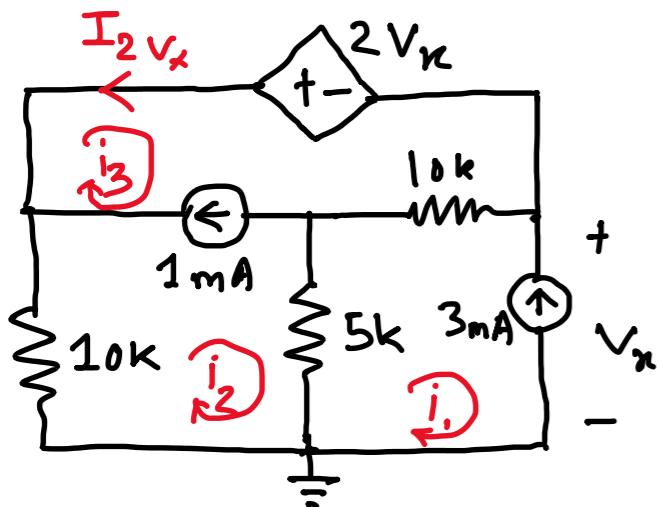


# Set A

Q-1(Mesh)

Monday, 25 November, 2024 8:14 AM

(a)



$$i_1 = -3 \text{ mA}$$

Supermesh KVL:

$$(10 + 5)i_2 + 10i_3 + 2 \times (-\frac{10}{3}i_2) - (10 + 5) \times (-3) = 0 \quad \textcircled{1}$$

Supermesh KCL:

$$i_3 - i_2 = 1 \quad \textcircled{2}$$

KVL along loop  $10k \rightarrow 2V_x \rightarrow 3mA$ :

$$10i_2 + 2V_x + V_x = 0$$

$$\Rightarrow V_x = -\frac{10}{3}i_2$$

Solving  $\textcircled{1}$  &  $\textcircled{2}$   $\Rightarrow i_2 = -3 \text{ mA}$   
 $i_3 = -2 \text{ mA}$

$$(b) P_{2V_x} = -I_{2V_x} \times 2V_x$$

$$= i_3 \times 2 \times \left(-\frac{10}{3}i_2\right)$$

$$= -(-2) \times 2 \times \frac{10}{3} \times (-3)$$

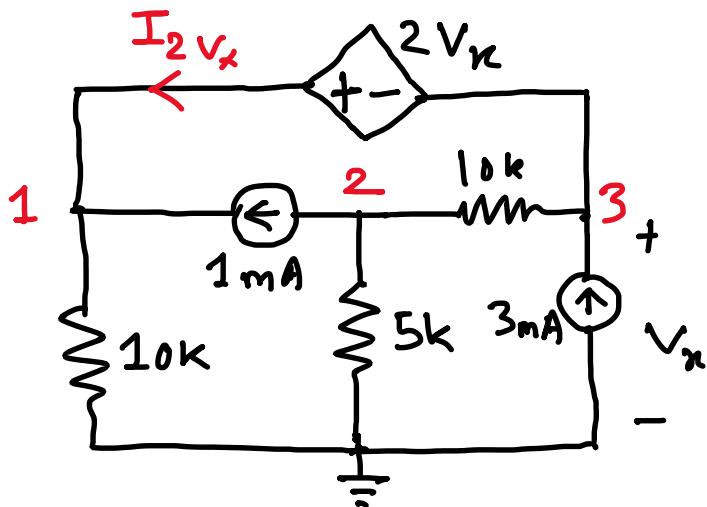
$$= -40 \text{ mW (Supplying)}$$

# Q-1(Node)

Monday, 25 November, 2024

7:36 AM

(a)



Supernode KCL (1 & 3) :

$$\frac{v_1}{10} + \frac{v_3 - v_2}{10} = 1 + 3$$

Supernode KV L :

$$v_1 - v_3 = 2v_x = 2v_3$$

$$\Rightarrow v_1 - 3v_3 = 0$$

KCL at '2' :

$$\frac{v_2}{5} + \frac{v_2 - v_3}{10} + 1 = 0$$

Solving,

$$v_1 = 30 \text{ V}$$

$$v_2 = 0 \text{ V}$$

$$v_3 = 10 \text{ V}$$

(b)

$$P_{2Vx} = -2v_x \times I_{2Vx}$$

$$= -(v_1 - v_3) \times \left[ \frac{v_1}{10} - 1 \right]$$

$$= -20 \times 2 = -40 \text{ mW}$$

(Supplying)

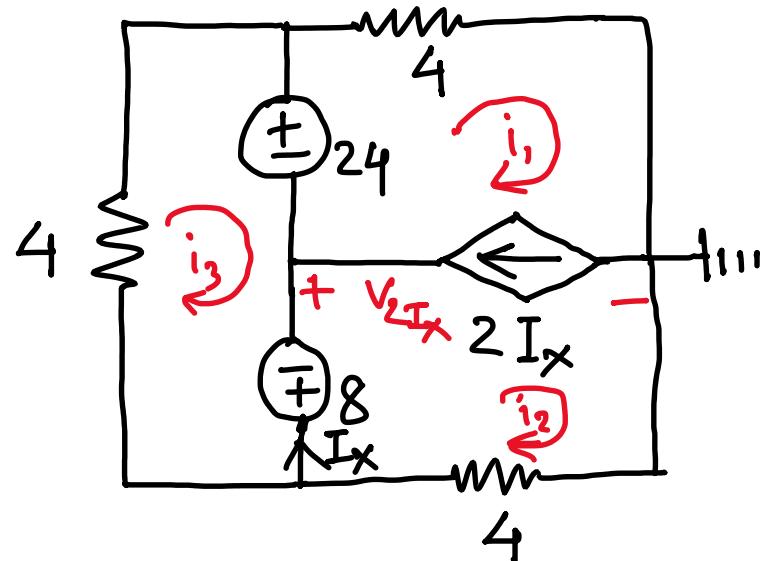
## Q-2(Mesh)

Monday, 25 November, 2024

7:20 AM

Supernode KVL:

(a)



$$4i_1 + 8 + 4i_2 - 24 = 0$$

$$\Rightarrow i_1 + i_2 = 4$$

Supernode KCL:

$$i_1 = 2I_x + i_2$$

$$\Rightarrow i_1 = 2(i_2 - i_3) + i_2$$

$$\Rightarrow i_1 - 3i_2 + 2i_3 = 0$$

Solving,

$$i_1 = 5 \text{ A}$$

3rd mesh KVL:

$$i_2 = -1 \text{ A}$$

$$4i_3 + 16 = 0$$

$$\Rightarrow i_3 = -4$$

$$(b) \text{ KVL in mesh 2} \rightarrow 8 + 4i_2 + V_{2I_x} = 0$$

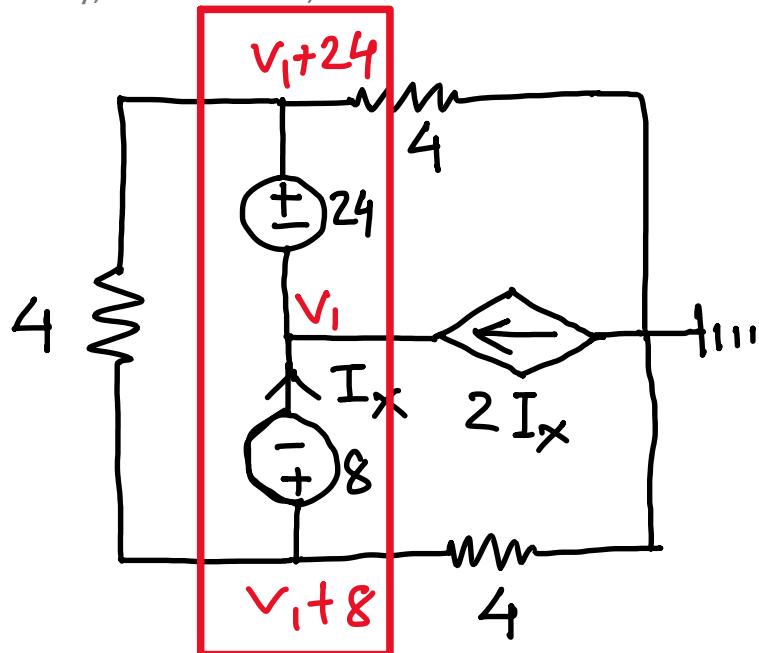
$$\Rightarrow V_{2I_x} = -8 - 4 \times (-1) = -4 \text{ V}$$

## Q-2(Nodal)

Monday, 25 November, 2024

7:11 AM

(a)



$$\text{KCL at } V_1+8,$$

$$\Rightarrow \frac{V_1+24 - (V_1+8)}{4} - \frac{V_1+8}{4} - I_x = 0$$

$$\Rightarrow I_x = 2 - \frac{V_1}{4}$$

KCL at supernode:

$$\frac{V_1+24}{4} + \frac{V_1+8}{4} - 2 \times \left(2 - \frac{V_1}{4}\right) = 0$$

$$\therefore V_1 = -4 \text{ V}$$

$\therefore$  Node voltages  $-4 \text{ V}$ ,  $4 \text{ V}$  &  $20 \text{ V}$ .

(b) Top node voltage of 4 ohm is higher ( $20 \text{ V}$ )

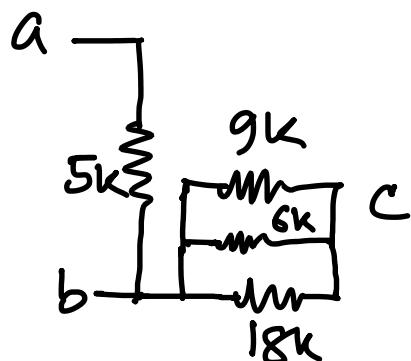
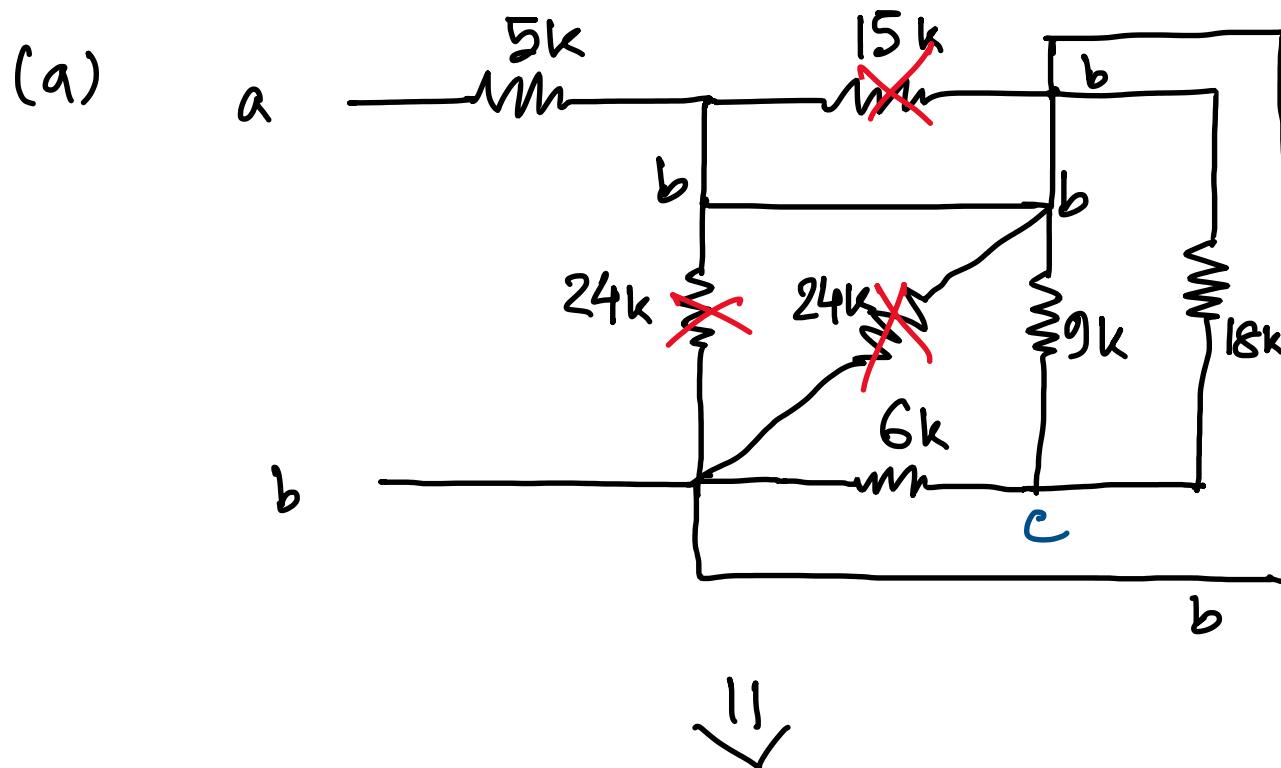
(c) Voltage of  $2I_x$  current source

$$= V_1 = -4 \text{ V}$$

### Q-3

Monday, 25 November, 2024

7:51 AM



$$\therefore R_{ab} = 5 \text{ k}\Omega$$

(b) (i) KVL  $\rightarrow V_y - 6 - 4 + (-2) + 12 - 9 - (-3) = 0$

$$\Rightarrow V_y = 6 \text{ V}$$

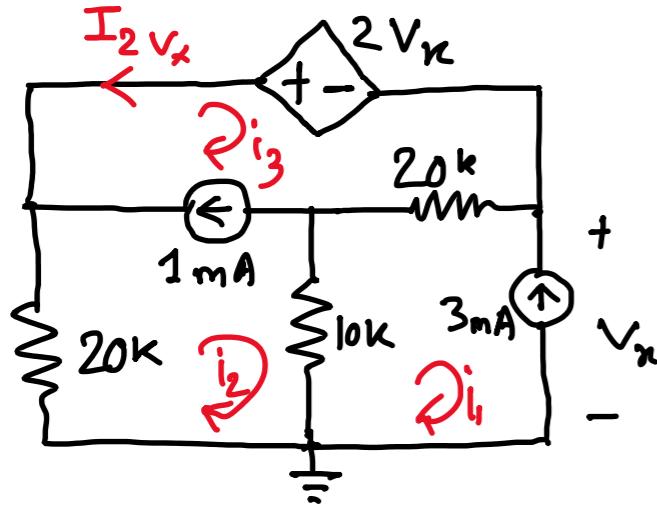
(ii) KVL  $\rightarrow -(-3) + V_y - 6 + V_{ab} - 9 = 0$

$$\Rightarrow V_{ab} = 12 - V_y = 6 \text{ V}$$

# Q-1(Mesh)

Monday, 25 November, 2024 8:14 AM

(a)



$$i_1 = -3 \text{ mA}$$

Supermesh KVL:

$$(20+10)i_2 + 20i_3 + 2 \times \left( \frac{20}{3} i_2 \right) - (10+20) \times (-3) = 0 \quad \textcircled{1}$$

Supermesh KCL:

$$i_3 - i_2 = 1 \quad \textcircled{2}$$

KVL along loop  $20k \rightarrow 2v_x \rightarrow 3mA$ :

$$20i_2 + 2v_x + v_x = 0$$

$$\Rightarrow v_x = -\frac{20}{3}i_2$$

Solving  $\textcircled{1}$  &  $\textcircled{2}$   $\Rightarrow i_2 = -3 \text{ mA}$   
 $i_3 = -2 \text{ mA}$

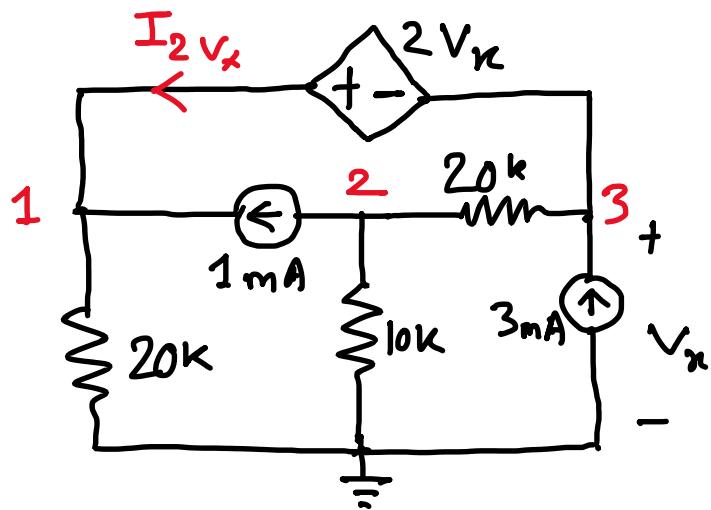
$$(b) P_{2v_x} = -I_{2v_x} \times 2v_x$$

$$= i_3 \times 2 \times \left( \frac{-20}{3} i_2 \right)$$

$$= (-2) \times 2 \times \left( \frac{-20}{3} (-3) \right)$$

$$= -80 \text{ mW (Supplying)}$$

(a)



Supernode KCL (1 &amp; 3) :

$$\frac{v_1}{20} + \frac{v_3 - v_2}{20} = 1 + 3$$

Supernode KVL :

$$v_1 - v_3 = 2v_x = 2v_3$$

$$\Rightarrow v_1 - 3v_3 = 0$$

KCL at '2' :

$$\frac{v_2}{10} + \frac{v_2 - v_3}{20} + 1 = 0$$

Solving,

$$v_1 = 60 \text{ V}$$

$$v_2 = 0 \text{ V}$$

$$v_3 = 20 \text{ V}$$

(b)

$$\begin{aligned}
 P_{2Vx} &= -2v_x \times I_{2Vx} \\
 &= -(v_1 - v_3) \times \left[ \frac{v_1}{20} - 1 \right] \\
 &= -40 \times 2 = -80 \text{ mW} \\
 &\quad (\text{Supplying})
 \end{aligned}$$

## Q-2(Mesh)

Monday, 25 November, 2024

7:20 AM

Supernode KVL:

$$2i_1 + 4 + 2i_2 - 12 = 0$$

$$\Rightarrow i_1 + i_2 = 4$$

Supernode KCL:

$$i_1 = 2I_x + i_2$$

$$\Rightarrow i_1 = 2(i_2 - i_3) + i_2$$

$$\Rightarrow i_1 - 3i_2 + 2i_3 = 0$$

Solving,

$$i_1 = 5 \text{ A}$$

3rd mesh KVL:

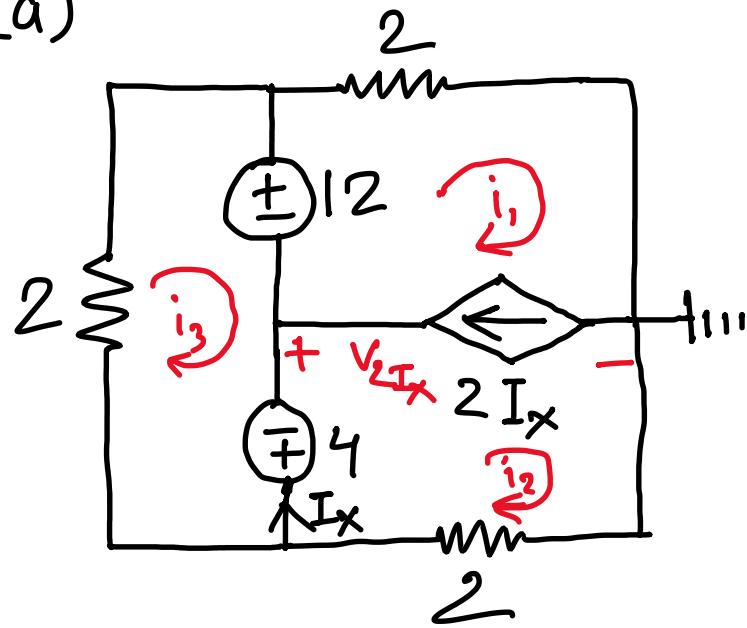
$$i_2 = -1 \text{ A}$$

$$2i_3 + 8 = 0$$

$$\Rightarrow i_3 = -4 \text{ A}$$

(b) KVL in mesh 2  $\rightarrow 4 + 2i_2 + V_{2I_x} = 0$

$$\Rightarrow V_{2I_x} = -4 - 2 \times (-1) = -2 \text{ V}$$

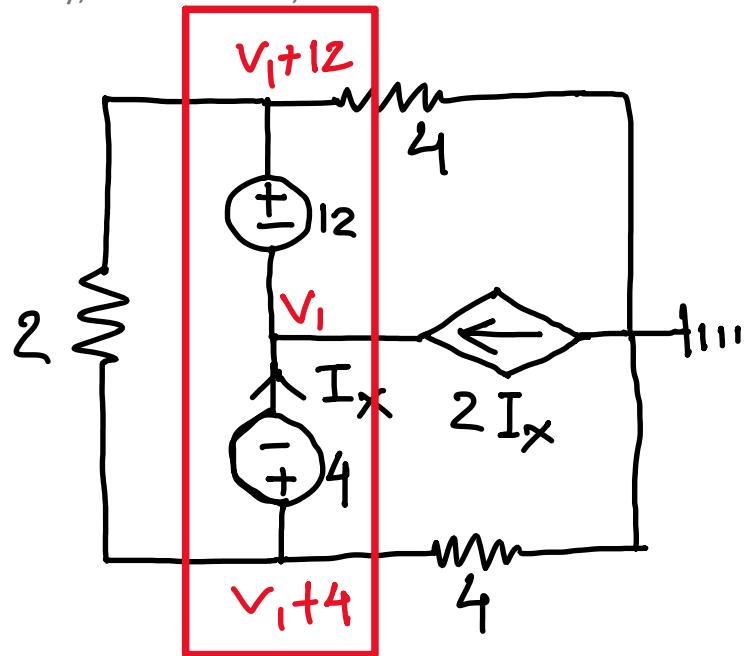


## Q-2(Nodal)

Monday, 25 November, 2024

7:11 AM

(a)



Supernode

$$\begin{aligned} \text{KCL at } V_1+8, \\ \Rightarrow \frac{V_1+12 - (V_1+4)}{2} - \frac{V_1+4}{2} - I_x = 0 \\ \Rightarrow I_x = 2 - \frac{V_1}{2} \end{aligned}$$

KCL at supernode:

$$\frac{V_1+12}{2} + \frac{V_1+4}{2} - 2 \times \left(2 - \frac{V_1}{2}\right) = 0$$

$$\therefore V_1 = -2V$$

$\therefore$  Node voltages  $-2V$ ,  $2V$  &  $10V$ .

(b) Voltage of  $2I_x$  current source

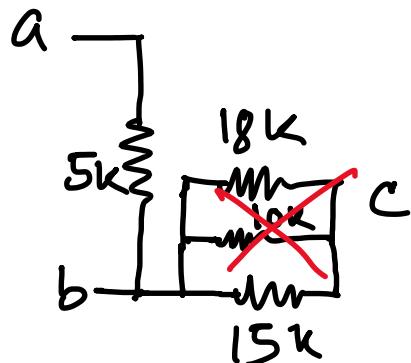
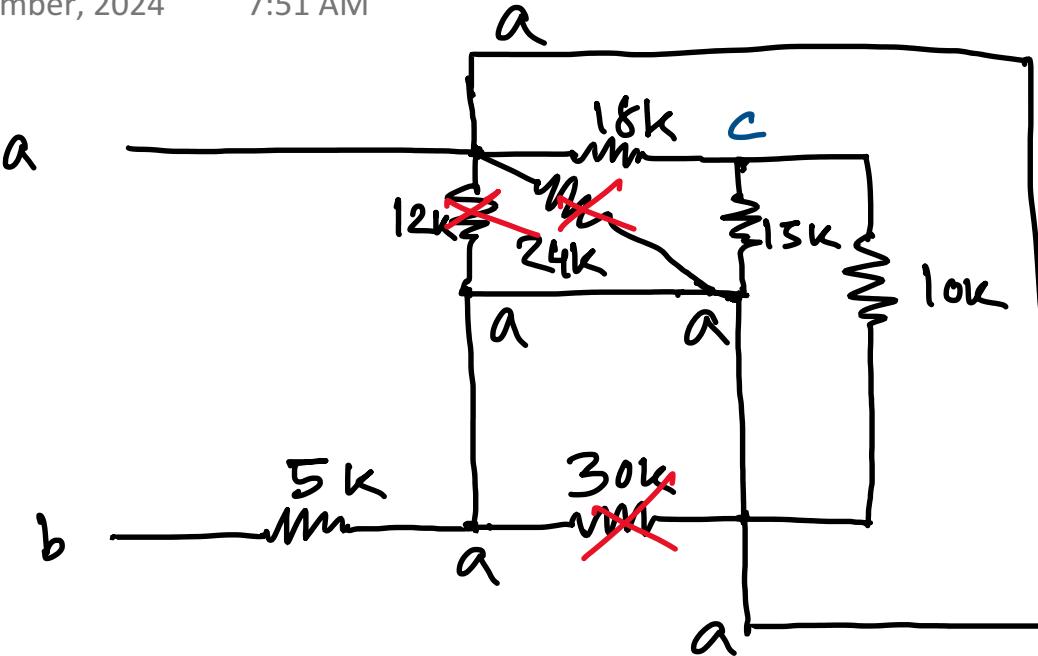
$$= V_1 = -2V$$

### Q-3

Monday, 25 November, 2024

7:51 AM

(a)



$$\therefore R_{ab} = 5\text{k}\Omega$$

$$(b) (i) \text{KVL} \rightarrow -V_y + (-6) + 12 - 24 - (-4) + 8 + 12 = 0$$

$$\Rightarrow V_y = 6\text{V}$$

$$(ii) \text{KVL} \rightarrow -V_{ab} - 24 - (-4) + 8 = 0$$

$$\Rightarrow V_{ab} = -12\text{V}$$