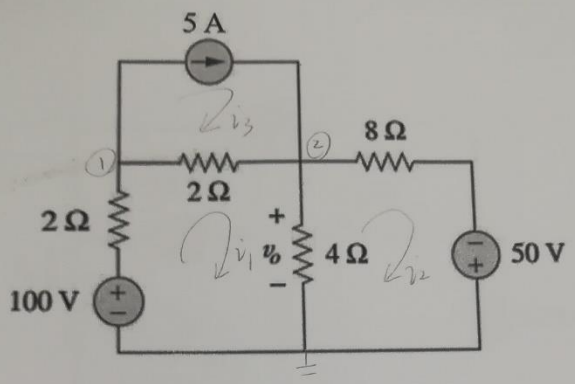
1. Using nodal analysis, find v_o



i) Nodal analysis

$\frac{V_1-100}{2}+\frac{V_1-V_2}{2}+5=0$ Node 1

$\frac{V_2}{4}+\frac{V_2+50}{8}-5=0$ Node 2 $\Rightarrow$ $V_1=62V$, $V_2=34V$

$V_2=V_0$ $V_0=34V$

ii) Mesh analysis

$2i_1+2(i_1-i_3)+4(i_1-i_2)-100=0$ Mesh 1

$4(i_2-i_1)+8i_2-50=0$ Mesh 2

Mesh 3

$i_3=5A$

$V_0=4(i_1-i_2)$

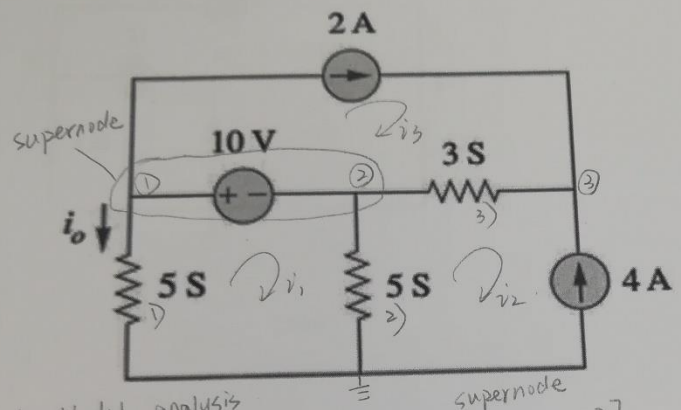
$i_1=19A$

$\Rightarrow$ $i_2=10.5A$

$i_3=5A$

$V_0=34$

2. Apply nodal analysis to find i_o, and the power dissipated in each resistor.



(1) Nodal analysis

supernode

$V_1 \times 5 + 2 + V_2 \times 5 + (V_2 - V_3) \times 3 = 0$

$(V_2 - V_3) \times 3 + 2 + 4 = 0$ Node3 $\Rightarrow$

$V_1 - 10 = V_2$

$i_o = V_1 \times 5$

$V_1 = \frac{27}{5} V$

$V_2 = -\frac{23}{5} V$

$V_3 = -\frac{13}{5} V$

$i_o = 27\,A$

$P_1 = V_1 \cdot i_o = 145.8\,W$

$P_2 = V_2^2 \cdot 5 = 105.8\,W$

$P_3 = (V_2 - V_3)^2 \cdot 3 = 12\,W$

(2) Mesh analysis

$\frac{1}{5} i_1 + 10 + \frac{1}{5}(i_1 - i_2) = 0$

$i_2 = -4\,A$

$i_3 = 2\,A$

$i_1 = -i_o$

Mesh 1

Mesh2 $\Rightarrow$ $i_1 = -i_o = -27\,A$

Mesh 3 $i_o = 27\,A$

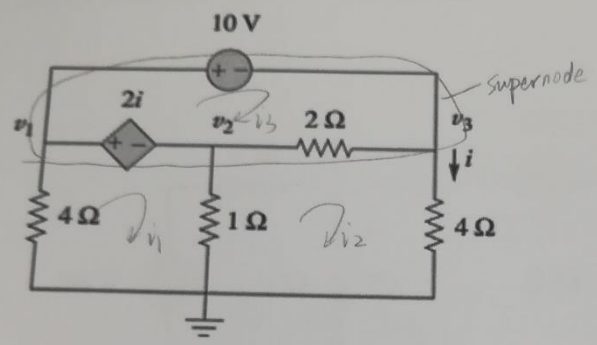
$\Rightarrow$

$P_1 = \frac{i_1^2}{5} = 145.8\,W$

$P_2 = \frac{(i_1 - i_2)^2}{5} = 105.8\,W$

$P_3 = \frac{(i_2 - i_3)^2}{3} = 12\,W$

3. Using nodal analysis, find v_1, v_2, *and* v_3.



(1) Nodal analysis

$\frac{V_1}{4} + \frac{V_2}{1} + \frac{V_3}{4} = 0$ supernode

$V_1 - V_2 = 2i$

$V_1 - V_3 = 10$

$\Rightarrow V_1 = -2.5\,V$

$V_2 = 3.75\,V$

$V_3 = -12.5\,V$

(2) Mesh analysis

$4i_1 + 2i + (i_1 - i_2) = 0$ Mesh 1

$(i_2 - i_1) + 2(i_2 - i_3) + 4i_2 = 0$ Mesh 2

$10 + 2(i_3 - i_2) - 2i = 0$ Mesh 3

$V_3 = 4i$

$V_1 - V_3 = 10$

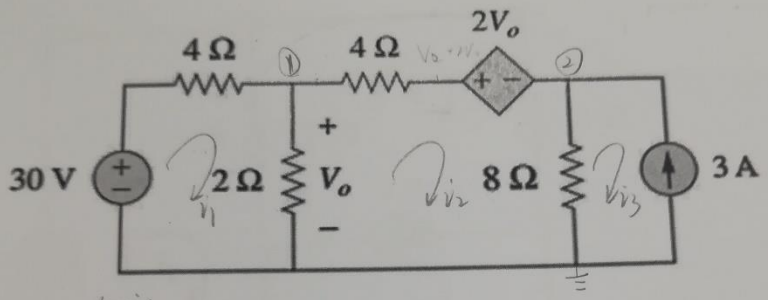
$V_1 - V_3 = 2i$

$i_2 = i$

$\Rightarrow \begin{cases} i_1 = 0.625\,A \\ i_2 = -3.125\,A = i \\ i_3 = 11.25\,A \end{cases}$

$\Rightarrow \begin{cases} V_1 = -2.5\,V \\ V_2 = 3.75\,V \\ V_3 = -12.5\,V \end{cases}$

4. Find V_o using the two methods you learned from EE111, (1) Nodal analysis; and (2) Mesh analysis.



(1) Nodal analysis

$$\frac{V_1-30}{4}+\frac{V_1}{2}+\frac{V_1-V_2-2V_o}{4}=0 \quad \text{Node 1}$$

$$\frac{V_2}{8}-3+\frac{V_2+2V_o-V_1}{4}=0 \quad \text{Node 2}$$

$$V_1=V_o$$

$$\Rightarrow V_o=\frac{57}{4}V=14.25\,V$$

(2) Mesh analysis

Mesh 1

Mesh 2

Mesh 3

$$-30+4i_1+2(i_1-i_2)=0$$

$$2(i_2-i_1)+4i_2+2V_o+8(i_2-i_3)=0$$

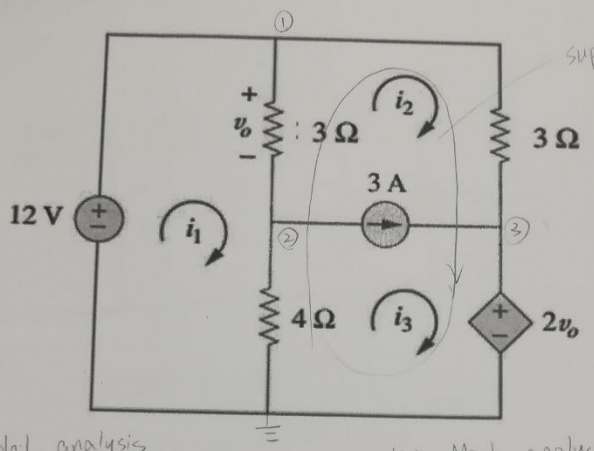
$$i_3=-3A$$

$$V_o=2(i_1-i_2)$$

$$\Rightarrow V_o=\frac{57}{4}V=14.25\,V$$

5. Use two different methods to solve i_1, i_2, & i_3 in the following circuit.

4. I



(1) Nodal analysis

$V_1 = 12V$ Node 1

$\frac{V_1 - V_2}{3} - 3 - \frac{V_2}{4} = 0$ Node 2

$V_3 = 2V_0$ Node 3

$V_0 = 3(i_1 - i_2)$

$i_2 = \frac{V_1 - V_3}{3}$

$i_3 - i_2 = 3$

$V_0 = \frac{72}{7} V$

$\Rightarrow V_2 = \frac{12}{7} V$

$V_3 = \frac{144}{7} V$

$i_1 = \frac{4}{7} A \approx 0.57A$

$i_2 = \frac{1}{7} A \approx 0.14A.$

$i_3 = -\frac{20}{7} A \approx -2.86A$

(2) Mesh analysis

$-12 + 3(i_1 - i_2) + 4(i_1 - i_3) = 0$ Mesh 1

$4(i_3 - i_1) + 3(i_2 - i_1) + 3i_2 + 2V_0 = 0$ supermesh

$i_3 - i_2 = 3$

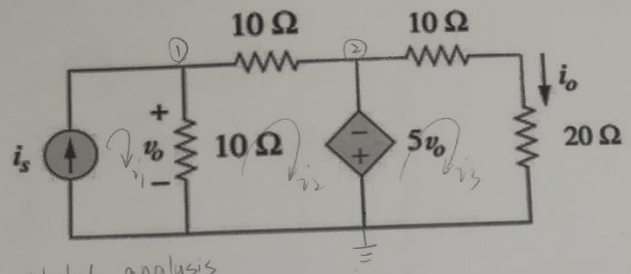
$V_0 = (i_1 - i_2) \times 3$

$i_1 = \frac{4}{7} A \approx 0.57A$

$i_2 = \frac{1}{7} A \approx 0.14A$

$i_3 = -\frac{20}{7} A \approx -2.86A$

6. Calculate i_s/i_o in the following circuit:



(1) Nodal analysis

$$-i_s + \frac{V_1}{10} + \frac{V_1 - V_2}{10} = 0 \quad \text{Node 1}$$

$$V_2 = (20+10)\cdot i_o = -5V_o$$

$$V_1 = V_o$$

$$\Rightarrow \frac{i_s}{i_o} = -\frac{21}{5} = -4.2$$

(2) Mesh analysis

$$i_1 = i_s \quad \text{Mesh 1}$$

$$10(i_2 - i_1) + 10i_2 - 5V_o = 0 \quad \text{Mesh 2}$$

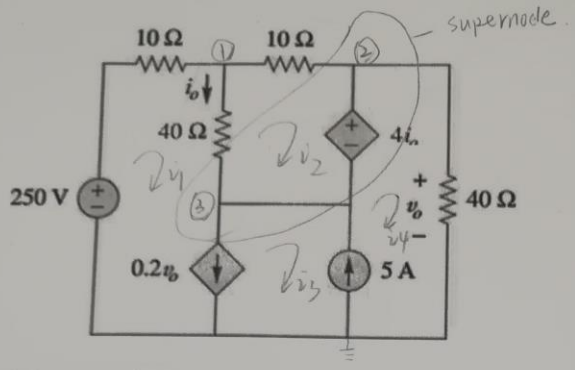
$$5V_o + (10+20)i_3 = 0 \quad \text{Mesh 3}$$

$$i_o = i_3$$

$$V_o = 10(i_1 - i_2)$$

$$\Rightarrow \frac{i_s}{i_o} = -\frac{21}{5} = -4.2$$

7. Find v_o *and* i_o in the following circuit.



Nodal analysis

$$\frac{V_1-250}{10}+\frac{V_1-V_3}{40}+\frac{V_1-V_2}{10}=0 \quad \text{Node 1}$$

$$\frac{V_1-V_3}{40}+\frac{V_1-V_2}{10}-0.2V_0+5=0 \quad \text{Supernode}$$

$$V_1-V_3=40-i_o$$

$$V_2=V_0$$

$$\Rightarrow \begin{cases} V_1=147.72\,V=\frac{68100}{461}\,V \\ V_2=V_0=67.68\,V=\frac{31200}{461}\,V \\ V_3=\frac{27100}{461}\,V=58.79\,V \\ i_o=\frac{1025}{461}\,A=2.22\,A \end{cases}$$

Mesh analysis

KVL

$$-250+10i_1+40(i_1-i_2)+V_3=0 \quad \text{Mesh 1}$$

$$40(i_2-i_1)+10i_2+4v_o=0 \quad \text{Mesh 2}$$

$$-4v_o+40i_4-V_3=0 \quad \text{Mesh 4}$$

KCL

$$i_1=i_o+i_2 \quad \text{Node 1}$$

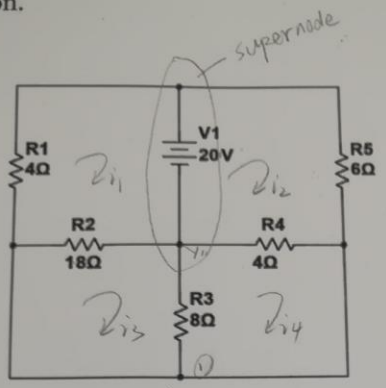
$$0.2V_o+i_3=i_o \quad \text{Node 3}$$

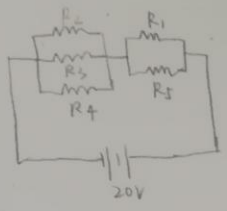
$$5+i_3=i_4$$

$$V_o=40i_4$$

$$\Rightarrow \begin{cases} i_o=2.22\,A \\ V_o=67.68\,V \end{cases}$$

8. Find the current through R2 and R3, indicate their value and direction.





Nodal analysis

$$\frac{V_1-20}{4}+\frac{V_1}{18}+\frac{V_1}{8}+\frac{V_1}{4}+\frac{V_1-20}{6}=0 \Rightarrow V_1=9.84V$$

$$I_{R_2}=\frac{V_1}{18}=0.55A$$

$$I_{R_3}=\frac{V_1}{8}=1.23A$$

Mesh analysis

$$\begin{cases} 4i_1+20+18(i_1-i_3)=0 & \text{Mesh 1} \\ -20+6i_2+4(i_2-i_4)=0 & \text{Mesh 2} \\ 4(i_4-i_2)+8(i_4-i_3)=0 & \text{Mesh 4} \\ 8(i_3-i_4)+18(i_3-i_1)=0 & \text{Mesh 3} \\ i_{R_1}=i_3-i_1 \qquad i_{R_3}=i_4-i_3 \end{cases}$$

$$\Rightarrow \begin{cases} i_1=-2.54A \\ i_2=1.69A \\ i_3=-1.99A \\ i_4=-0.76A \\ i_{R_2}=0.55A \\ i_{R_3}=1.23A \end{cases}$$