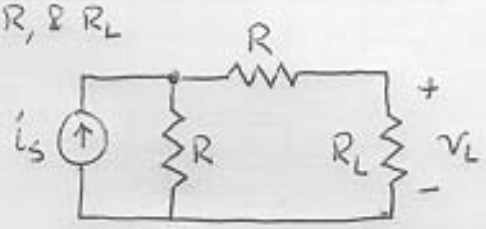
Homework II

Ch. 2: 42, 43, 45, 49, 51, 52, 56
Ch. 3: 37, 38, 41

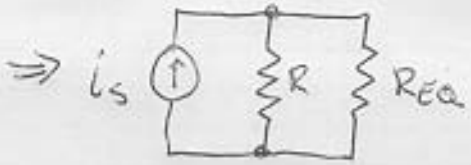
P. 2.42 Find v_L in terms of i_s, R, & R_L



$R_{EQ} = R + R_L$

current division

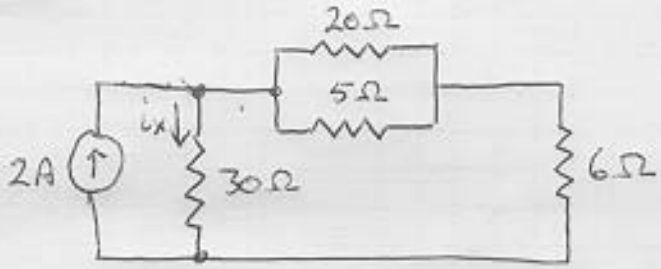
$$i_L = \frac{R}{R+(R+R_L)}\, i_s$$



$v_L = i_L R_L$

$$\boxed{v_L = \frac{R R_L}{2R + R_L}\, i_s}$$

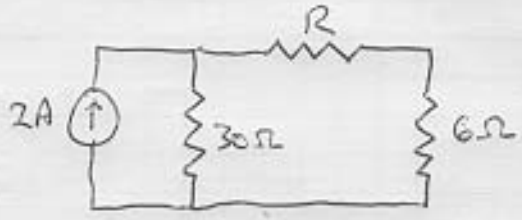
P. 2.43 Find i_x



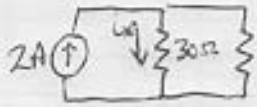
current division

$$i_x = \frac{10}{10+30}(2A)$$

$$\boxed{i_x = 0.5A}$$



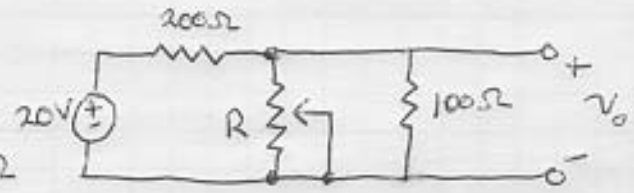
$$R = \frac{(20)(5)}{20+5}\,\Omega = 4\,\Omega$$



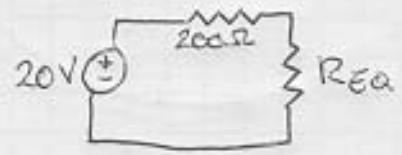
$R_{EQ} = 6\Omega + 4\Omega = 10\,\Omega$

P. 2.45 Find range of v_o

$$R_{EQ} = \frac{R(100)}{R+100} \qquad 0\Omega \le R_{EQ} \le 50\Omega$$



$0 \le R \le 100\,\Omega$



voltage division

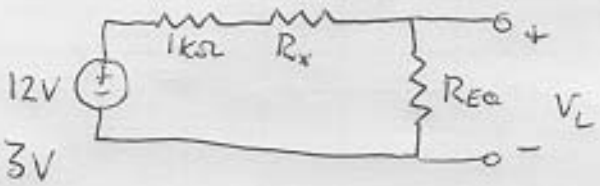
$$v_o = \frac{R_{EQ}}{200+R_{EQ}}(20V)$$

$$\boxed{0V \le v_o \le 4V}$$

P.2.49 Select R_x such that $v_L = 3V$

$$R_{EQ} = \frac{(1)(1)}{1+1}\,k\Omega$$

$$= 500\,\Omega$$



voltage division

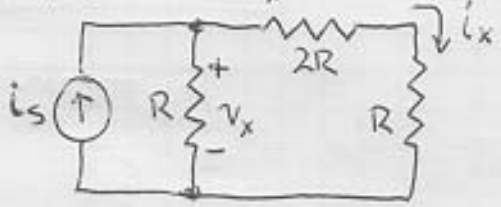
$$v_L = \frac{R_{EQ}}{1k\Omega + R_x + R_{EQ}}(12V) = 3V$$

solve for R_x

$$R_x = \frac{(R_{EQ})(12V)}{(3V)} - 1k\Omega - R_{EQ}$$

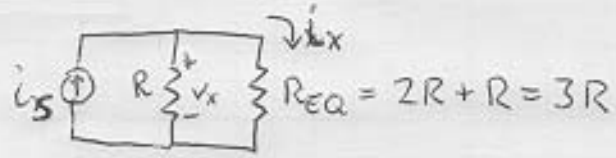
$$\boxed{R_x = 500\,\Omega}$$

P.2.51 Use circuit reduction to find v_x & i_x



current division

$$i_x = \frac{R}{R+3R} i_s = \boxed{\frac{i_s}{4}}$$

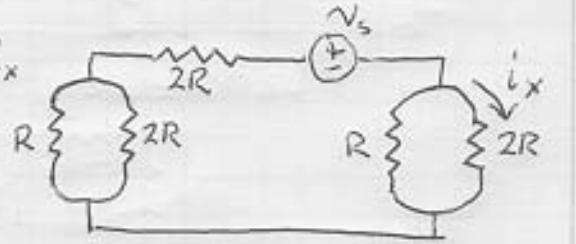


$$v_x = R(i_s - i_x)$$

$$= R\left(i_s - \frac{i_s}{4}\right)$$

$$\boxed{v_x = \frac{3}{4} i_s R}$$

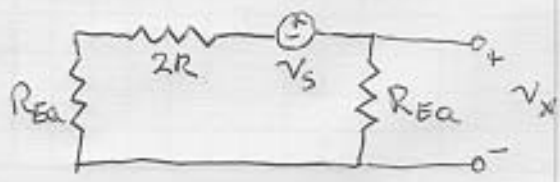
P.2.52 Use circuit reduction to find i_x



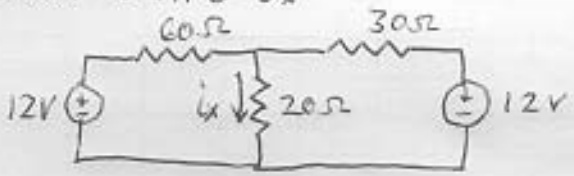
$$R_{EQ} = \frac{(2R)(R)}{2R+R} = \frac{2}{3}R$$

$$v_x = \frac{\left(\frac{2}{3}R\right)}{\left(\frac{10}{3}R\right)} v_s = \frac{v_s}{5}$$

$$i_x = \frac{v_x}{2R} = \boxed{\frac{v_s}{10R}}$$



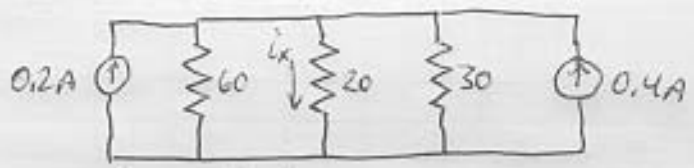
P.2.56 Use source transformation to find i_x



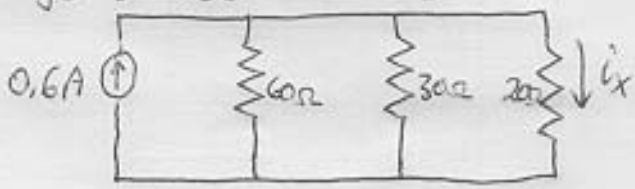
current division

$$i_x = \frac{\left(\frac{1}{20}\right)}{\frac{1}{60}+\frac{1}{30}+\frac{1}{20}}(0.6A)$$

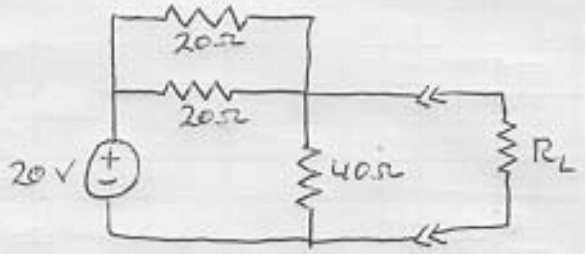
$$\boxed{i_x = 0.3A}$$



rearrange & add sources



P.3.37 Find Thevenin Equivalent circuit. Find voltage across load when $R_L = 5\Omega$, 10Ω, and 50Ω



Step 1 - remove load & find voltage between the terminals of the interface.

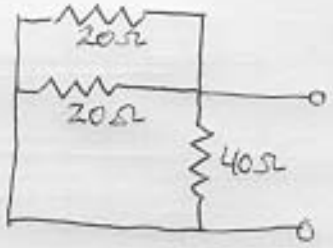
$$R = \frac{(20)(20)}{20+20}\Omega = 10\Omega$$

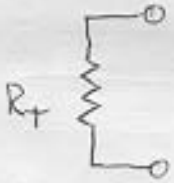
voltage division

$$v_T = \frac{40}{10+40}(20V)$$

$$\boxed{v_T = 16V}$$

Step 2 - find the equivalent resistance seen by the load, turn off all sources.



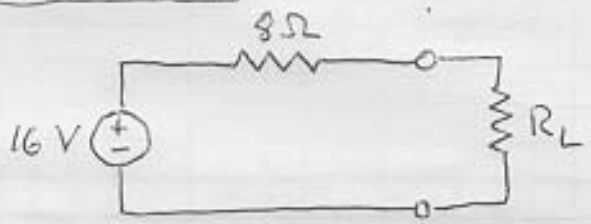
$\Rightarrow$ 

$$\frac{1}{R_T} = \frac{1}{20\Omega} + \frac{1}{20\Omega} + \frac{1}{40\Omega}$$

$$R_T = \frac{(20)(20)(40)}{(20)(20)+(20)(40)+(20)(40)}$$

$$\boxed{R_T = 8\Omega}$$

Thevenin Circuit



When

$R_L = 5\Omega$ $\quad v_L = \frac{5}{8+5}(16V)$

$$\boxed{v_L = \frac{80}{16}V \approx 6.15V}$$

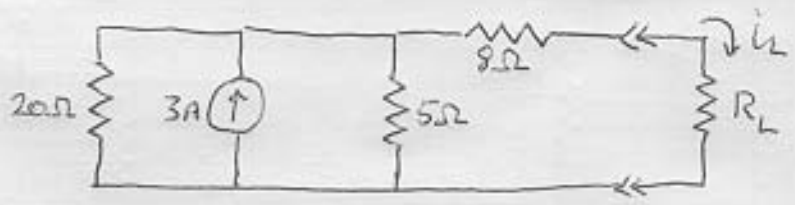
$R_L = 10\Omega$ $\quad v_L = \frac{10}{8+10}(16V)$

$$\boxed{v_L = \frac{80}{9}V \approx 8.89V}$$

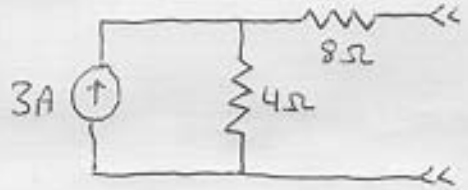
$R_L = 50\Omega$ $\quad v_L = \frac{50}{8+50}(16V)$

$$\boxed{v_L = \frac{400}{29}V \approx 13.8V}$$

P.3.38 Find Norton equivalent circuit. Find current through load when $R_L = 6\Omega, 12\Omega,$ and 60Ω

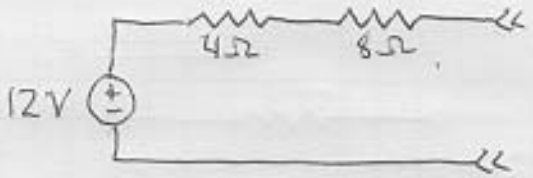


$20\Omega \parallel 5\Omega$

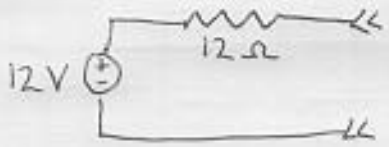


$\frac{(20)(5)}{20+5}\Omega = 4\Omega$

Source transformation



$(3A)(4\Omega) = 12V$



source transf.

Norton Circuit

$\frac{(12V)}{(12\Omega)} = 1A$

When

$R_L = 6\Omega$ $\quad i_L = \frac{12}{12+6}(1A) =$

$$\boxed{i_L = \tfrac{2}{3}A \approx 0.67A}$$

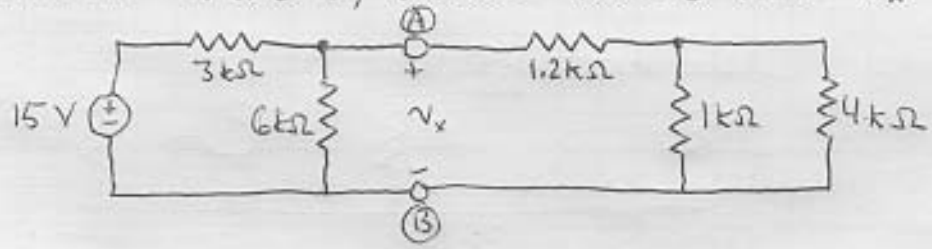
$R_L = 12\Omega$ $\quad i_L = \frac{12}{12+12}(1A)$

$$\boxed{i_L = \tfrac{1}{2}A = 0.5A}$$

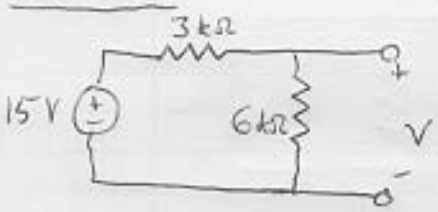
$R_L = 60\Omega$ $\quad i_L = \frac{12}{12+60}(1A)$

$$\boxed{i_L = \tfrac{1}{6}A \approx 0.17A}$$

P.3.41 Find Thevenin equivalent circuits on both sides of terminals A and B, connect them & find v_x



left side



Step 1

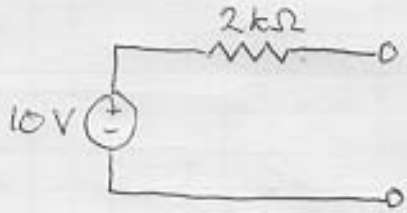
$$v = \left(\frac{6k\Omega}{3k\Omega + 6k\Omega}\right)(15\,V)$$

$$v = 10\,V$$

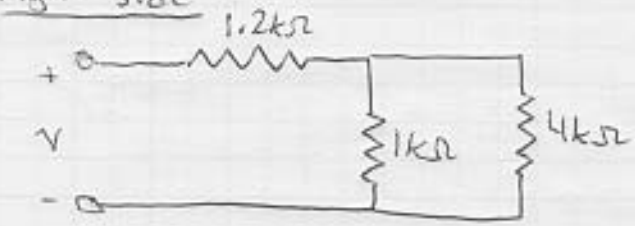
Step 2

$$R_{EQ} = \frac{(3)(6)}{3+6}\,k\Omega$$

$$= 2\,k\Omega$$



right side



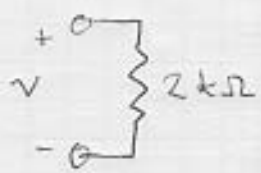
Step 1

$v = 0$ (no source)

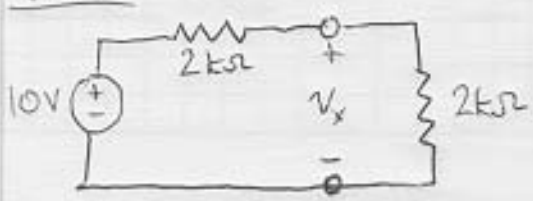
Step 2

$$R_T = 1.2k\Omega + \frac{(1)(4)}{1+4}\,k\Omega$$

$$= 2\,k\Omega$$



join



voltage division

$$v_x = \frac{(2)}{2+2}(10\,V) = \boxed{5\,V}$$