

## WORKSHEET

1. Consider the system described by

$$\dot{x} = \begin{bmatrix} -4 & -1 \\ 3 & -1 \end{bmatrix} x + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u$$

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

Obtain the transfer function of the system

2. Consider the following transfer function system

$$\frac{y(s)}{u(s)} = \frac{s + 6}{s^2 + 5s + 6}$$

Obtain the state-space representation of this system in

- a. Controllable canonical form
  - b. Diagonal canonical form
3. Consider the network of Figure-1.1 with initial conditions  $i_L(0) = 1$  and  $v_C(0) = 0$ . The input, the state variables, and the output of the network are shown in Figure-1.2. Determine
- a. A state space description
  - b. The state transition matrix using
  - c. The solution of zero input response
  - d. The state transition equation
  - e. The output of the system

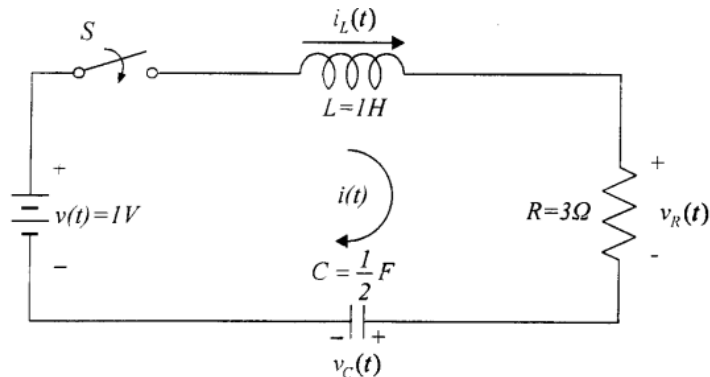


Figure-1.1 RLC network

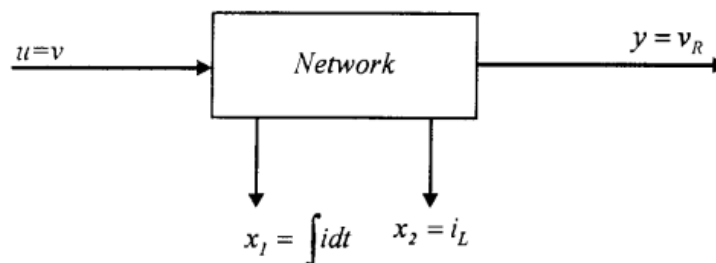


Figure-1.2 the input, the state variables, and the output of the network.

4. For the following state space representation of the system

$$\dot{x} = \begin{bmatrix} 0 & 1 & 0 \\ 1 & -3 & 2 \\ 0 & \beta & -1 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \\ -1 \end{bmatrix} u$$
$$y = [1 \quad 0 \quad 0]x$$

Examine the controllability and observability of the system.

5. For the following state space representation of the system

$$\dot{x} = \begin{bmatrix} 0 & 1 \\ 2 & 1 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$
$$y = [1 \quad -2]x$$

Examine the BIBO stability, internal stability, controllability and observability of the system

6. Consider

$$\dot{x} = \begin{bmatrix} -1 & 10 \\ 0 & 1 \end{bmatrix} x + \begin{bmatrix} -2 \\ 0 \end{bmatrix} u$$
$$y = [-2 \quad -3]x - 2u$$

Is it BIBO stable?

Is it internally stable?

7. Consider a system, where

$$A = \begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix} \text{ and } B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$$

The closed-loop system has eigenvalues -1 and -1.5, find the control gain matrix using

- Transformation method
- Direct substitution method

8. Consider the system, where

$$A = \begin{bmatrix} 1 & 1 & 0 \\ 0 & 1 & 1 \\ -1 & 2 & 1 \end{bmatrix} \quad B = \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix} \quad C = [0 \quad 0 \quad 1]$$

Using direct substitution method, Design a full-order state observer, such that the observer poles are located at -1, -2