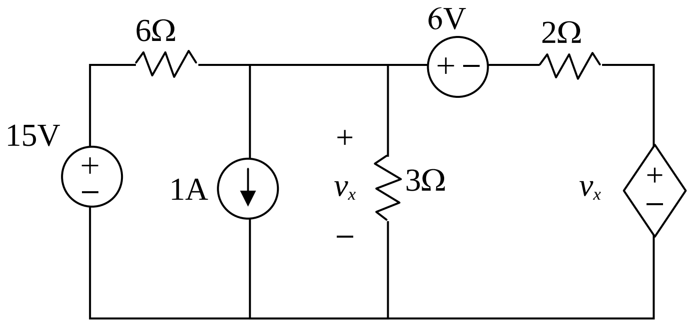
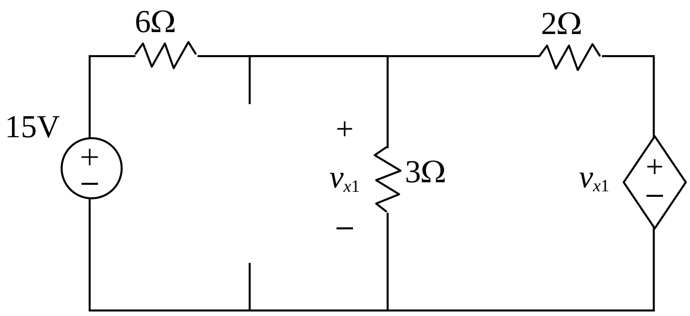
國立交通大學 95 暑修課程 電路一 Quiz-2 (Chap5 and 6)Sol

1. Use superposition to determine voltage v_x in the circuit on the right.



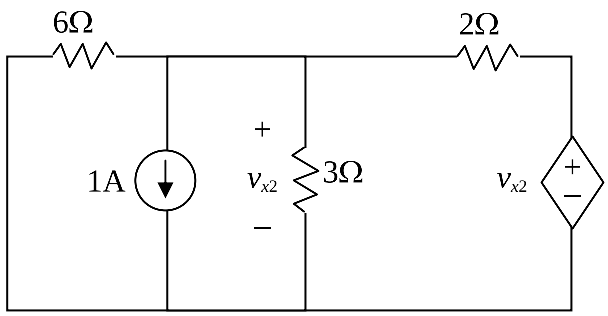
Sol:

(1) v_{x1}



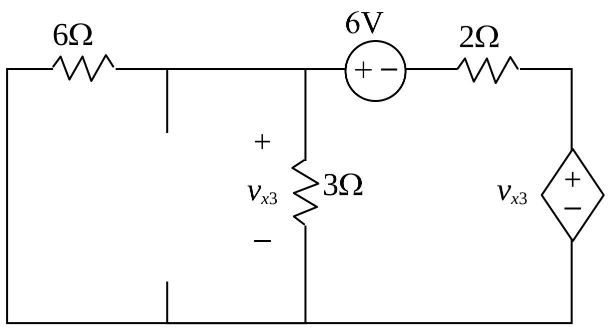
$$\frac{v_{x1}-15}{6}+\frac{v_{x1}}{3}+\frac{v_{x1}-v_{x1}}{2}=0$$
$$\Rightarrow v_{x1}-15+2v_{x1}=0 \Rightarrow v_{x1}=5$$

(2) v_{x2}



$$\frac{v_{x2}}{6}+1+\frac{v_{x2}}{3}+\frac{v_{x2}-v_{x2}}{2}=0$$
$$\Rightarrow v_{x2}+6+2v_{x2}=0 \Rightarrow v_{x1}=-2$$

(3) v_{x3}

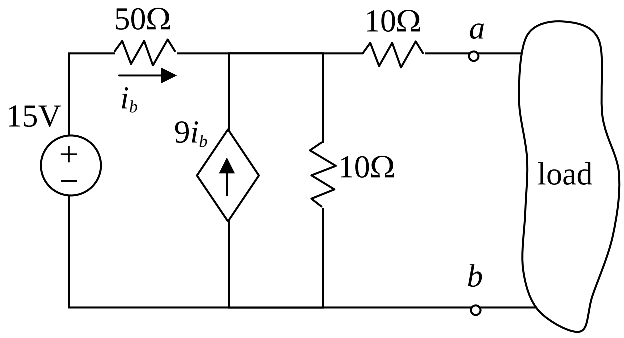


$$\frac{v_{x3}}{6}+\frac{v_{x2}}{3}+\frac{v_{x3}-6-v_{x3}}{2}=0$$
$$\Rightarrow v_{x3}+2v_{x3}-18=0 \Rightarrow v_{x1}=6$$

Hence,

$$v_x=v_{x1}+v_{x2}+v_{x3}=5-2+6=9\text{ V}$$

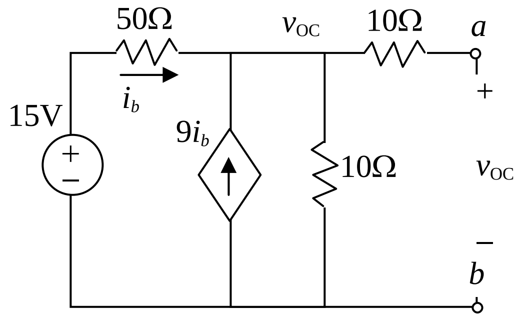
2. (a) Determine the Thevenin and Norton equivalents circuit to the left of terminals *a* and *b*.



(b) If the load can absorb maximum power from the source, what is the equivalent resistance to the right of terminals *a* and *b*? What is the maximum power?

Sol:

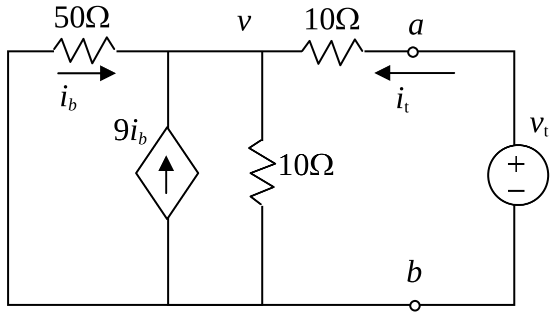
(a) Thevenin equivalent circuit is derived as below:



<i> v_{OC}:

$$i_b = \frac{15 - v_{OC}}{50}, \qquad i_b + 9i_b = \frac{v_{OC}}{10} \Rightarrow i_b = \frac{v_{OC}}{100} = \frac{15 - v_{OC}}{50} \Rightarrow v_{OC} = 10$$

<ii> R_{Th} (idle source)



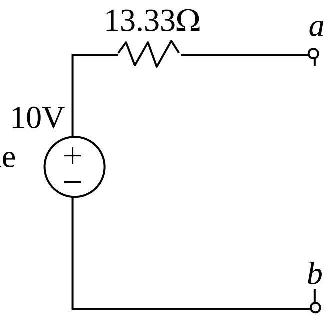
$$i_b = -\frac{v}{50}$$

$$i_b + 9i_b + i_t = \frac{v}{10}$$

$$\Rightarrow i_b = \frac{v - 10i_t}{100} = -\frac{v}{50} \Rightarrow v = \frac{10}{3} i_t$$

$$v_t = 10i_t + v = 13.33 i_t$$

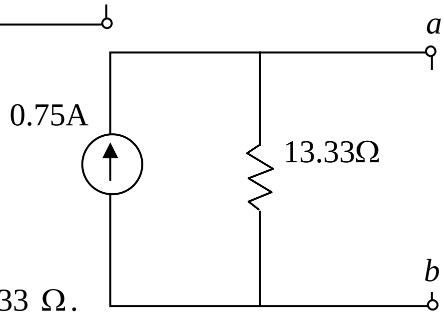
Hence, $R_{Th} = \frac{v_t}{i_t} = 13.33\ \Omega$.



As for the Norton equivalent circuit, the current source and resistance is

$$i_{SC} = \frac{v_{OC}}{R_{Th}} = \frac{10}{13.33} = 0.75\,\text{A}$$

$$R_N = R_{Th} = 13.33\ \Omega$$



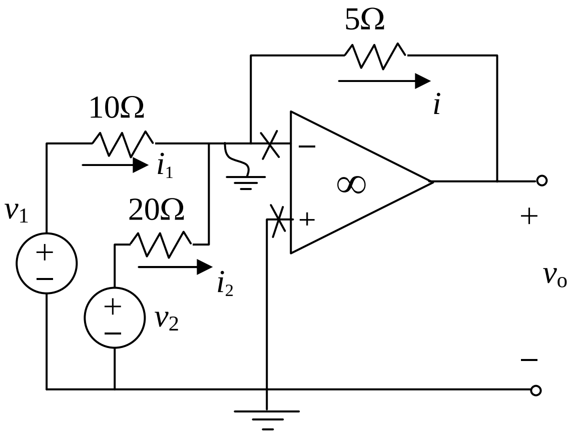
Hence, the Thevenin and Norton equivalent circuits are shown on the right.

(b) The equivalent resistance of the load that absorbs maximum power is matched, i.e., $R_L = R_N = R_{Th} = 13.33\ \Omega$.

The maximum power is $\frac{1}{2} R_L \left(\frac{10}{13.33 + R_L} \right)^2 = \frac{15}{16}\,\text{W}$.

3. Given v_1=1V and v_2=2V, find the output voltages v_o of the circuits (a) and (b).

Sol:



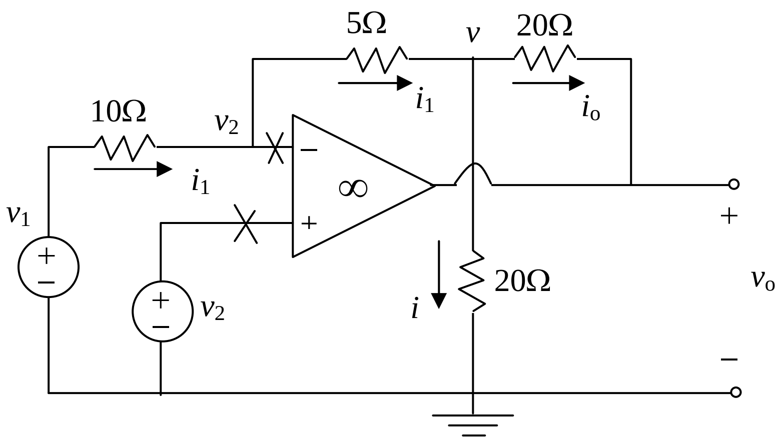
(a) $i_1 = \frac{v_1}{10}$, $i_2 = \frac{v_2}{20}$, $i = -\frac{v_o}{5}$

Since $i = i_1 + i_2$, we have

$$-\frac{v_o}{5} = \frac{v_1}{10} + \frac{v_2}{20}$$

$$\Rightarrow v_o = -\frac{1}{2}v_1 - \frac{1}{4}v_2 = -1 \text{ V}$$

(b)



$$i_1 = \frac{v_2 - v}{5} = \frac{v_1 - v_2}{10} = -0.1\,\text{A} \Rightarrow v = -\frac{1}{2}v_1 + \frac{3}{2}v_2 = 2.5\,\text{V}$$

$$i = \frac{v}{20} = 0.125\,\text{V}, \quad i_o = \frac{v - v_o}{20} = i_1 - i = -0.225\,\text{A}$$

Hence, $v_o = 7\,\text{V}$.