EE 310 - LAB 3

State Variables

Step1:

Consider the circuit in Figure 1, Determine the state-Space representation of the circuit.

Where v_s is the input and i_x is the output. Take $R = 1\Omega, C = 0.25\ F, and\ L = 0.5\ H.$

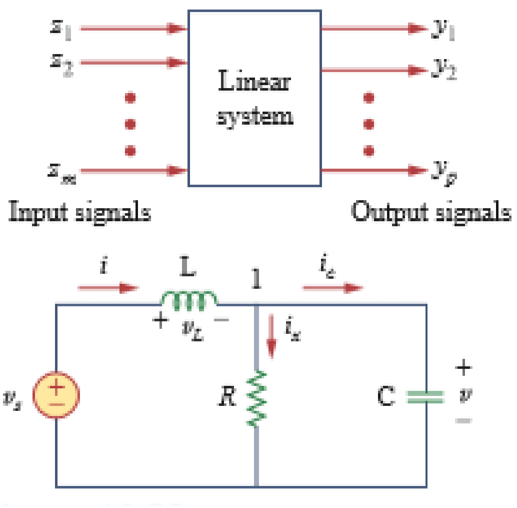


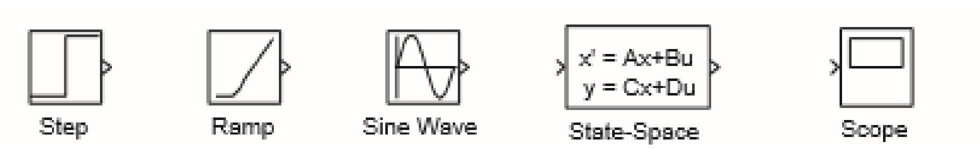
Figure 1

Step2:

We want to use Simulink for simulating the state space model found in step1.

a) Use **step input signal** and find simulation results
b) Use **ramp input signals** and find simulation results
c) Use **sinusoidal input signal** and find simulation results.

HINT: Use the following blocks in the Simulink Library Browser



$$\dot{\boldsymbol{x}} = \boldsymbol{Ax} + \boldsymbol{Bz}$$

$$\boldsymbol{y} = \boldsymbol{Cx} + \boldsymbol{Dz}$$

Solution of first model:

Solution:

We select the inductor current i and capacitor voltage v as the state variables.

$$v_L = L\frac{di}{dt} \quad \textbf{(16.10.1)}$$

$$i_C = C\frac{dv}{dt} \quad \textbf{(16.10.2)}$$

Applying KCL at node 1 gives

$$i = i_x + i_C \quad \rightarrow \quad C\frac{dv}{dt} = i - \frac{v}{R}$$

or

$$\dot{v} = -\frac{v}{RC} + \frac{i}{C} \quad \textbf{(16.10.3)}$$

since the same voltage v is across both R and C. Applying KVL around the outer loop yields

$$v_s = v_L + v \quad \rightarrow \quad L\frac{di}{dt} = -v + v_s$$

$$\dot{i} = -\frac{v}{L} + \frac{v_s}{L} \quad \textbf{(16.10.4)}$$

Equations (16.10.3) and (16.10.4) constitute the state equations. If we regard i_x as the output,

$$i_x = \frac{v}{R} \quad \textbf{(16.10.5)}$$

Putting Eqs. (16.10.3), (16.10.4), and (16.10.5) in the standard form leads to

$$\begin{bmatrix} \dot{v} \\ \dot{i} \end{bmatrix} = \begin{bmatrix} \frac{-1}{RC} & \frac{1}{C} \\ \frac{-1}{L} & 0 \end{bmatrix} \begin{bmatrix} v \\ i \end{bmatrix} + \begin{bmatrix} 0 \\ \frac{1}{L} \end{bmatrix} v_s \quad \textbf{(16.10.6a)}$$

$$i_x = \begin{bmatrix} \frac{1}{R} & 0 \end{bmatrix} \begin{bmatrix} v \\ i \end{bmatrix} \quad \textbf{(16.10.6b)}$$