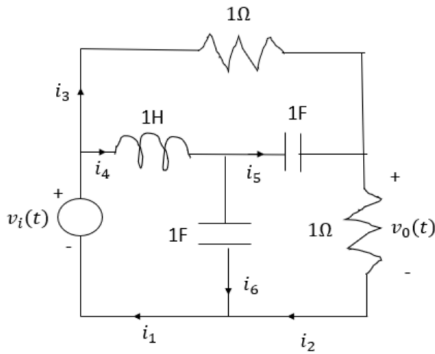


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Problem 3: [10 points] Find the state-space representation of the network shown below if the output is $v_0(t)$. Use the branch currents as labeled in your analysis.



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Expert Answer (1)


Usha Kumari answered this
 282 answers

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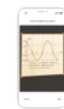
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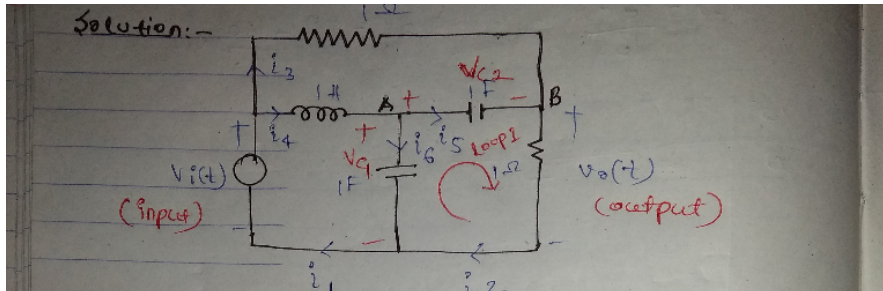


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Solution:-



This circuit consists of one inductor and 2 capacitors. So, it is a 3rd order system

state variables - i_4 (current through inductor)
 $-V_{c1}$ (voltage across capacitor 1)
 $-V_{c2}$ (voltage across capacitor 2)

Apply KCL at node A:-

$$i_6 - i_4 + i_5 = 0$$

$$C_1 \frac{dV_{c1}}{dt} - \frac{1}{L} \int (V_i(t) - V_{c1}(t)) dt + C_2 \frac{dV_{c2}}{dt} = 0$$

$$\Rightarrow C_1 \frac{dV_{c1}}{dt} - i_4 + C_2 \frac{dV_{c2}}{dt} = 0 \quad \text{--- (I)}$$

Apply KCL at B.

$$\frac{V_o(t) - V_i(t)}{R} - C_2 \frac{dV_{c2}}{dt} + \frac{V_o(t)}{R} = 0$$

$$\Rightarrow V_o(t) - V_i(t) - \frac{dV_{c2}}{dt} + V_o(t) = 0$$

$$\Rightarrow 2V_o(t) = V_i(t) + \frac{dV_{c2}}{dt} \quad \text{--- (II)}$$

Write KVL in loop I.

$$V_{c1} - V_{c2} - V_o(t) = 0$$

$$\Rightarrow V_o(t) = V_{c1} - V_{c2} \quad \text{--- (III)}$$

put (III) in (II)

$$2V_{c1} - 2V_{c2} = V_i(t) + \frac{dV_{c2}}{dt}$$

$$\Rightarrow \frac{dV_{c2}}{dt} = 2V_{c1}(t) - 2V_{c2}(t) - V_i(t)$$

$$\Rightarrow V_{C2} = 2V_{C1(t)} - 2V_{C2(t)} - V_i(t)$$

put (iv) in (i)

$$\frac{dV_{C1}}{dt} - i_4 + 2V_{C1(t)} - 2V_{C2(t)} - V_i(t) = 0$$

$$\Rightarrow \dot{V}_{C1} = i_4 - 2V_{C1(t)} + 2V_{C2(t)} + V_i(t) \quad \text{--- (v)}$$

Now $i_4 = \frac{1}{L} \int [V_i(t) - V_{C1(t)}] dt$

$$\frac{d i_4}{dt} = \frac{1}{L} (V_i(t) - V_{C1}(t))$$

$$\dot{i}_4 = V_i(t) - V_{C1}(t) \quad \text{--- (vi)}$$

using (iv), (v) and (vi)

$$\begin{bmatrix} \dot{V}_{C1} \\ \dot{V}_{C2} \\ \dot{i}_4 \end{bmatrix} = \begin{bmatrix} -2 & 2 & 1 \\ 2 & -2 & 0 \\ -1 & 0 & 0 \end{bmatrix} \begin{bmatrix} V_{C1} \\ V_{C2} \\ i_4 \end{bmatrix} + \begin{bmatrix} 1 \\ -1 \\ 1 \end{bmatrix} V_i(t)$$

State-space equations Ans

Now o/p equations \therefore using (iii)

$$V_o(t) = \begin{bmatrix} 1 & -1 & 0 \end{bmatrix} \begin{bmatrix} V_{C1} \\ V_{C2} \\ i_4 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix} V_i(t)$$

Ans

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Up next for you in Electrical Engineering

j5.6 ohm and $Z_2 = 8 - j16$ ohm and a single phase

4. Two impedances $Z_1 = 0.8 + j5.6\Omega$ and $Z_2 = 8 - j16\Omega$ and a single phase motor are connected in parallel across a 200-V rms, 60-Hz supply. If the motor draws 5 kVA at 0.8 lagging P.F.

- Draw the schematic of the system.
- Find the complex powers for two impedances and motors (S1,S2,S3).
- Determine the total power taken from the supply, the supply current, and the overall power factor seen from the source.
- A capacitor is connected in parallel with the loads, find the KVAR and the capacitance in μF to improve the overall power factor to unity. What is the new line current?

[See answer](#)

j5.6 2 and $Z_2 = 8 - j16$ 12, and

Two impedances, $Z_1 = 0.8 + j5.6\Omega$ and $Z_2 = 8 - j16\Omega$, and a single-phase motor are connected in parallel across a 200-V rms, 60-Hz supply as shown in Figure. 5. The motor draws 5 kVA at 0.8 power factor lagging.

Figure 5: Single-phase Circuit with Motor Load

[See answer](#)

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Q: Problem 3: (10 points) Find the state-space representation of the network shown below if the output is $v_o(t)$. Use the branch currents as labeled in your analysis. 112 1H 1F $v_i(t)$ (E in 3 $v_o(t)$)

A: [See answer](#)

Q: 7. A ball thrown vertically upward is caught by the thrower after 2.00 s. Find (a) the initial speed of the ball and (b) the maximum height the ball reaches See Diagram below: $t = 2.00$ s Show your work below:

A: [See answer](#)

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