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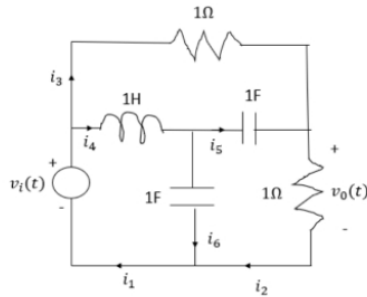
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Question: Problem 3: (10 points) Find the state-space representation of th...



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.



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Expert Answer 

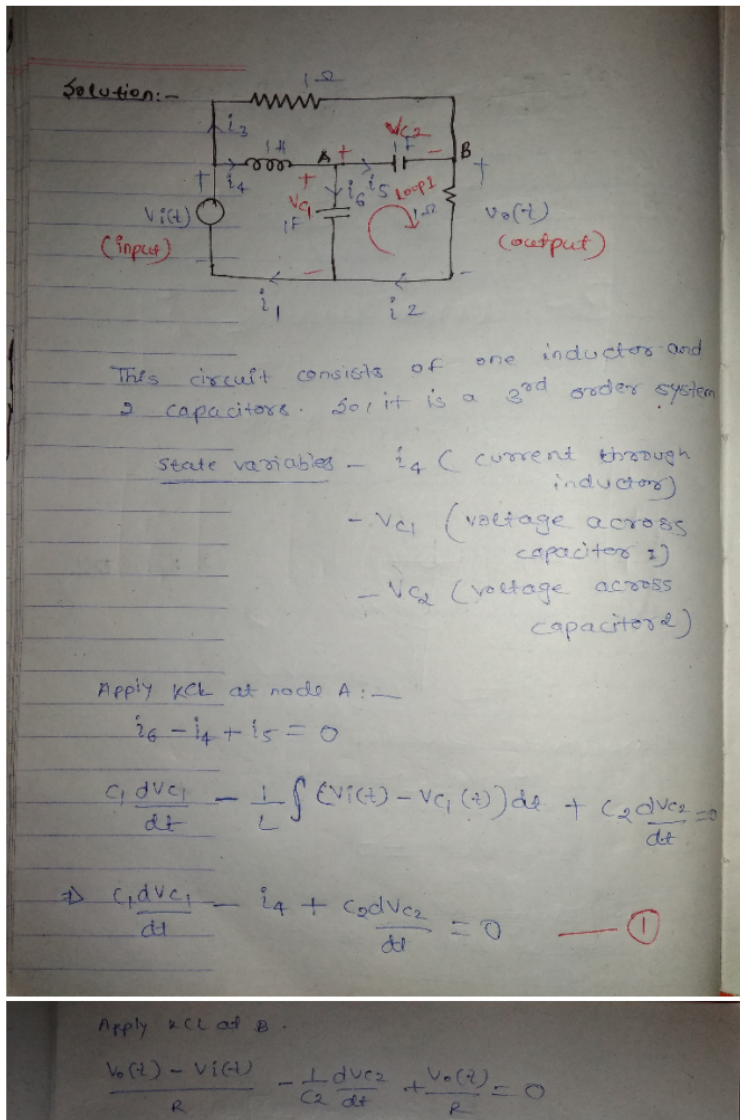


Usha Kumari answered this
282 answers

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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:-
 $i_6 - i_4 + i_5 = 0$

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

$$\Rightarrow C_1 \frac{dV_{c1}}{dt} - i_4 + C_2 \frac{dV_{c2}}{dt} = 0 \quad \text{--- (1)}$$

Apply KCL at B:-
 $\frac{V_o(t) - V_i(t)}{R} - \frac{1}{C_2} \frac{dV_{c2}}{dt} + \frac{V_o(t)}{R} = 0$

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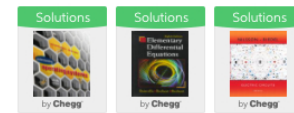
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$$\Rightarrow v_o(t) - v_i(t) - \frac{dv_{C2}}{dt} + v_o(t) = 0$$

$$\Rightarrow 2v_o(t) = v_i(t) + \frac{dv_{C2}}{dt} \quad \text{--- (ii)}$$

Write KVL in loop 1.

$$v_{C1} - v_{C2} - v_o(t) = 0$$

$$\Rightarrow v_o(t) = v_{C1} - v_{C2} \quad \text{--- (iii)}$$

put (iii) in (ii)

$$2v_{C1} - 2v_{C2} = v_i(t) + \frac{dv_{C2}}{dt}$$

$$\Rightarrow \frac{dv_{C2}}{dt} = 2v_{C1}(t) - 2v_{C2}(t) - v_i(t)$$

$$\Rightarrow \dot{v}_{C2} = 2v_{C1}(t) - 2v_{C2}(t) - v_i(t) \quad \text{--- (iv)}$$

put (iv) in (i)

$$\frac{dv_{C1}}{dt} - i_4 + 2v_{C1}(t) - 2v_{C2}(t) - v_i(t) = 0$$

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

$$\text{Now } i_4 = \frac{1}{L} \int [v_i(t) - v_{C1}(t)] dt$$

$$\frac{di_4}{dt} = \frac{1}{L} (v_i(t) - v_{C1}(t))$$

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

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

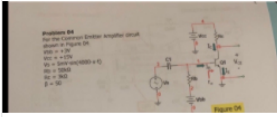
Now o/p equations: using (iii)

$$v_o(t) = \begin{bmatrix} 1 & -1 & 0 \end{bmatrix} \begin{bmatrix} v_{C1} \\ v_{C2} \\ i_4 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix} v_i(t)$$

Ans

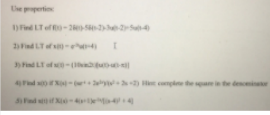
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Problem 04 For the Common Emitter Amplifier circuit shown in Figure 04 $V_{bb} = +3V$ $V_{cc} = +15V$ $V_s = 5mV$ -si...



[See answer](#)

LT= laplace transform



[See answer](#)

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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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