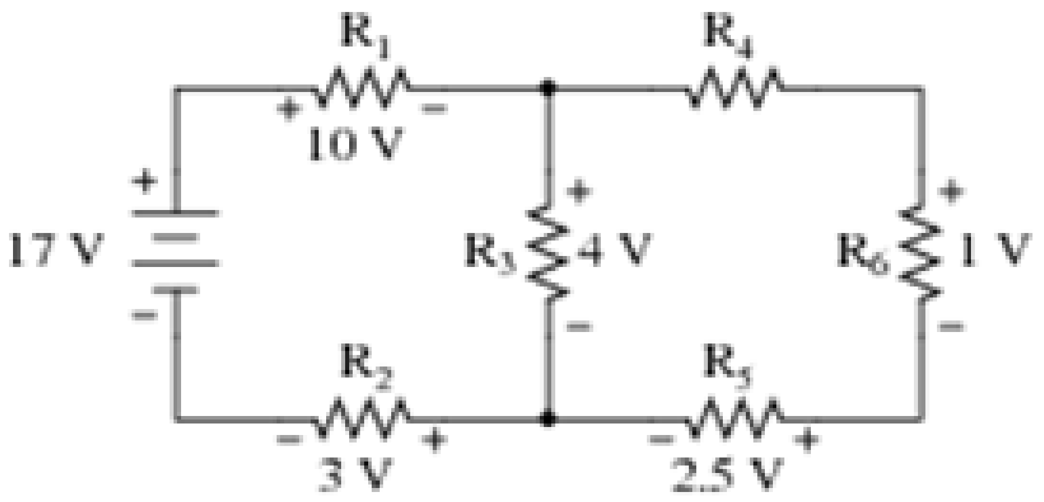
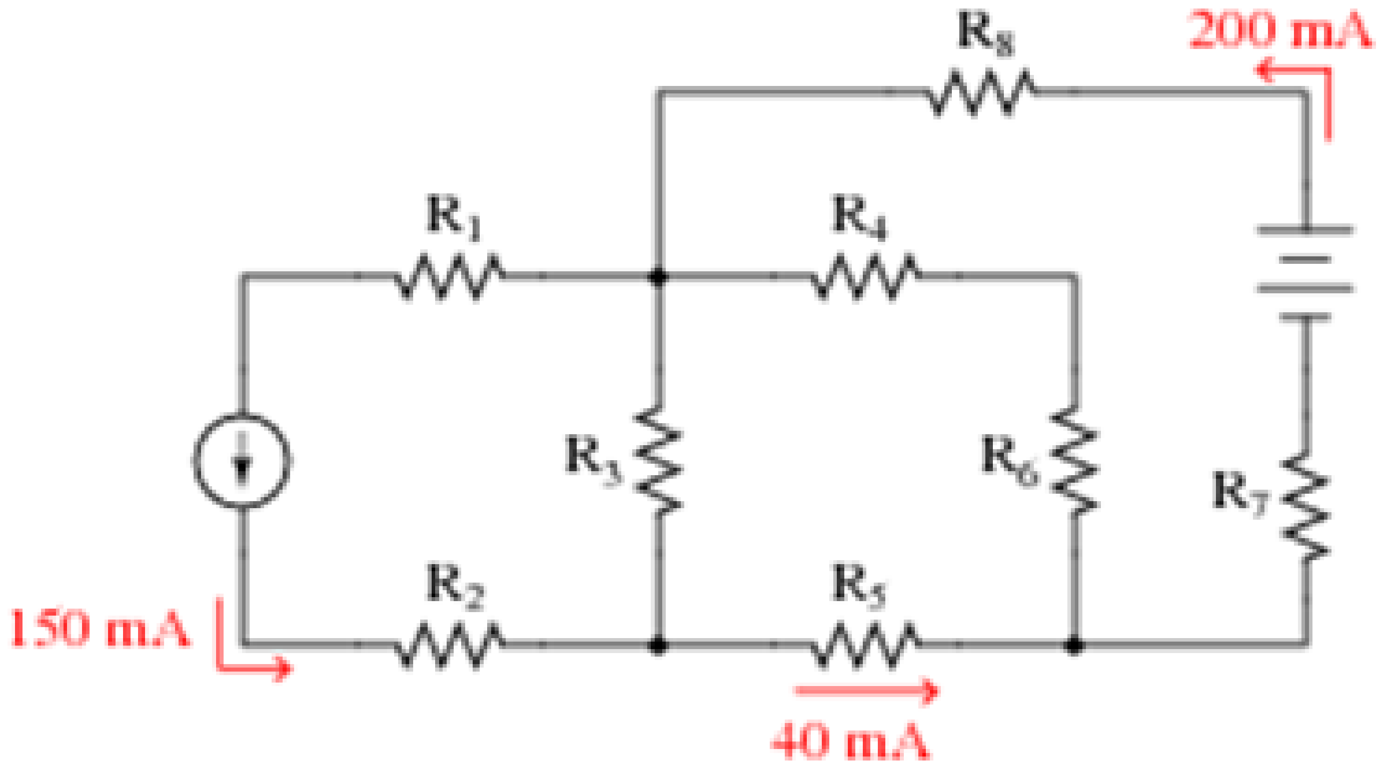
EE 101H – Electric Circuits

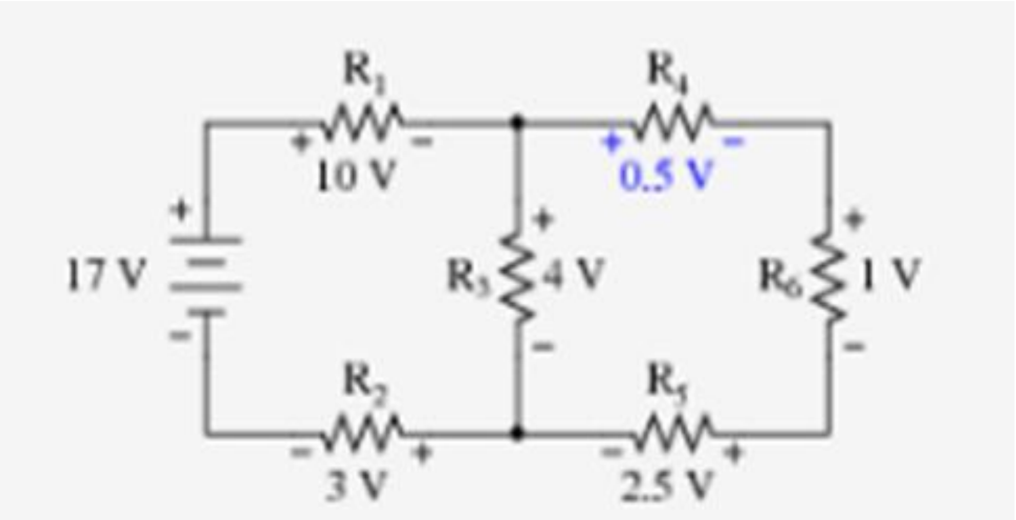
Practice Problems

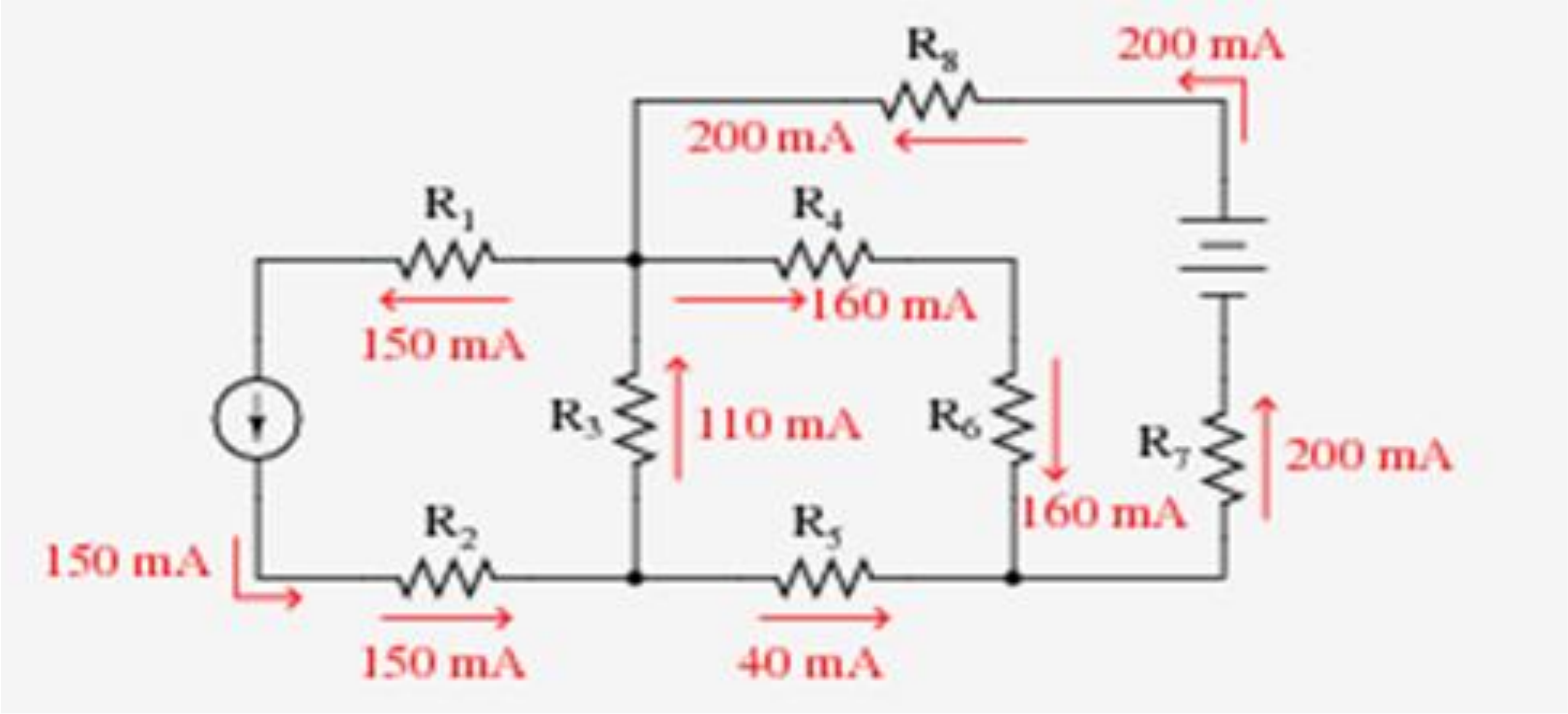


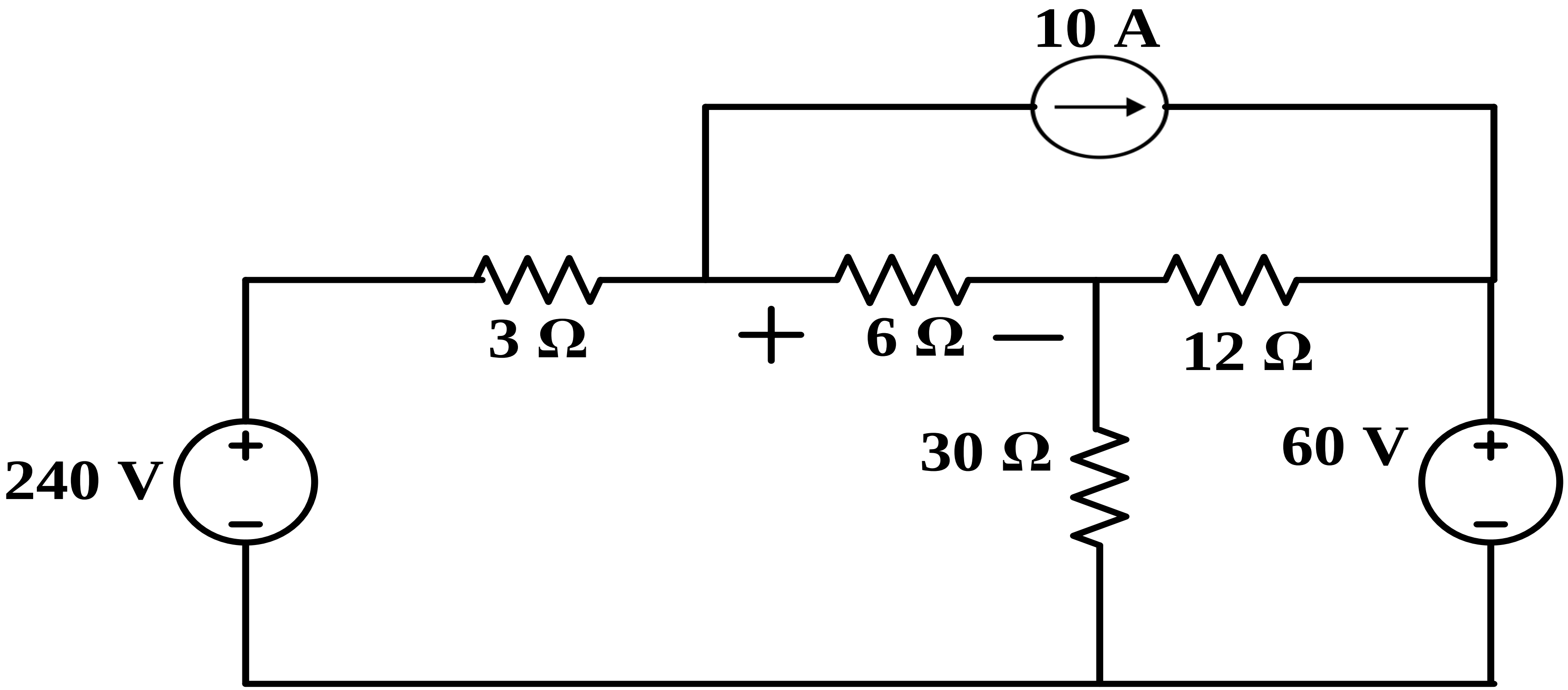
Q1. Use Kirchhoff's Voltage Law to determine magnitude and polarity of the voltage across the resistor R_4 in this resistor network:

Q2. Use Kirchhoff's Current Law to find magnitudes and directions of currents through all the resistors in this circuit:

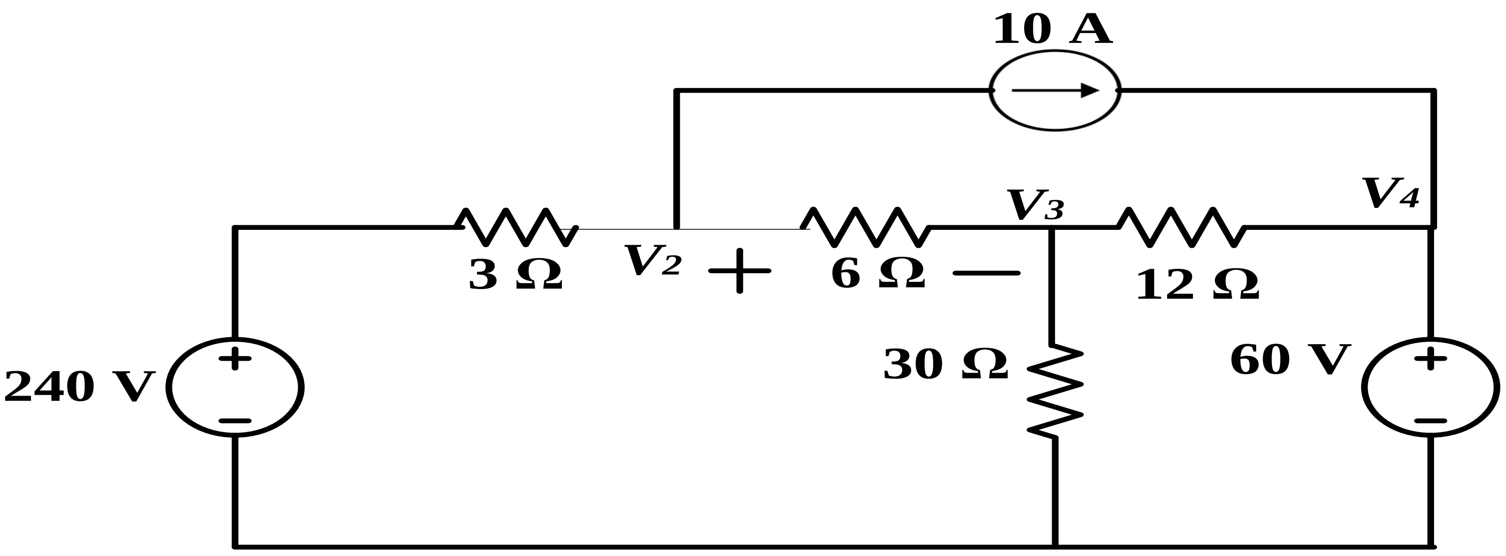



R1
10 V
R4
0.5 V
17 V
R3
4 V
R6
1 V
R2
3 V
R5
2.5 V


R8
200 mA
200 mA
R1
R4
150 mA
160 mA
R3
110 mA
R6
R7
200 mA
160 mA
150 mA
R2
R5
150 mA
40 mA



Q3. Using nodal analysis, compute voltage across the 6Ω resistor.



Using Kirchoff's current law (KCL) at the node V_2:

$\frac{V_2-240}{3}$ + $\frac{V_2-V_3}{6}$ +10 = 0 or 2(v_2- 240)+ v_2 - v_3 +60 = 0 giving

$3v_2$ - v_3 -420=0 ……………………………….(1)

Using KCL at the node V_3:

$\frac{V_3 - V_2}{6} + \frac{V_3}{30} + \frac{V_3 - 60}{12}$ = 0 or 10(v_3- v_2) + 2v_3+ 5(v_3-60) = 0 giving

17v_3 - 10v_2 -300 = 0 ……………………………..…… .(2)

Now, (1) x10 becomes

$$30v_2 - 10v_3 - 4200=0 \quad \ldots\ldots\ldots\ldots\ldots .(3)$$

and, (2) x3 gives

$$-30v_2 + 51v_3 -900=0 \quad \ldots\ldots\ldots\ldots\ldots .(4)$$

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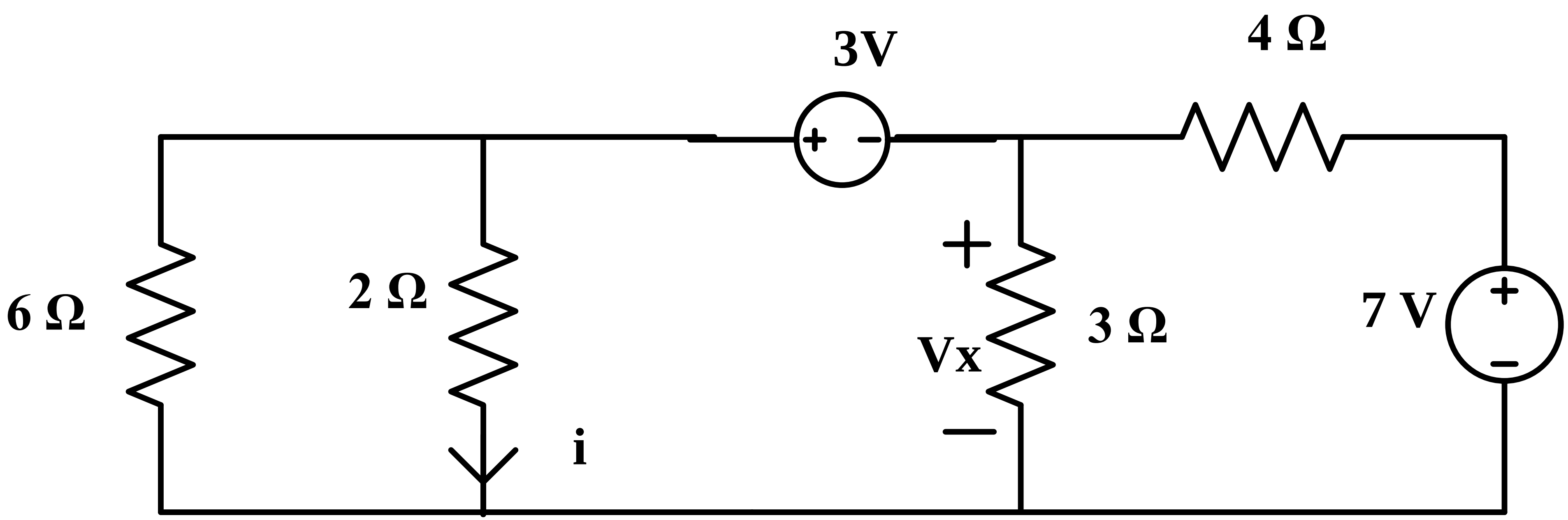
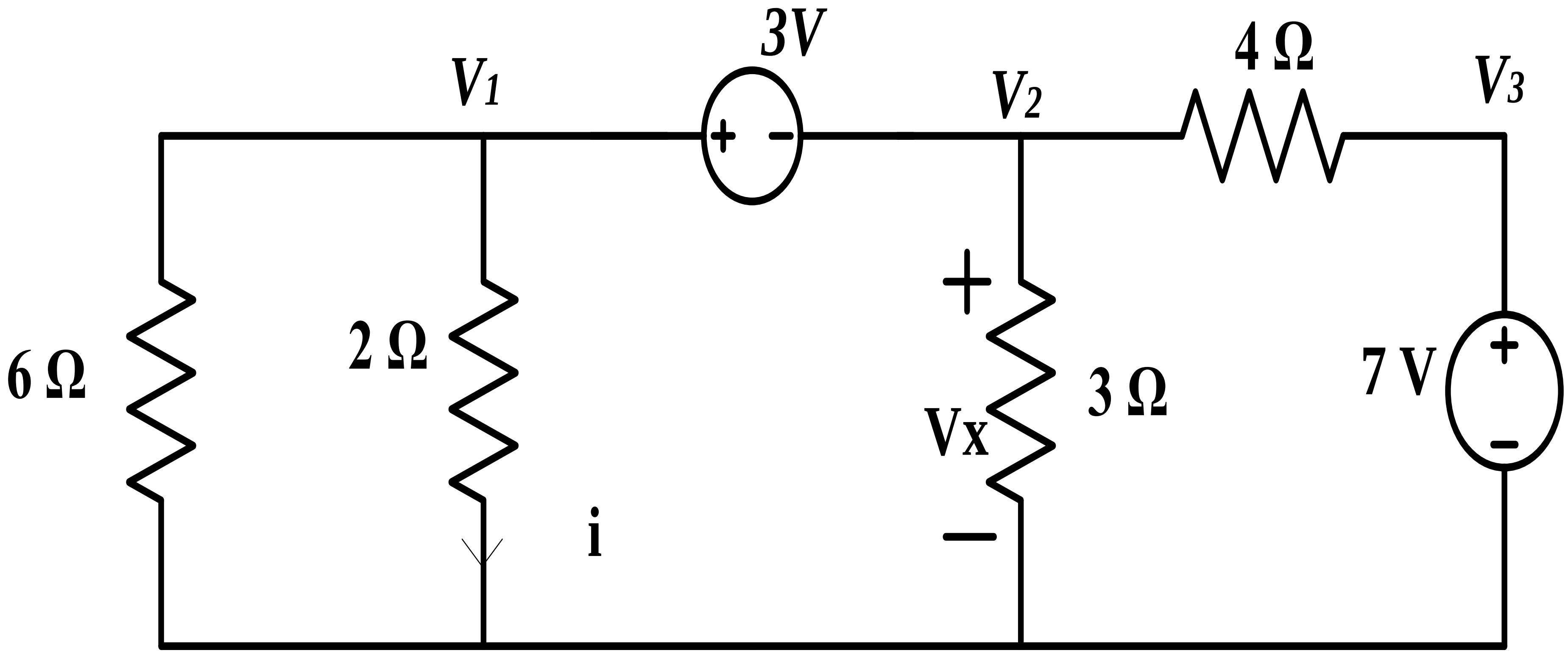
(3)+(4) becomes $41v_3$-5100=0 => v_3=124.39 V

Substitution of v_3 in (2) gives v_2=181.46v

Voltage across the 6**Ω** resistor is v_2-v_3= 181.46-124.39 = 57.07 V (Ans)



Q4. Using nodal analysis and supernode, find Vx and i in the circuit



V_1, V_2, V_3 are the three nodes apart from the reference node. As a source is connected in between V_1 and V_2 it forms **a super node.**

Due to the super node V_1 - V_2: $v_1 - v_2$=3 ………………………………….(1)

Applying KCL at supernode overlapping V_1 and V_2:

$\frac{V_2-7}{4}$ + $\frac{V_2}{3}$ + $\frac{V_1}{2}$ + $\frac{V_1}{6}$ =0

OR

3(v_2 -7)+ 4v_2+6v_1+2v_1= 0 resulting in

8v_1+7v_2=21 ……………………………………….(2)

Substitution of (1) in (2) gives

$24+8v_2+7v_2= 21$

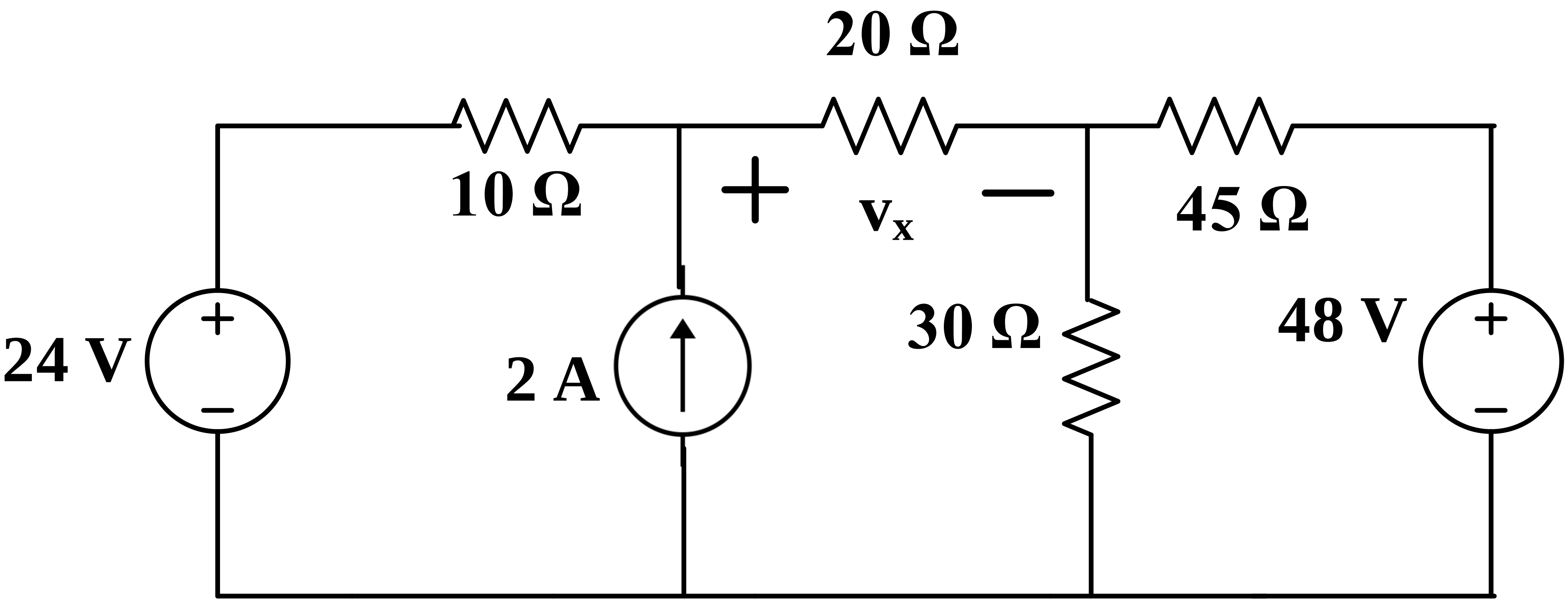
$=> \; v_2= -\ 0.2$ V

Now, (1) gives $v_1 = 2.8$

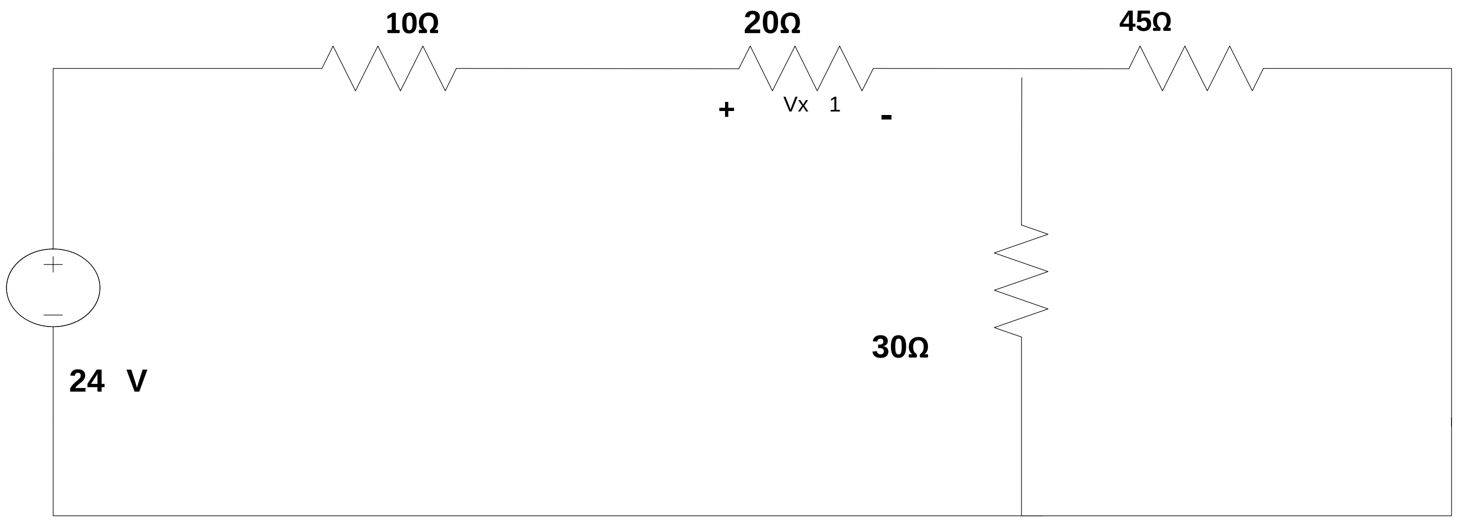
Therefore, i = $v_1/2 = (3+v_2) / 2 = (3-0.2) / 2 =$ **1.4 A** (Ans)

Lastly, **Vx = v_2 = - 0.2 V (Ans)**

Q5. Use superposition and source transformation to find the value of v_x for the circuit shown below.



Considering only 24 V source and setting 2A and 48V sources to ZERO the circuit becomes:



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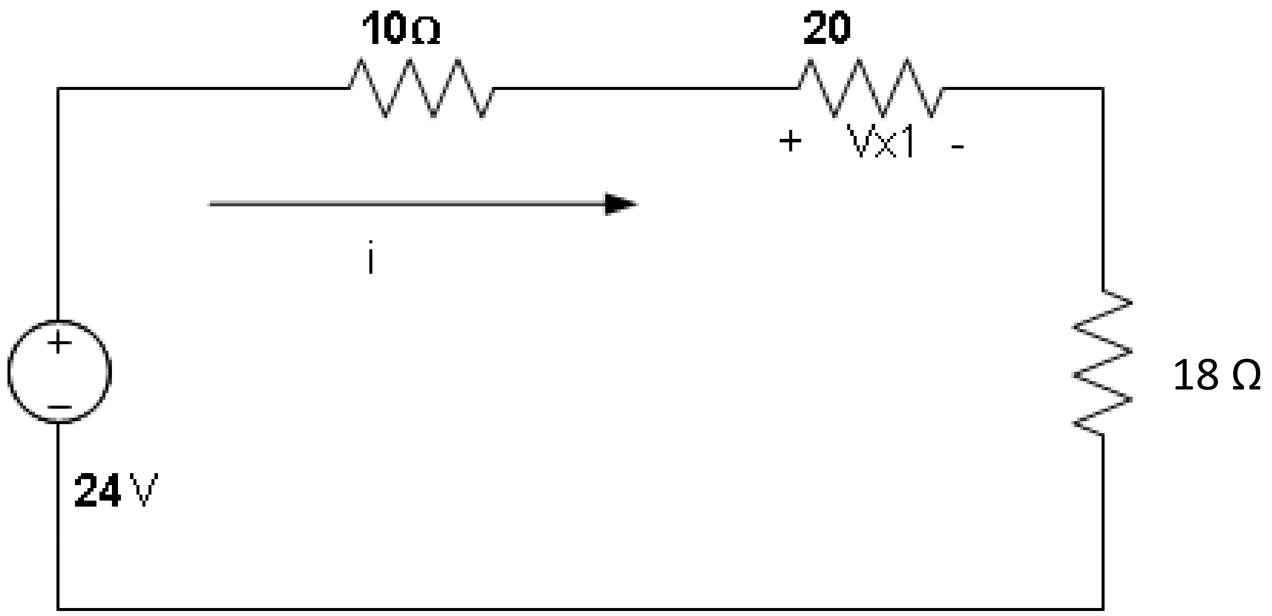
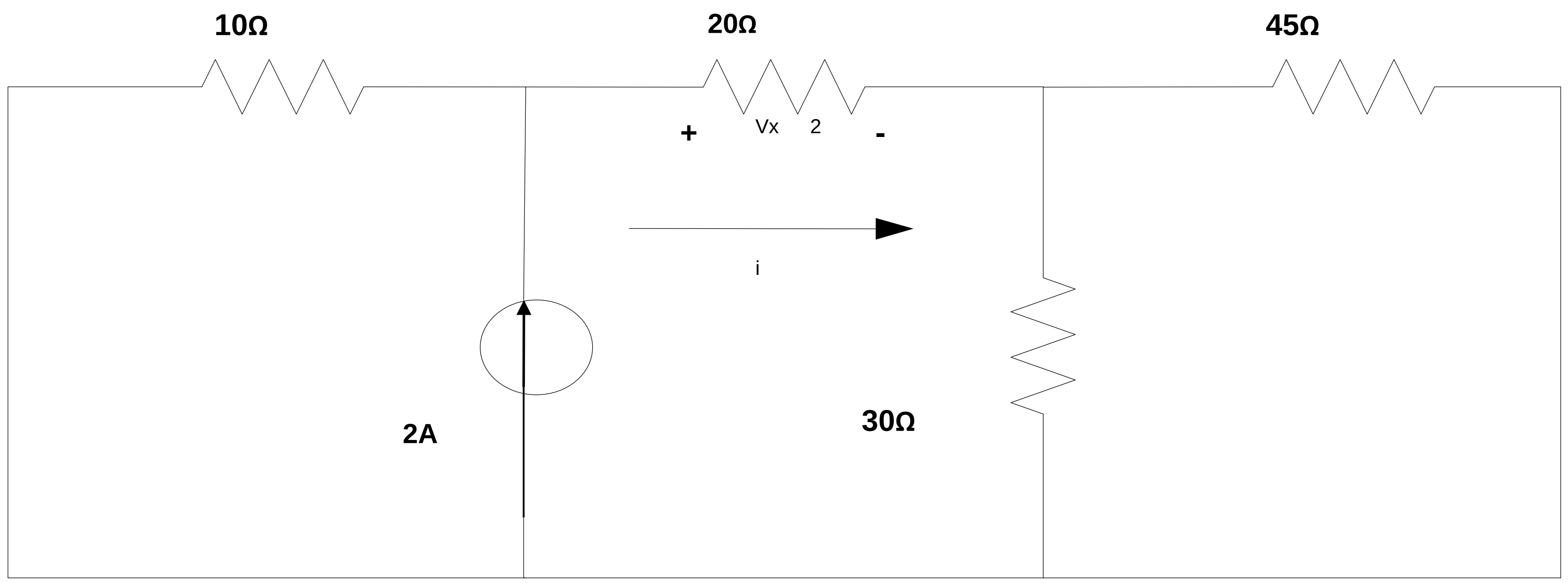


$$i = \frac{24}{10 + 20 + 18} = 0.5\ \text{A}$$

V_{X1} = 0.5 x 20 = 10 V

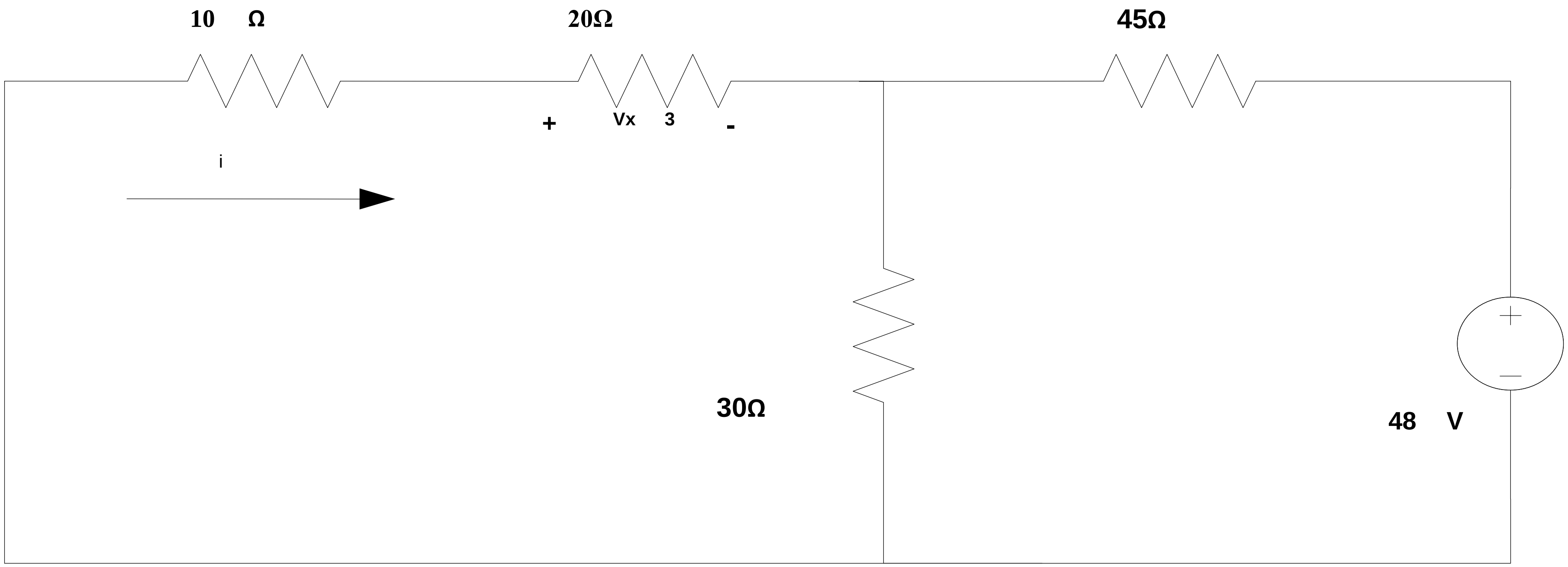
Similarly, considering only the 2 A current source, the circuit is:



Current through 20 Ω is 2 x 10/(10+20+18) = 0.41666 A

Then, Vx2 = i x 20 = 0.416 x 20 = 8.33 V

Considering only the 48 V source,



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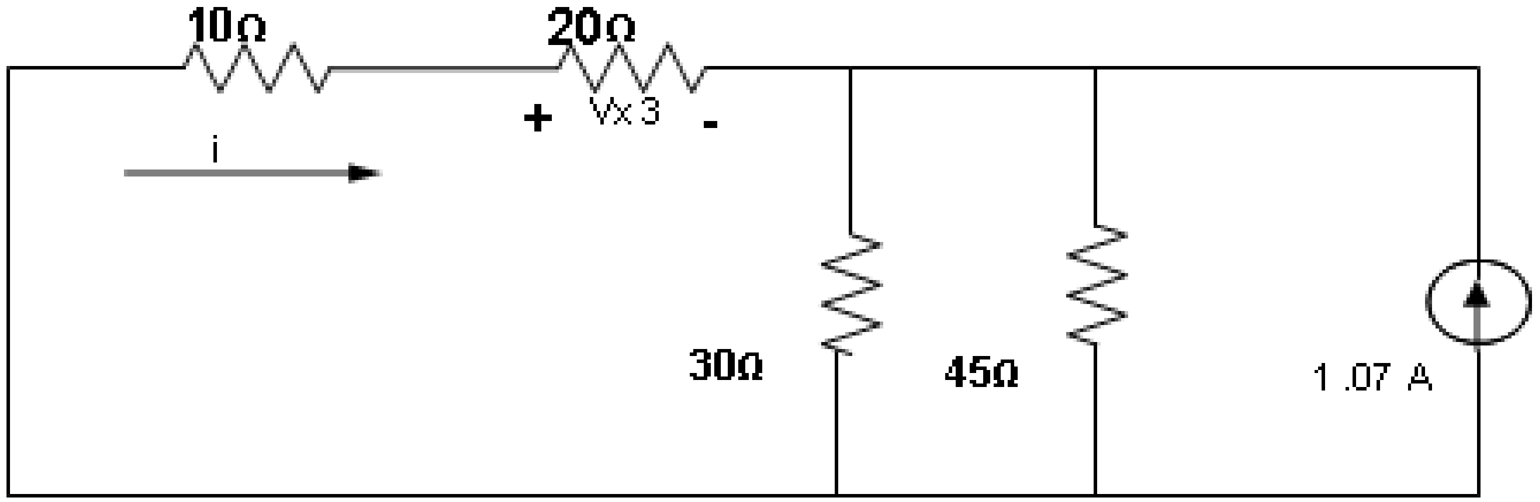
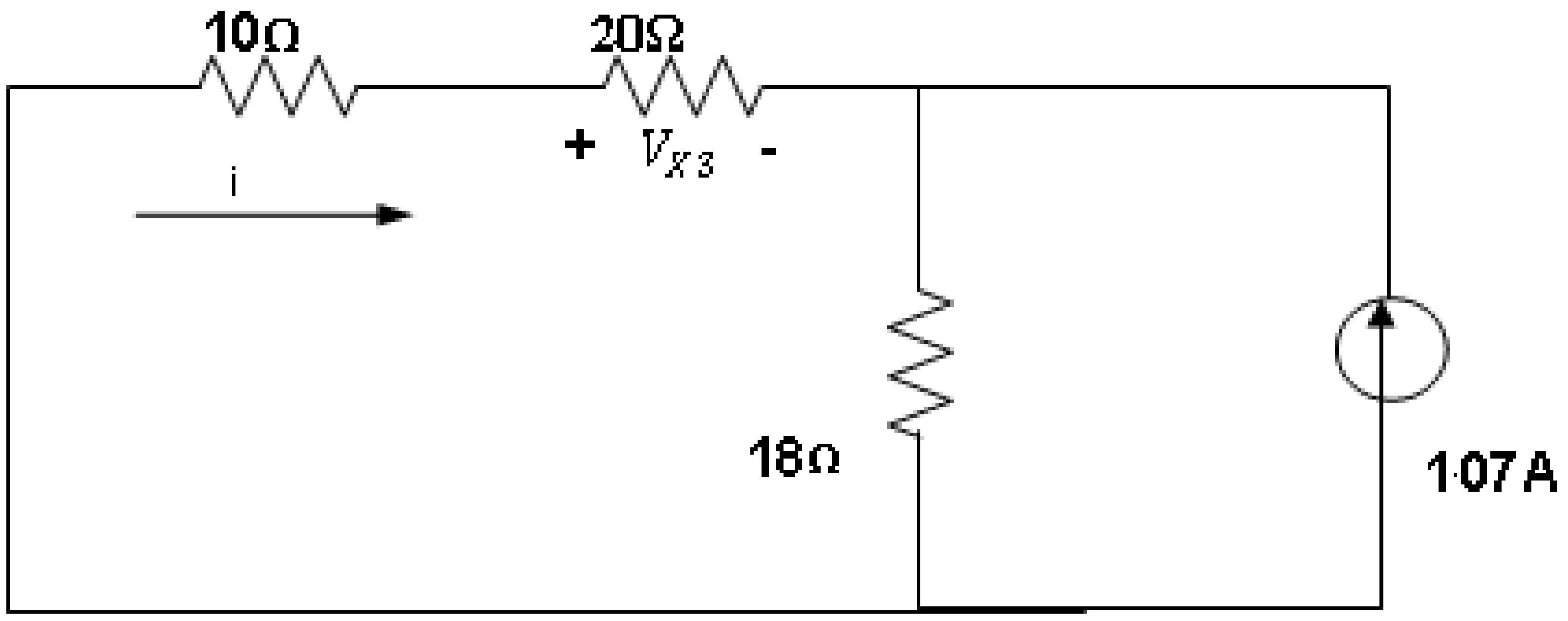
Using source transformation,





10Ω
20Ω
+ V_{X3} -
i
18Ω
107 A

$$i = -1.07 \times \frac{18}{18 + (10 + 20)} = -0.4\,\mathrm{A}$$

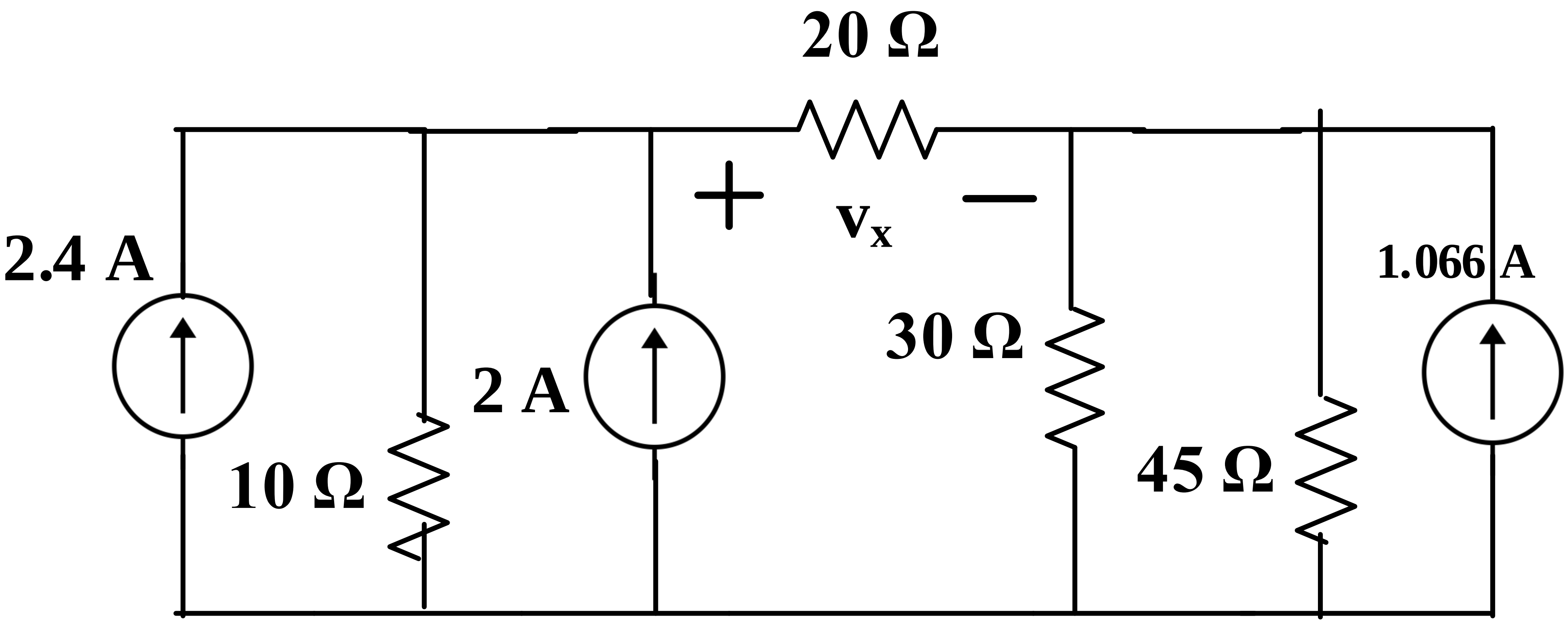
V_{X3}= i x 20 = - 8 V

Using superposition,

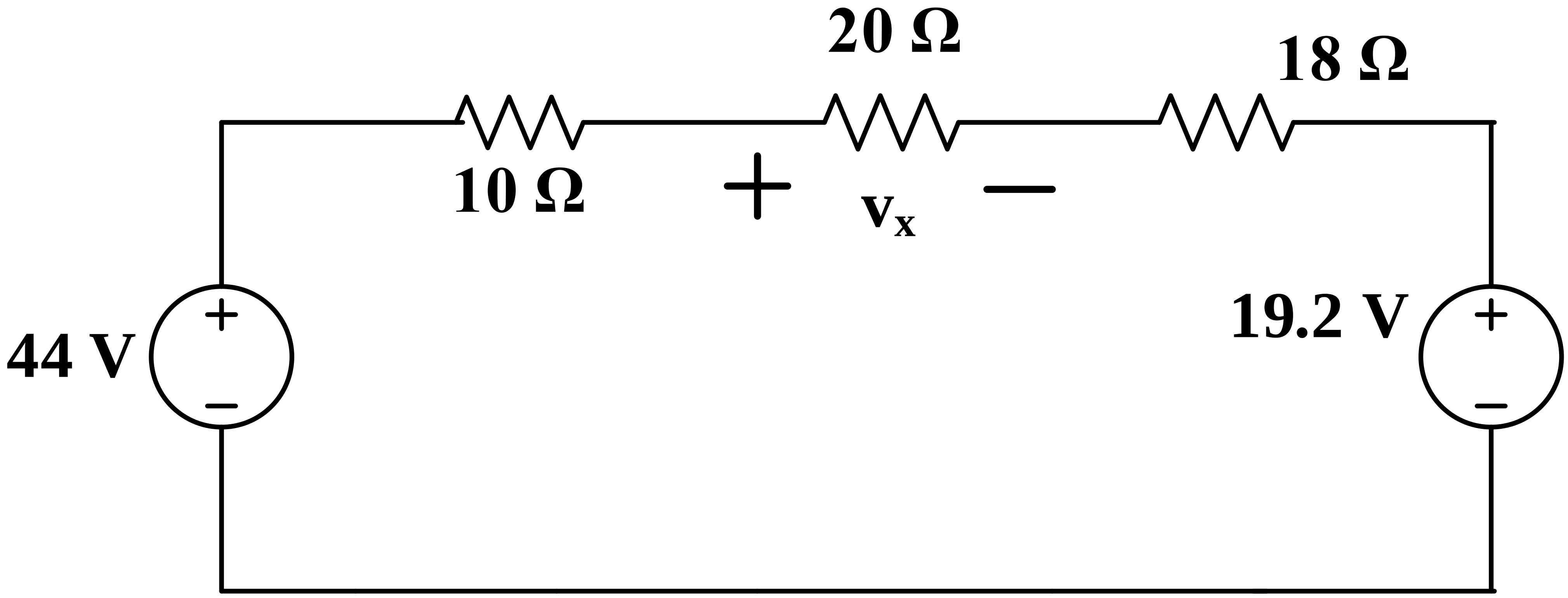
Vx = V_{X1}+V_{X2}+V_{X3} = 10 + 8.33 – 8 = 10.33 V.

ANOTHER METHOD

Converting both the VOLTAGE SOURCES (24V and 48V) into current sources:



Converting all the CURRENT SOURCES into Voltage sources:



Loop current $i = \frac{44-19.2}{10+20+18}$ = 0.516A

V_X = 0.516 x 20 = 10.33 V

END