**
- **State vector : a vector whose elements are the state variables**
- **State space : the n-dimensional space whose axes are the state variables**
- **State equations : a set of first-order differential equations with b variables, where the n variables to be solved are the state variables**
- **Output equation : the algebraic equation that expresses the output variables of a system as linear combination of the state variables and the inputs.**

Graphic representation of state space and a state vector