1. (20%) Find i and Vo in the circuit of Fig. 1.

$R_{eq1} = 30//(50+10) = 20$,

$20 + R_{eq1} = 40$,

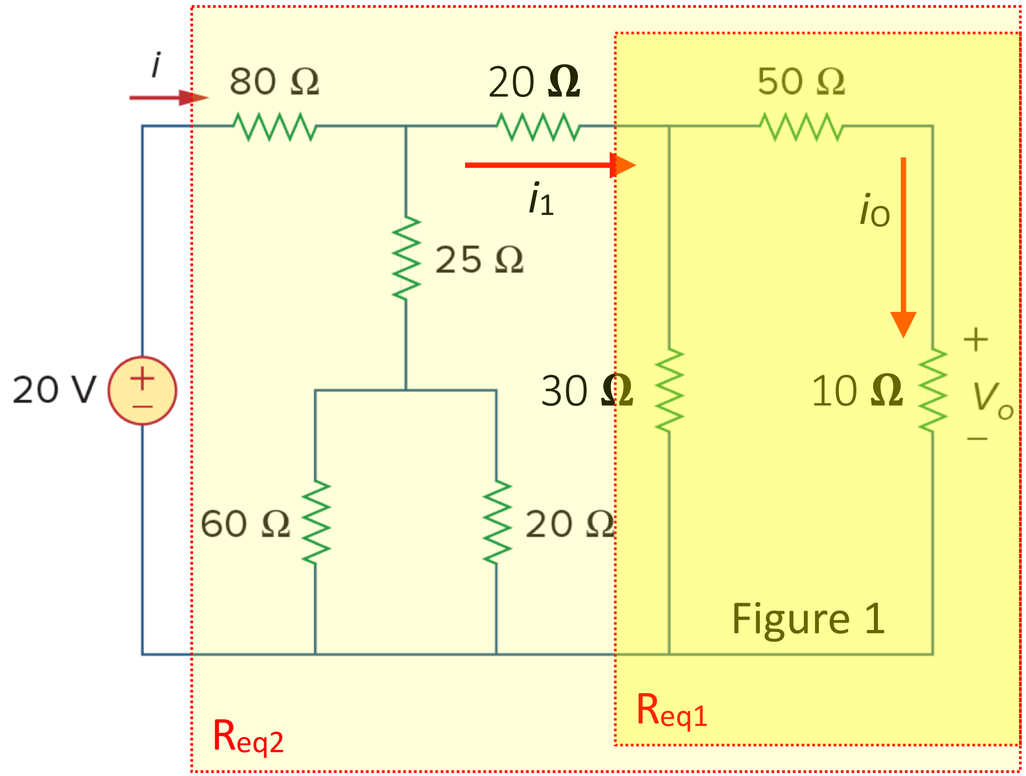
$60//20 = 15$,

$R_{eq2} = 80+(25+ 60//20)//(20+ R_{eq1})$

$= 80+ (25+15)//40$

$= 100\ \Omega$

***i* = 20/100 = 0.2 (A)**



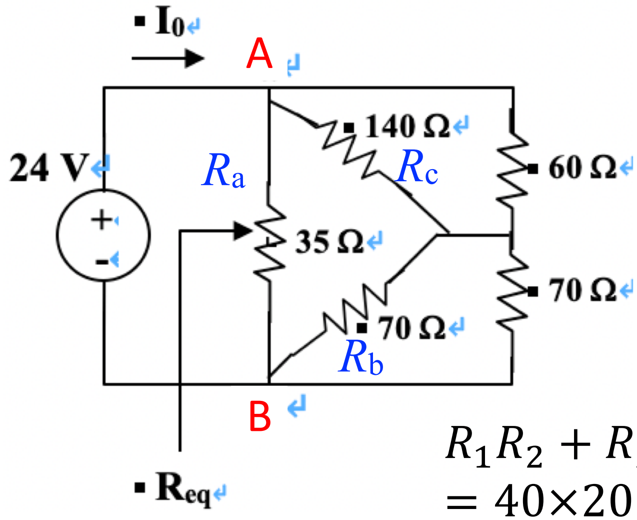
$$i_1 = i \times \frac{(25 + 60//20)}{(25 + 60//20) + (20 + R_{eq1})}$$

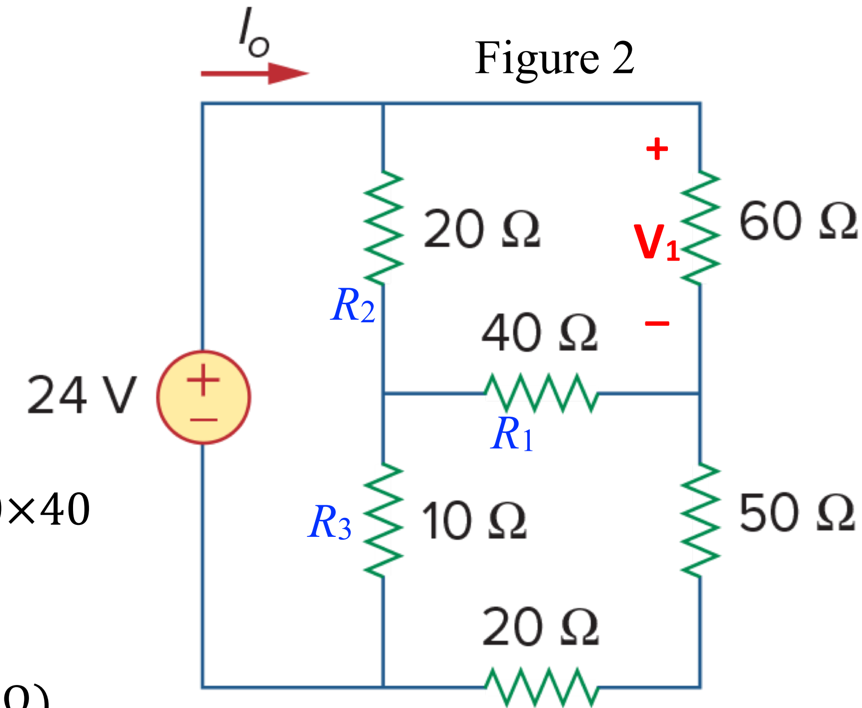
$$= 0.2 \times \frac{(25 + 15)}{(25 + 15) + (20 + 20)} = \mathbf{0.1\ (A)}$$

$$i_o = i_1 \times \frac{30}{30+(50+10)} = 0.1 \times \frac{30}{90} = \frac{0.1}{3} = \mathbf{0.0333\ (A)}$$

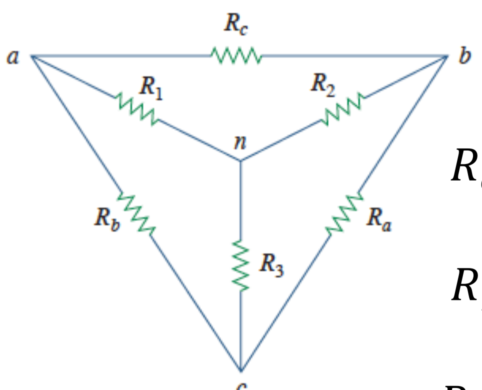
$$V_o = 10 \times i_o = \frac{1}{3} = \mathbf{0.3333\ (V)}$$

2. (20%) Calculate I_o and V_1 in the circuit of Fig. 2.





$$R_1R_2 + R_2R_3 + R_3R_1$$
$$= 40\times 20 + 20\times 10 + 10\times 40$$
$$= 1400(\Omega)$$



$$R_a = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_1}$$
$$R_b = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_2}$$
$$R_c = \frac{R_1R_2 + R_2R_3 + R_3R_1}{R_3}$$

$$R_a = \frac{1400}{R_1} = \frac{1400}{40} = 35(\Omega)$$
$$R_b = \frac{1400}{R_2} = \frac{1400}{20} = 70(\Omega)$$
$$R_c = \frac{1400}{R_3} = \frac{1400}{10} = 140(\Omega)$$

$$R_{AB} = 35//\big((140//60) + (70//70)\big)$$
$$= 35//(42 + 35)$$
$$= 24.0625$$

$$I_O = \frac{24}{R_{AB}} = \frac{24}{24.0625}$$
$$= 0.9974(\text{A})$$

$$V_1 = 24\times\frac{140//60}{(140//60) + (70//70)}$$
$$= 24\times\frac{42}{42 + 35} = 13.0909(V)$$

3. (20%) Calculate **V** and $\boldsymbol{i}_x$ in the circuit of Fig. 3.

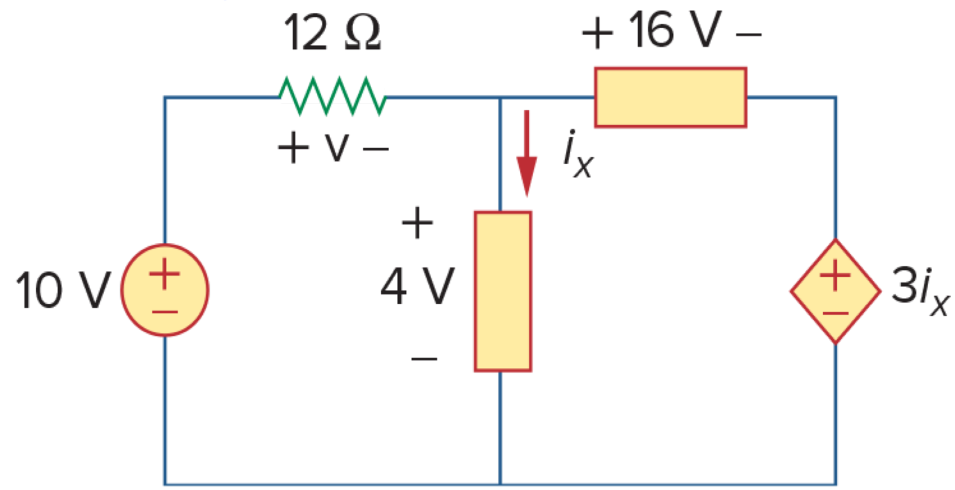


Figure 3

For loop 1,

$$-10 + v + 4 = 0, \quad v = \mathbf{6\ (V)}$$

For loop 2,

$$-4 + 16 + 3\,i_x = 0, \quad i_x = \mathbf{-4\ (A)}$$

4. (30%) Consider the Wheatstone Bridge shown in Fig. 4.

(A) (15%) Calculate v_a, v_b, and v_{ab},

(B) (15%) Recalculate v_a, v_b, and v_{ab}, if the ground is placed at ***a*** instead of ***o***.

(A) Voltage division,

$$v_a = 25\times\frac{8}{12+8} = 10\ (\mathrm{V})$$

$$v_b = 25\times\frac{15}{10+15} = 15\ (\mathrm{V})$$

$$v_{ab} = v_a - v_b = 10 - 15 = -5(\mathrm{V})$$

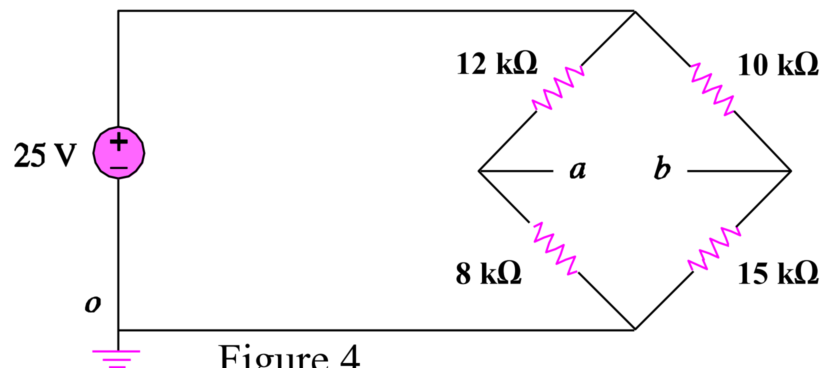


Figure 4

(B) if the ground is placed at ***a***

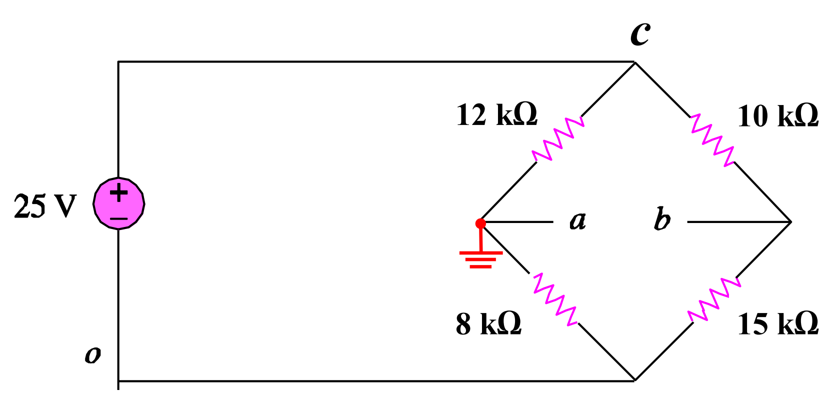
$$v_a = 0\ (\mathrm{V})$$

$$v_{ac} = -25\times\frac{12}{8+12} = -15\ (\mathrm{V})$$

$$v_{cb} = 25\times\frac{10}{10+15} = 10\ (\mathrm{V})$$

$$v_{ab} = v_{ac} + v_{cb} = -15 + 10 = -5(\mathrm{V})$$

$$v_b = v_{ba} = -v_{ab} = 5\ (\mathrm{V})$$



5. (15%) Obtain $\boldsymbol{v}_1$ through $\boldsymbol{v}_3$ in the circuit of Fig. 5.

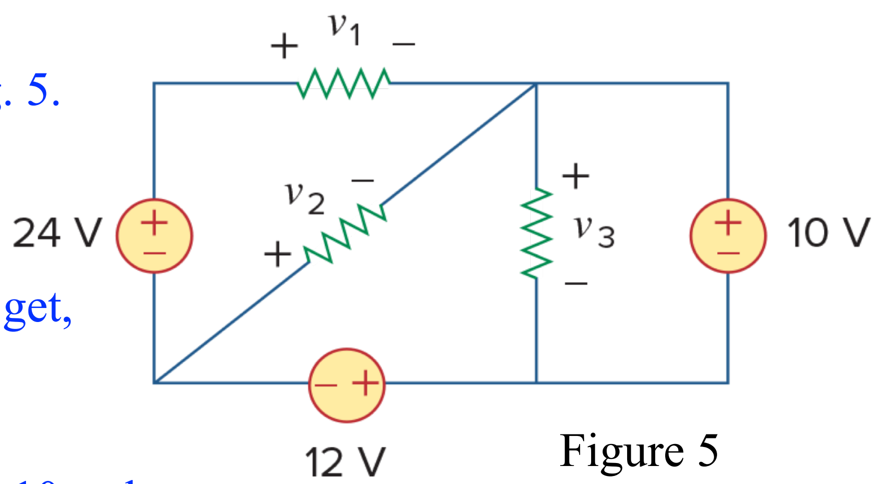


Figure 5

Applying KVL around the entire outside loop we get,

$$-24 + \boldsymbol{v}_1 + 10 + 12 = 0 \text{ or } \boldsymbol{v}_1 = \mathbf{2V}$$

Applying KVL around the loop containing v_2, the 10-volt source, and the 12-volt source we get,

$$\boldsymbol{v}_2 + 10 + 12 = 0 \text{ or } \boldsymbol{v}_2 = \mathbf{-22V}$$

Applying KVL around the loop containing v_3 and the 10-volt source we get,

$$-\boldsymbol{v}_3 + 10 = 0 \text{ or } \boldsymbol{v}_3 = \mathbf{10V}$$

6. (20%) Calculate **Vo** and **Io** in the circuit of Fig. 6.

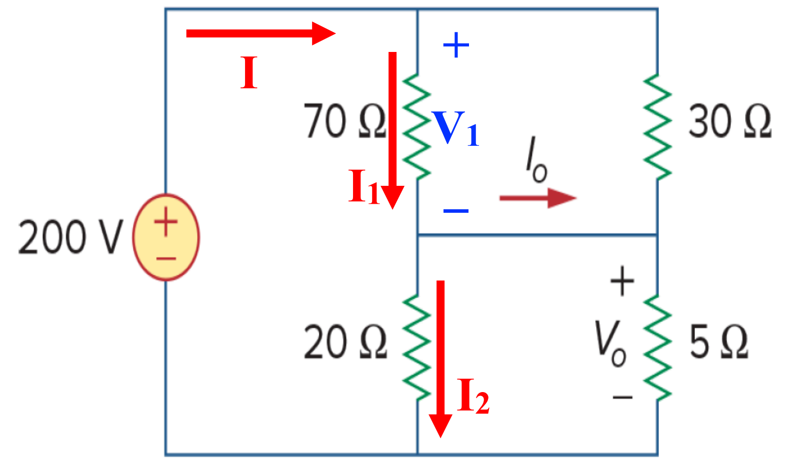


Figure 6

$$70//30=\frac{70\times 30}{70+30}=21\ (\Omega)$$

$$20//5=\frac{20\times 5}{20+5}=4\ (\Omega)$$

$$I=\frac{200}{21+4}=8\ (A)$$

$$V_1=I\times 21=8\times 21=168\ (V)$$

$$\boldsymbol{V_O=I\times 4=8\times 4=32\ (V)}$$

$$I_1=\frac{V_1}{70}=\frac{168}{70}=2.4\ (A)$$

$$I_2=\frac{V_O}{20}=\frac{32}{20}=1.6\ (A)$$

$$\boldsymbol{I_O=I_1-I_2=2.4-1.6=0.8\ (A)}$$