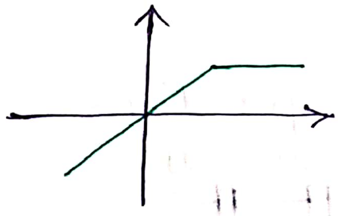
BE Mid Sem Exam - 2023 Rubrics

SOL(1): Condition: When V-I characteristic passes through origin (0,0) then—

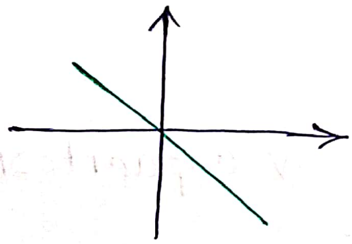
(1) If $\left(\frac{V}{I}\right) = (+ve)$ in both co-ordinate then the elements are Passive.

(2) If $\left(\frac{V}{I}\right) = (-ve)$ either in one co-ordinate or in both co-ordinate then the elements are Active.

(3) If V-I characteristic is symmetric in opposite co-ordinate then the elements are Bidirectional otherwise Unidirectional.



* Passive
* Unidirectional
* Non-linear → (1 Point)



* Active
* Bidirectional
* Linear → (1 Point)

SOL(2): According to the circuit condition— There will be spark in switch (S_2) at time $t = (t_0 + \Delta t_0)$ sec.

→ (2 Point)

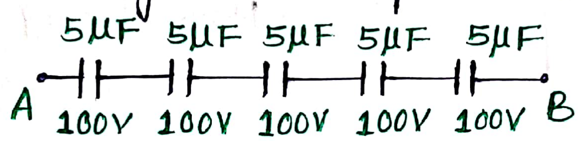
SOL(3): At steady state/after long time —

* Inductor behave as a short circuit.
* Capacitor behave as a open circuit.

There will be no effect in current 'I' because if ideal current source is in series with variable R, L or C then there will be no effect on current value (either you increase or decrease the value of R, L or C). → (2 Point)

$\therefore I = 1\,A$ → (1 Point)

SOL(4): According to the question —

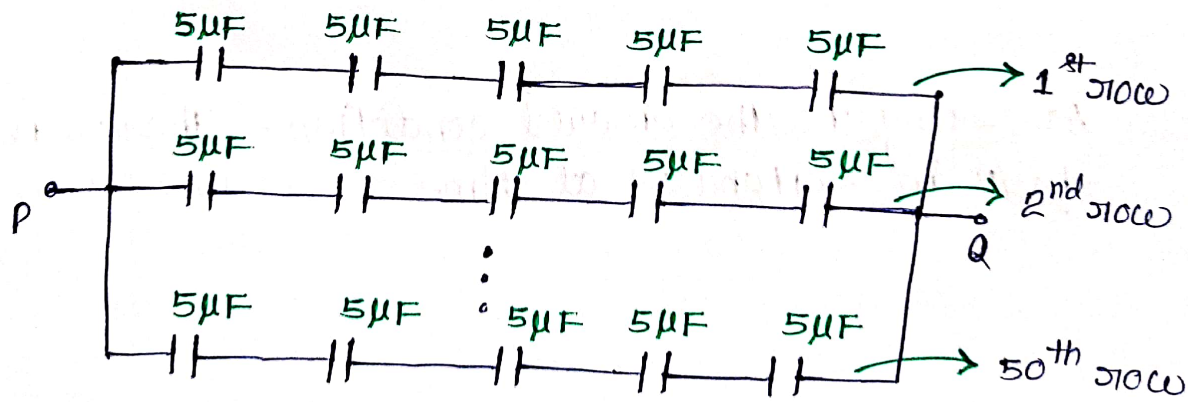


$V_{AB} = 5 \times 100V = 500V$

$C_{AB} = 5 \times \frac{1}{5} = 1\,\mu F$

Hence to get 50μF, 500V capacitor, we required 50 such combination.

$\therefore$



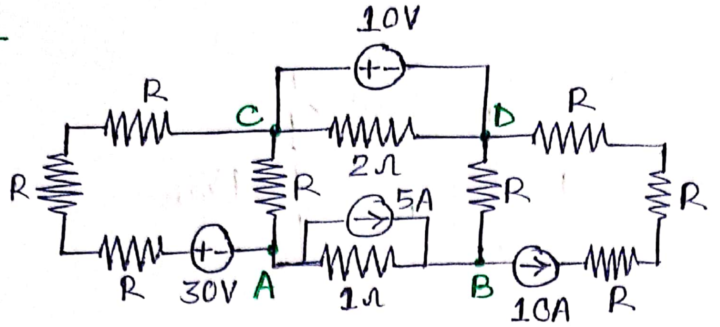
$\therefore V_{PQ} = 5 \times 100 = 500V$ → (1.5 Point)

$\therefore C_{PQ} = 50 \times (5 \times \frac{1}{5}) = 50\,\mu F$

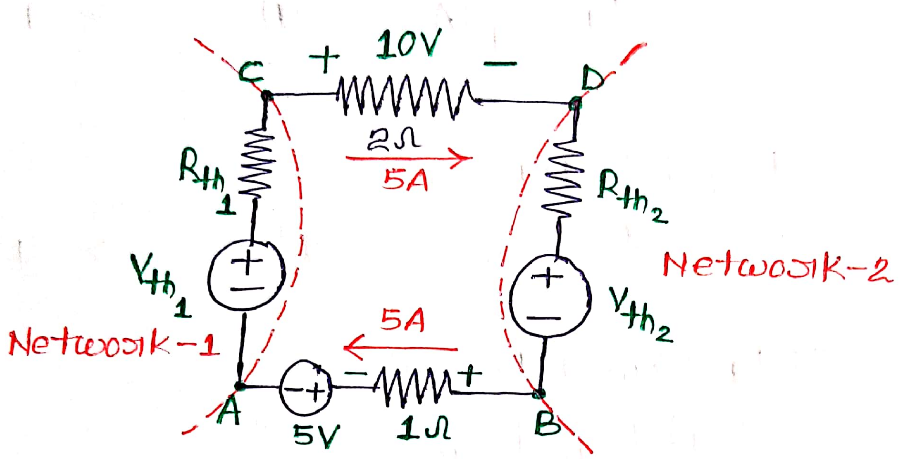
$\therefore$ Total no of capacitors required of value 5μF, 100V

$= 5 \times 50 = 250$ Capacitors → (1.5 Point)

SOL(5):-



The above circuit can be redrawn as —



→ (2 Point)

The current entering & leaving any network must be same. (By KCL)

$\therefore\ I_{CD} = \left(\frac{10}{2}\right) = 5A$ (current entering in Network-2) → (1 Point)

$\therefore\ I_{BA} = 5A$ (current leaving from Network-2) → (1 Point)

By above circuit —

$$V_{AB} = -5-(5\times1) = -10\,V$$

$\therefore\ V_{AB} = (-10)$ Volt → (2 Point)

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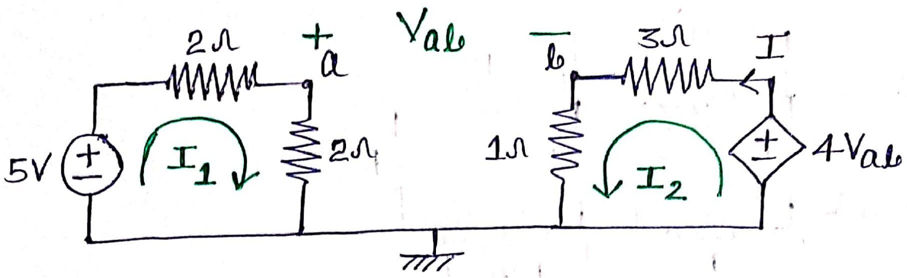
SOL(6):



In Mesh-1 — $-5+(2+2)I_1=0$

$I_1=\left(\frac{5}{4}\right)A$ — (1) → (1 Point)

In Mesh-2 — $-4V_{ab}+(3+1)I_2=0$

$I_2=V_{ab}$ — (2) → (1 Point)

By circuit — $-2I_1+V_{ab}+I_2=0$

$-2(5/4)+V_{ab}+V_{ab}=0$

$\therefore V_{ab}=1.25$ Volt → (2 Point)

$\therefore I = I_2 = V_{ab} = 1.25\,A$ → (2 Point)

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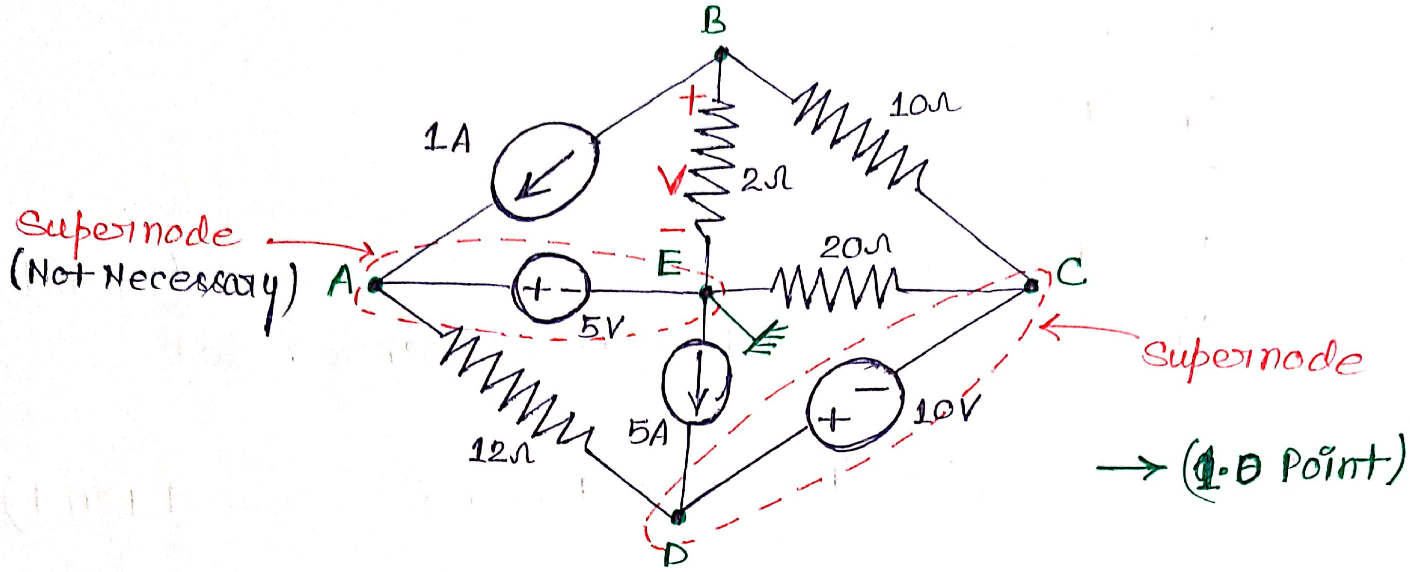
SOL(7):-



→ (1.0 Point)

at Node B —

$$\frac{V_B - V_C}{10} + \frac{V_B - V_E}{2} + 1 = 0 \qquad (\because V_E = 0)$$

$$V_B - V_C + 5V_B + 10 = 0$$

$$6V_B - V_C = -10 \quad \text{—— (1)} \quad \rightarrow \text{(1 Point)}$$

at Node A & E (By Supernode) — (Not necessary)

$$\frac{V_A - V_D}{12} - 1 + \frac{V_E - V_B}{2} + 5 + \frac{V_E - V_C}{20} = 0 \qquad (\because V_E = 0)$$

$$\frac{V_A - V_D}{12} - \frac{V_B}{2} - \frac{V_C}{20} = -4$$

$$5V_A - 5V_D - 30V_B - 3V_C = -240$$

$$5V_A - 30V_B - 3V_C - 5V_D = -240 \quad \text{—— (2)}$$

at Node C & D (By Supernode) —

$$\frac{V_C - V_B}{10} + \frac{V_C - V_E}{20} + \frac{V_D - V_A}{12} - 5 = 0 \qquad (\because V_E = 0)$$

$$\frac{V_C - V_B}{10} + \frac{V_C}{20} + \frac{V_D - V_A}{12} = 5$$

$$6V_C - 6V_B + 3V_C + 5V_D - 5V_A = 300$$

$$-5V_A - 6V_B + 9V_C + 5V_D = 300 \quad \text{—— (3)} \quad \rightarrow \text{(1 Point)}$$

$$V_D - V_C = 10 \quad \text{—— (4)} \quad \rightarrow \text{(0.5 Point)}$$

$$V_A - V_E = 5$$

$$V_A = 5 \quad \text{—— (5)} \quad \rightarrow \text{(0.5 Point)}$$

After solving eqⁿ (1), (2), (3), (4) & (5), we get —

$V_A = 5$ Volt

$V_B = 1.73$ Volt

$V_D = 30.38$ Volt

$V_C = 40.38$ Volt → (1 Point)

$V_E = 0$ Volt (Taking as reference node)

$\therefore\ V = (V_B - V_E) = (1.73 - 0) = 1.73$ Volt → (1 Point)

SOL(B):- In duality—

$R \leftrightarrow G$

$L \leftrightarrow C$

$V \leftrightarrow I$

$KVL \leftrightarrow KCL$

Series $\leftrightarrow$ Parallel

Loop(Mesh) $\leftrightarrow$ Node

$Z \leftrightarrow Y$

$\frac{dV}{dt} \leftrightarrow \frac{dI}{dt}$

$\int V dt \leftrightarrow \int I dt$

→ (1 Point)

Short Trick to draw dual Network—

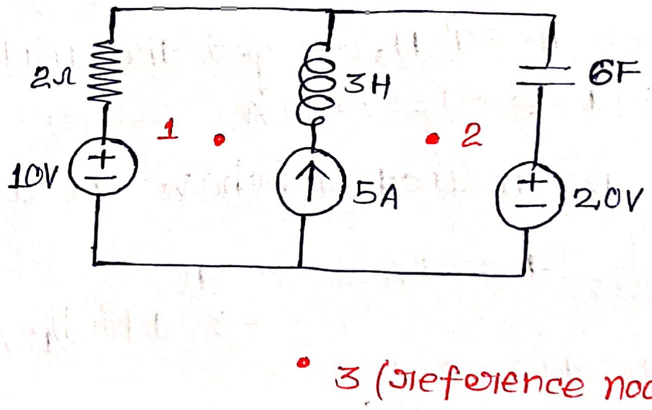
(1) When voltage source circulate current in CW direction, then the arrow mark of the current source is indicated towards respective node.

(2) When current source circulate current in CW directi. then the (+ve) sign of the voltage source is assigned to respective node.

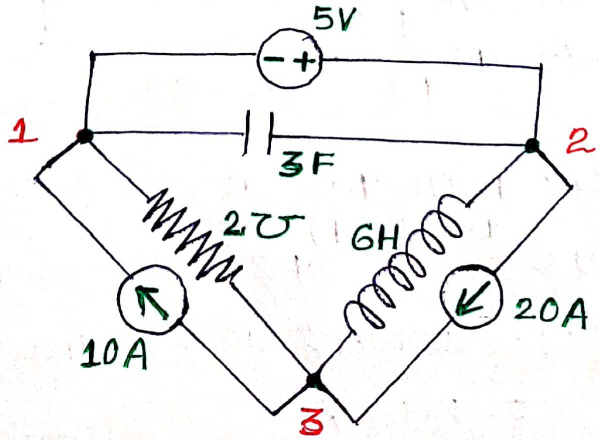
Alternate Method to draw dual Network—

Write down the equations from given network & convert them according to the properties of duality & finally draw the network.

Given Network—



Dual Network—

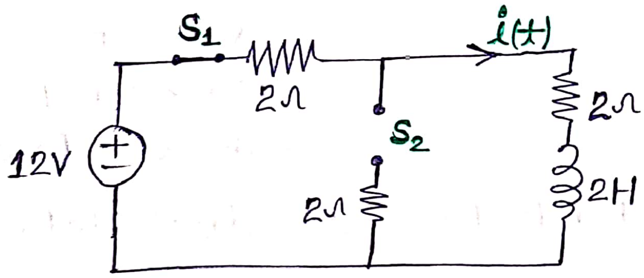


→ (5 Point)

SOL(9):-

Step(I): $0 < t < 4$ sec [S_1 is closed & S_2 is open]

Current through Inductor,



$$i(t) = \frac{V}{R}\left[1 - e^{-t/\tau}\right]$$

$$= \left(\frac{12}{4}\right)\left[1 - e^{-t/0.5}\right]$$

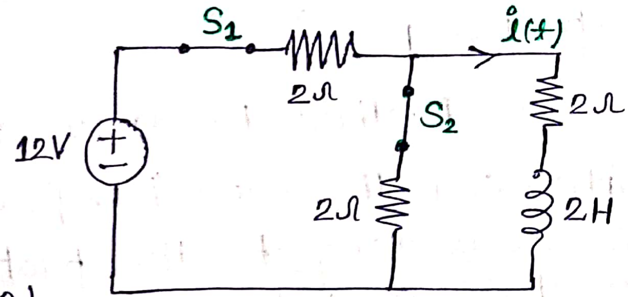
$$= 3\left[1 - e^{-2t}\right] \quad \text{—— (1)}$$

$$\therefore \tau = \left(\frac{L}{R}\right) = \left(\frac{2}{2+2}\right) = 0.5 \text{ sec}$$

→ (1 Point)

Step(II): $t > 4$ sec [S_1 & S_2 both are closed]

Current through Inductor,



$$i(t) = \left[i(0^+) - i(\infty)\right]e^{-t/\tau} + i(\infty)$$

$$= \left[i(4) - i(\infty)\right]e^{-(t-4)/\tau} + i(\infty) \quad \text{—— (2)}$$

$$\therefore \tau = \frac{L}{R} = \left(\frac{2}{2+1}\right) = \frac{2}{3} \text{ sec}$$

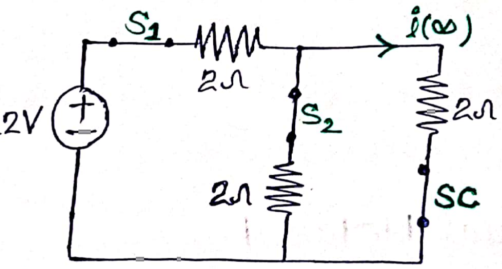
→ (1 Point)

Put $t = 4$ sec in eq^n (1), we get the initial current,

$i(0^+) = i(4) = 3(1 - e^{-8}) = 2.99$ A —— (3) → (1 Point)

at $t = \infty$, the inductor behave as a short circuit.

$\therefore i(\infty) = \left(\frac{2}{2+2}\right)4 = 2A$ —— (4) → (1 Point)



By eq^n (2), (3) & (4), we get—

$$i(t) = (2.99 - 2)\,e^{-3(t-4)/2} + 2$$

$$i(t) = 0.99\,e^{-1.5(t-4)} + 2 \quad \text{—— (5)}$$

→ (1 Point)

$\therefore$ current across inductor at $t = 5$ sec,

$$i(5) = 0.99\,e^{-1.5(5-4)} + 2 = 2.22 \text{ A}$$

$\therefore i(5) =$ Current across inductor (at $t = 5$sec)

$= 2.22$ A → (1 Point)