112-1
Electrical Engineering Fundamentals I

Quiz 4

Keys

1. 30% Use superposition to obtain i_O for the circuit of Fig. 1.

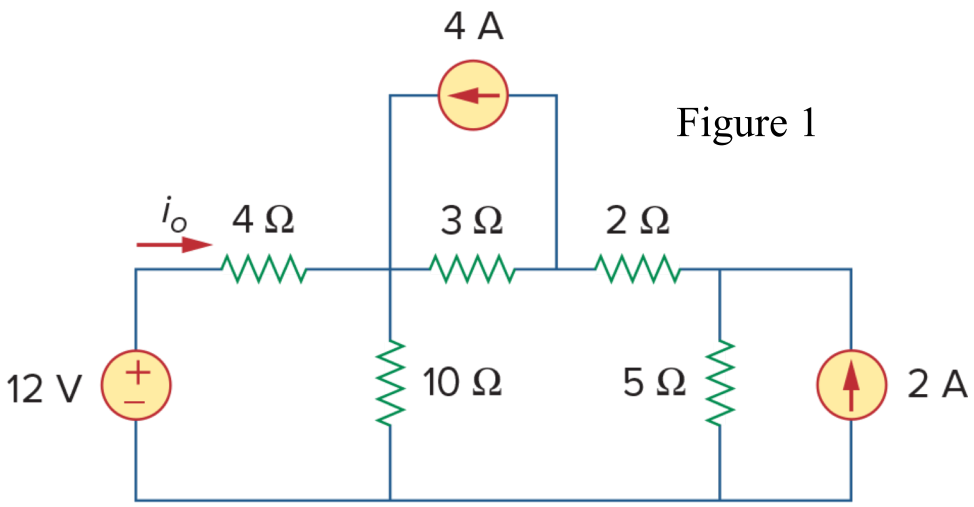
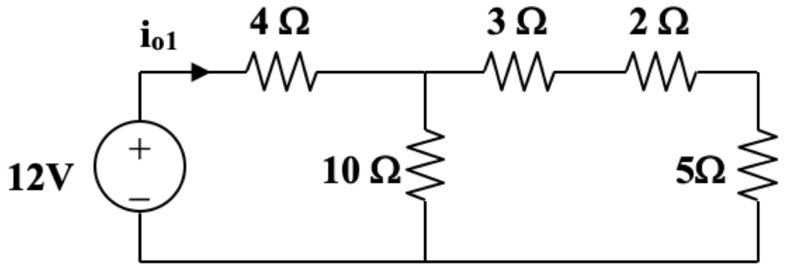


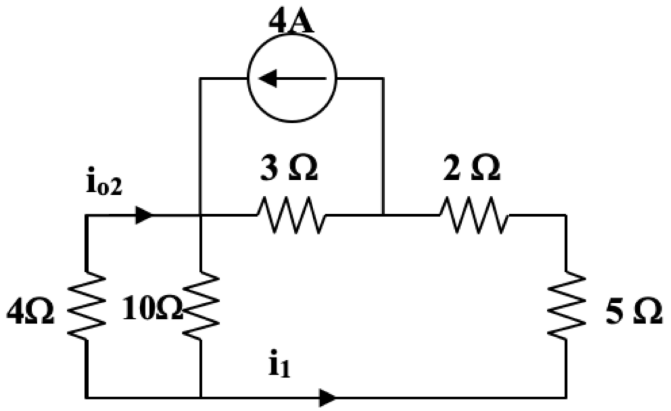
Figure 1

$i_O = i_{O1} + i_{O2} + i_{O3}$ due to the 12-V, 4-A, and 2-A sources



$$R_{eq}=4+10 \parallel (3+2+5) = 9(\Omega)$$

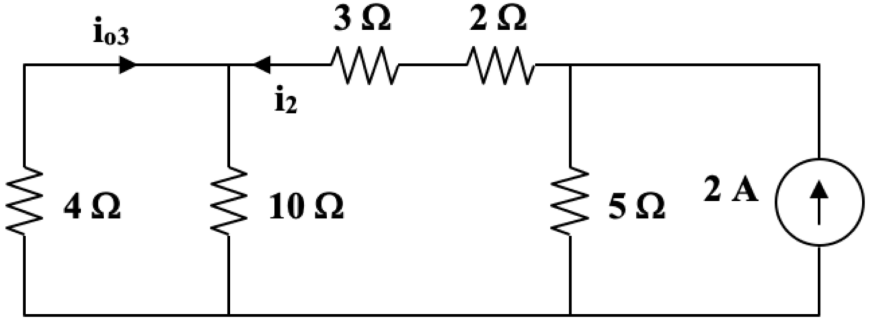
$$i_{O1}=\frac{12}{9} = 1.3333(A)$$



$$R_{eq}=2+5+4 \parallel 10 = \frac{69}{7} = 9.8571(\Omega)$$

$$i_1=4\times\frac{3}{3+9.8571}=0.9333(\mathrm{A})$$

$$i_{O2}=-i_1\times\frac{10}{10+4} = -0.6666(A)$$



$$R_{eq}=2+3+4 \parallel 10 = \frac{55}{7} = 7.8571(\Omega)$$

$$i_2=2\times\frac{5}{5+7.8571}=0.7778(\mathrm{A})$$

$$i_{O3}=-i_2\times\frac{10}{10+4} = -0.5556(A)$$

$$i_O = i_{O1}+i_{O2}+i_{O3}$$
$$= 1.3333 - 0.6666 - 0.5556 = 0.1111(A)$$

2. 20% Use ***source transformation*** to obtain $\boldsymbol{v}_o$ in the circuit of Fig. 2. (Redraw the equivalent circuit as you convert the source.)

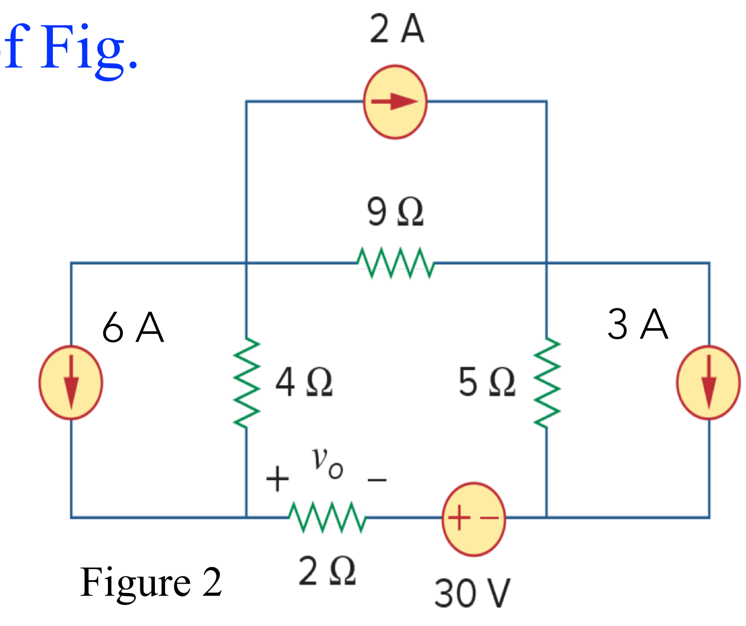
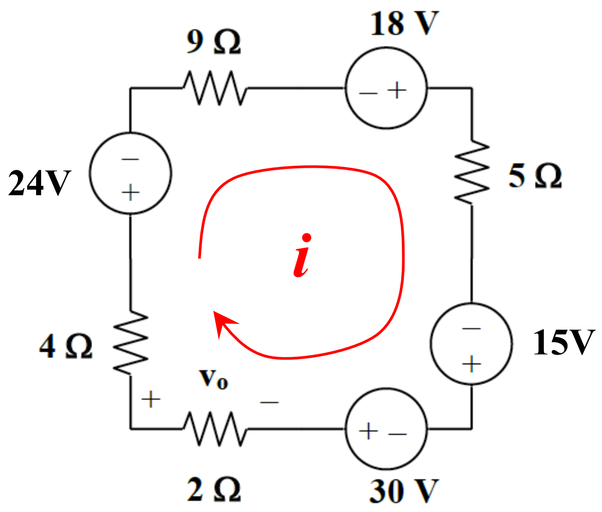


Figure 2

Applying KVL to the loop gives,



$$(9 + 5 + 2 + 4) \cdot i - 18 - 15 - 30 + 24 = 0$$

$$\Rightarrow i = \frac{39}{20} = 1.95\ (A)$$

$$\Rightarrow v_O = -i \times 2 = -3.9\ (V)$$

3. 30% In the circuit of Fig. 3, use Thevenin theorem to find the V_{Th} and R_{Th} across the terminal a-b.

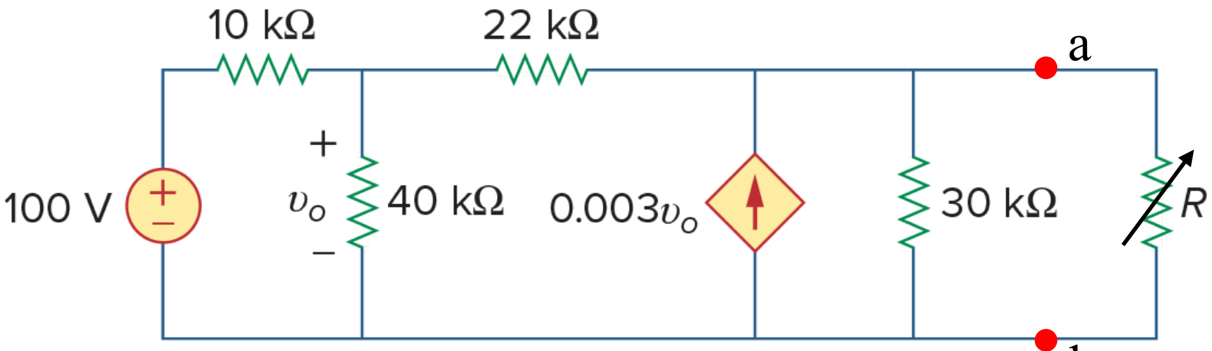
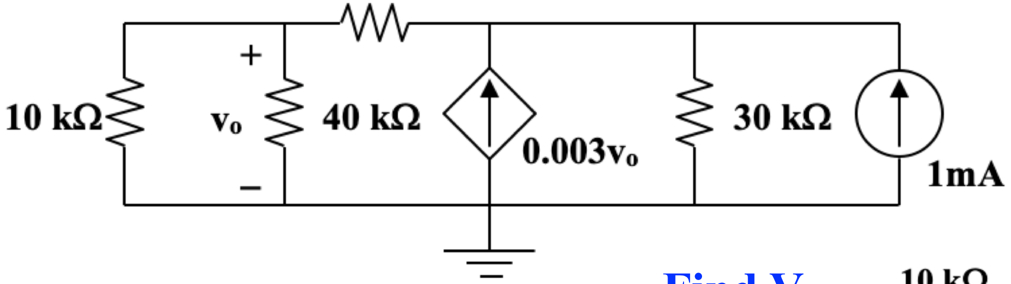


Figure 3

Find R_{Th}



R_{eq}=22+10 ∥ 40 = 30($k\Omega$)

Nodal analysis on v_1:

$$\frac{v_1}{30}+\frac{v_1}{30}=1+3\cdot v_O$$

$$\longrightarrow v_1=15+45v_O$$

$$v_O=v_1\times\frac{10\parallel 40}{22+10\parallel 40}=\frac{4v_1}{15}$$

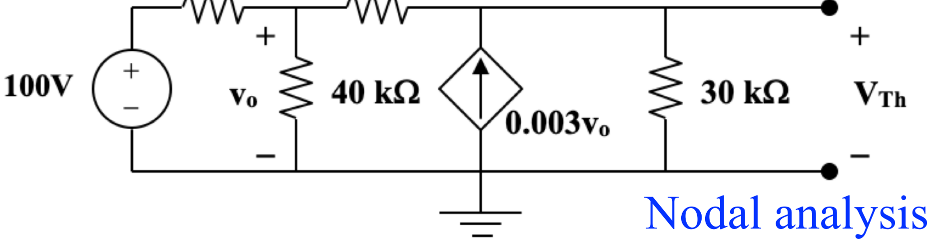
$$\Rightarrow v_1=15+45v_O$$

$$=15+45\times\frac{4}{15}v_1$$

$$\Rightarrow v_1=-\frac{15}{11}=-1.3636(V)$$

$$R_{Th}=\frac{v_1}{i}=-1.3636(k\Omega)$$

Find V_{Th}



Nodal analysis on v_O:

$$\frac{100-v_O}{10}=\frac{v_O}{40}+\frac{v_O-v_1}{22}\cdots\cdots(1)$$

$$\frac{v_O-v_1}{22}+3\cdot v_O=\frac{v_1}{30}\cdots\cdots\cdots\cdots(2)$$

$$\Rightarrow 75v_O-20v_1=4400$$

$$2010v_O-52v_1=0$$

$$\Rightarrow v_1=-243.6364\ (V)$$

$$v_O=-6.3030\ (V)$$

$$V_{Th}=v_1=-243.6364(V)$$

4. 30% For the circuit in Fig. 4,

(A) 10% Use the Norton theorem to obtain equivalent circuit (find I_{SC} and R_N, and draw the Norton equivalent circuit)) at terminals a-b

(B) 10% Convert the Norton equivalent circuit of (A) into its Thevenin's form.

(C) 10% As the circuit is connected to a load, what is the maximal power that can be transferred to the load?

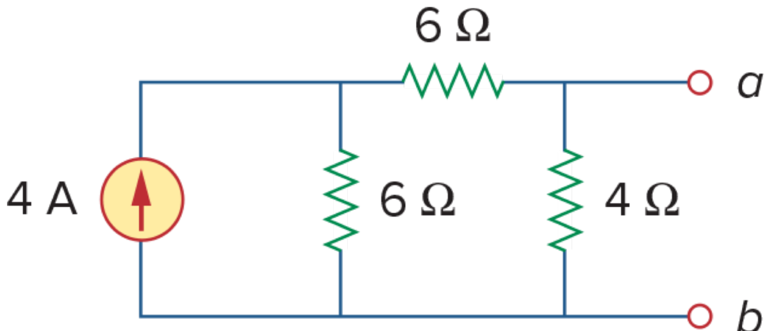
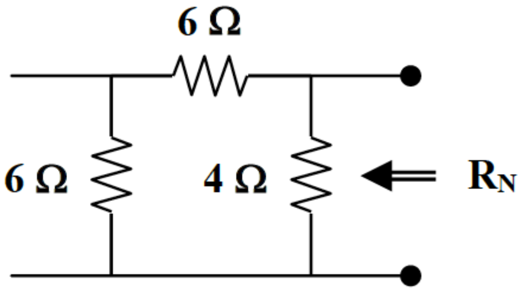


Figure 4

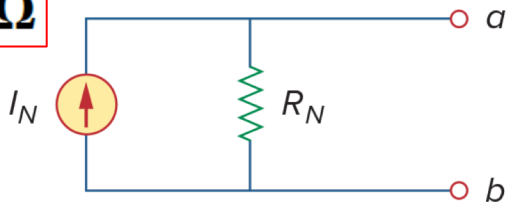
Norton

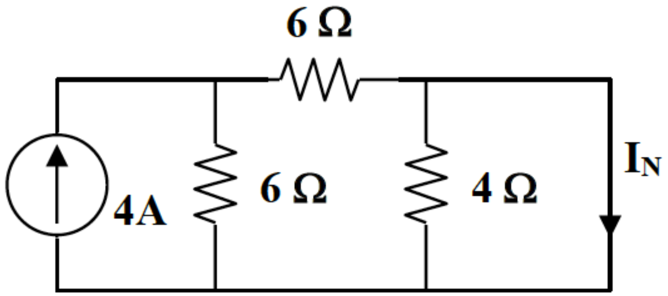
R_N



$\boxed{R_N = (6+6)\|4 = \mathbf{3\ \Omega}}$

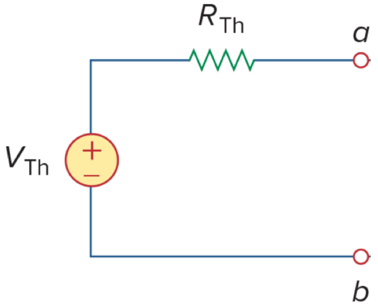
$\boxed{I_N = 4/2 = \mathbf{2\ A}}$





$\boxed{V_{Thev} = 2x3 = \mathbf{6\ V}}$

$\boxed{R_{Th} = R_N = 3\ (\Omega)}$



$$P_{max} = \frac{V_{Th}^2}{4 \cdot R_{Th}} = \frac{6^2}{4 \cdot 3} = 3\ (w)$$