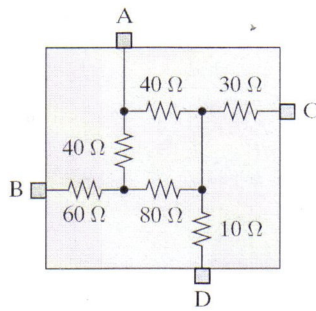
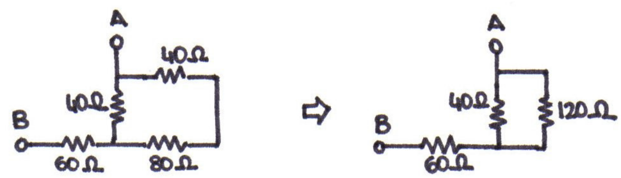
Problem#1: Problem 2-31 textbook

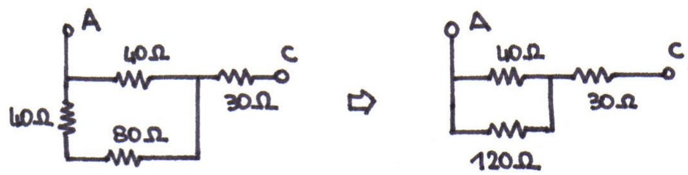
Find the equivalent resistance between terminals A-B, A-C, A-D, B-C, B-D, and C-D.





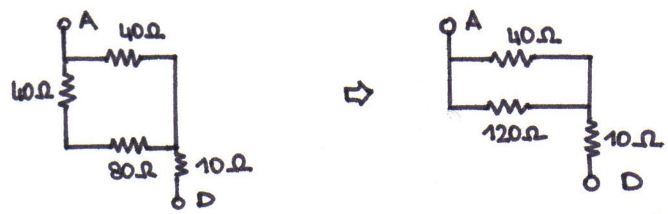
$$\underline{\underline{R_{AB}}} = (60 + 40 // 120)\,\Omega$$

$$= 60 + \frac{40 \cdot 120}{40+120} = \underline{\underline{90\,\Omega}}$$



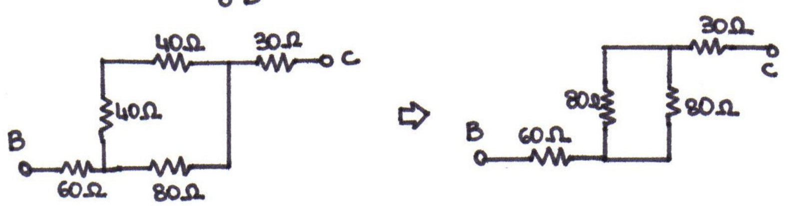
$$\underline{\underline{R_{AC}}} = (30 + 40 // 120)\,\Omega$$

$$= 30 + \frac{40 \cdot 120}{40+120} = \underline{\underline{60\,\Omega}}$$



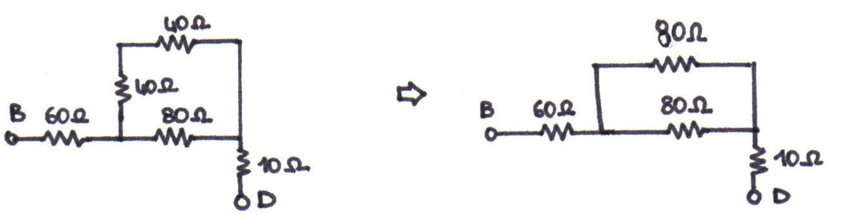
$$\underline{\underline{R_{AD}}} = (10 + 40 // 120)\,\Omega$$

$$= 10 + \frac{40 \cdot 120}{40+120} = \underline{\underline{40\,\Omega}}$$



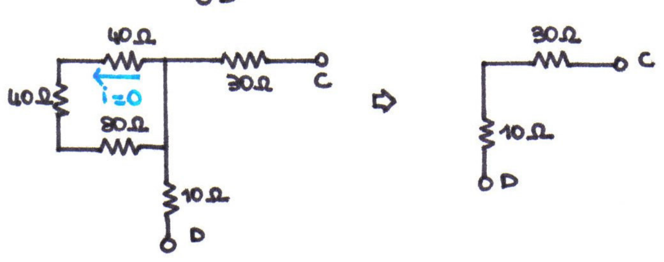
$$\underline{\underline{R_{BC}}} = (60 + 80 // 80 + 30)\,\Omega$$

$$= 60 + \frac{80 \cdot 80}{80+80} + 30 = \underline{\underline{130\,\Omega}}$$



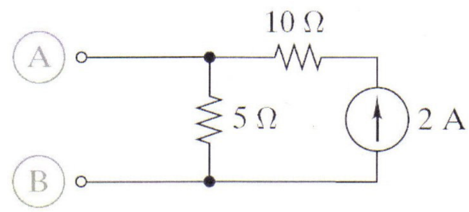
$$\underline{\underline{R_{BD}}} = (60 + 80 // 80 + 10)\,\Omega$$

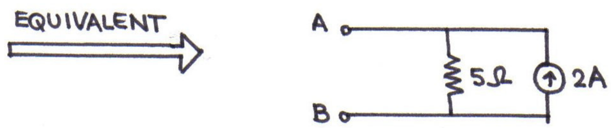
$$= 60 + \frac{80 \cdot 80}{80+80} + 10 = \underline{\underline{110\,\Omega}}$$

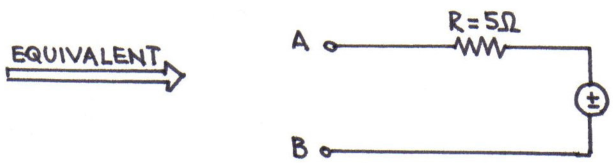


$$\underline{\underline{R_{CD}}} = 30 + 10 = \underline{\underline{40\,\Omega}}$$

Problem#2: Problem 2-34 textbook
Find the equivalent practical voltage source at terminals A and B.

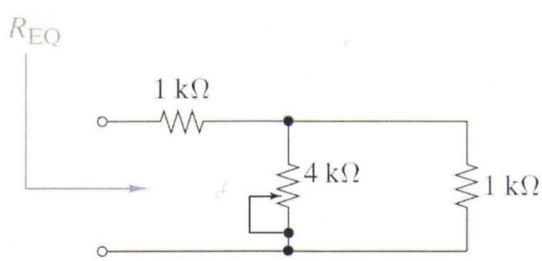




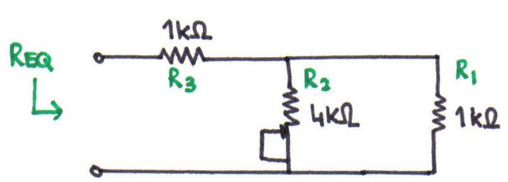


$V_s = R \cdot i_s = 5 \cdot 2 = \boxed{10V}$

Problem#3: Problem 2-39 textbook
What is the range of R_{EQ}?



CASE 1

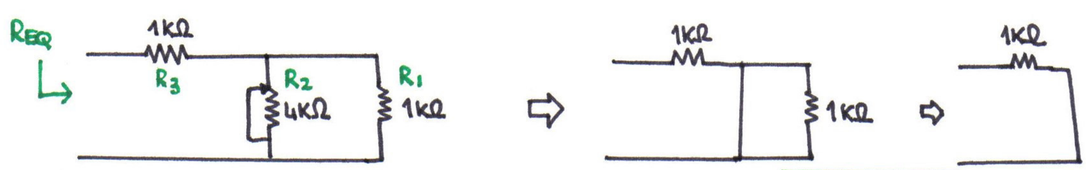


$R_{EQ} = R_3 + (R_1 // R_2)$

$R_1 // R_2 = \frac{R_1 R_2}{R_1 + R_2} = \frac{4 \cdot 1}{4+1} = \frac{4}{5}\Omega$

$R_{EQ} = 1 + \frac{4}{5} = \frac{9}{5} = \boxed{1.8\ \Omega}$

CASE 2

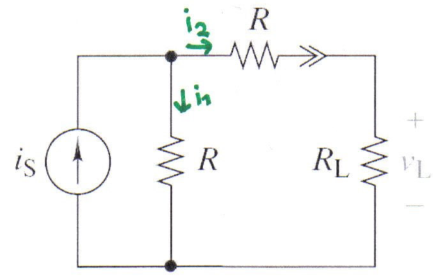


$\boxed{R_{EQ} = 1k\Omega}$

The range of REQ is $\boxed{[1, 1.8]\ \Omega}$

Problem#4: Problem 2-42 textbook

Use the current division to obtain an expression for V_L in terms of R and R_L and i_s.



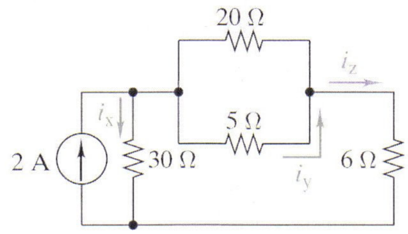
$$R_{EQ} = R + R_L$$

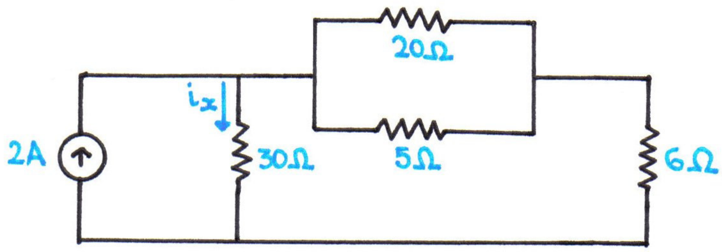
$$i_2 = \frac{R}{R_{EQ}} i_s = \frac{R}{R + R_L} i_s$$

$$\boxed{V_L} = R_L \cdot i_2 = \boxed{\frac{R R_L}{R + R_L} i_s}$$

Problem#5: Problem 2-43 textbook

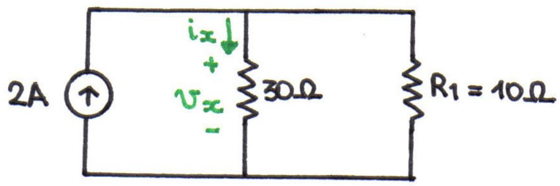
Find i_x in the given circuit.





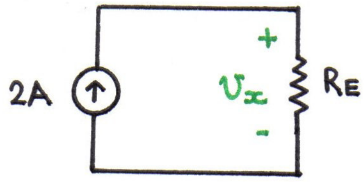
$$R_1 = 6 + 20 // 5$$

$$= 6 + \frac{5 \cdot 20}{20+5} = 6 + 4 = 10\,\Omega$$



$$i_x = \frac{v_x}{30}\ \text{A}$$

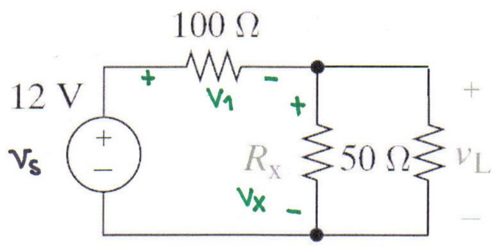
$$R_E = 30 // 10 = \frac{30 \cdot 10}{30+10} = \frac{30}{4} = 7.5\,\Omega$$



$$v_x = R_E \cdot 2 = 15\ \text{V}$$

$$\underline{\underline{i_x}} = \frac{v_x}{30} = \frac{15}{30} = \underline{\underline{0.5\ \text{A}}}$$

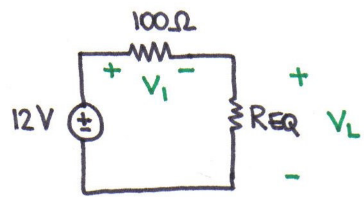
Problem#6: Problem 2-50 textbook
Select a positive value for Rx so that v_L=6 V.



$V_x = V_L = 6V$

Since $V_s = 12V$ then $V_1 = 6V$

Let $R_{EQ} = R_x \,//\, 50\Omega$, then

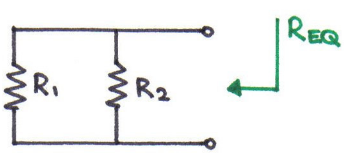


$V_L = 6V \Leftrightarrow R_{EQ} = 100\,\Omega$

$R_{EQ} = \dfrac{R_x \cdot 50\,\Omega}{R_x + 50} = 100\,\Omega \Rightarrow \overset{2}{\cancel{100}}\,(R_x + 50) = \cancel{50}\,R_x$

$R_x = -100\Omega$ UNFEASIBLE !!

NOTE ON PARALLEL CONNECTION



$$R_{EQ} = R_1 \,//\, R_2 = \frac{R_1 R_2}{R_1 + R_2} < \min\{R_1, R_2\}$$

In fact, since $R_1 > 0$, $R_2 > 0$

$R_1 R_2 < R_1 R_2 + R_1^2 = R_1 (R_1 + R_2) \Rightarrow \dfrac{R_1 R_2}{R_1 + R_2} < R_1$

$R_1 R_2 < R_1 R_2 + R_2^2 = R_2 (R_1 + R_2) \Rightarrow \dfrac{R_1 \cdot R_2}{R_1 R_2} < R_2$

NOTE THAT, IF $R_1 = R_2$, THEN $R_{EQ} = R_1/2 = R_2/2$

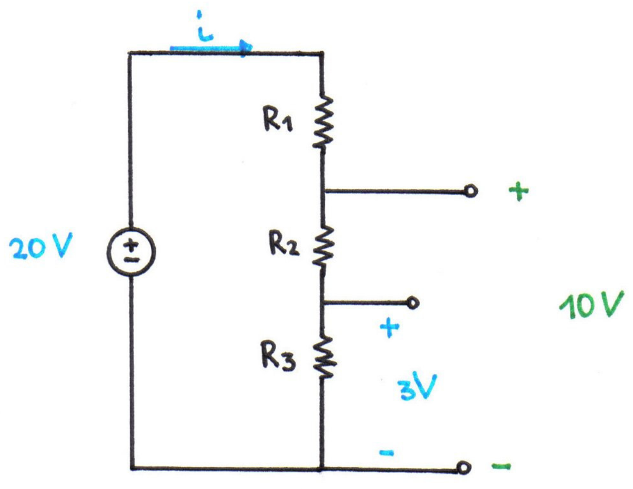
We want $R_{EQ} = R_x \,//\, 50 = 100\Omega$ but using the previous note we have that $R_{EQ} < 50\Omega$ for every $R_x > 0$

as a result, the problem does not have a feasible solution.

↓ positive Rx

Problem#7: Problem 2-48 textbook

Select the values of R_1 and R_2 and R_3 so that the voltage divider produces the shown output voltages.



$$i = \frac{V}{R} = \frac{20}{R_1+R_2+R_3}$$

$$(R_2+R_3)\cdot i = 10\ V \quad \Rightarrow \quad \frac{(R_2+R_3)\,20}{R_1+R_2+R_3} = 10$$

$$20\,(R_2+R_3) = 10\,(R_1+R_2+R_3)$$

$$10R_1 - 10R_2 - 10R_3 = 0 \qquad (A)$$

$$R_3\cdot i = 3V \quad \Rightarrow \quad \frac{R_3\cdot 20}{R_1+R_2+R_3} = 3$$

$$3R_1 + 3R_2 - 17R_3 = 0 \qquad (B)$$

You have

2 EQUATIONS ((A) & (B)) = 2 CONSTRAINTS

3 UNKNOWNS (R_1, R_2, R_3)

↳ you have 1 degree of freedom ; for instance choose $R_1 = 10\Omega$.

Then (A) becomes $R_2 + R_3 = 10$

(B) becomes $3R_2 - 17R_3 = 30$

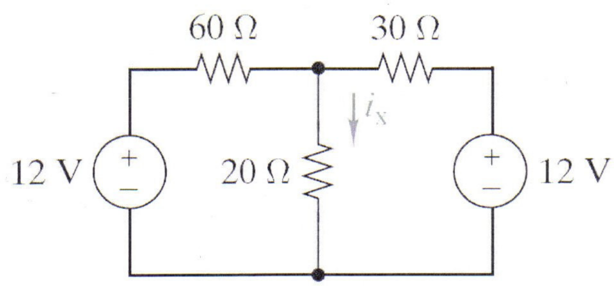
$$\begin{cases} R_2 + R_3 = 10 & (1) \\ 3R_2 - 17R_3 = 30 & (2) \end{cases}$$

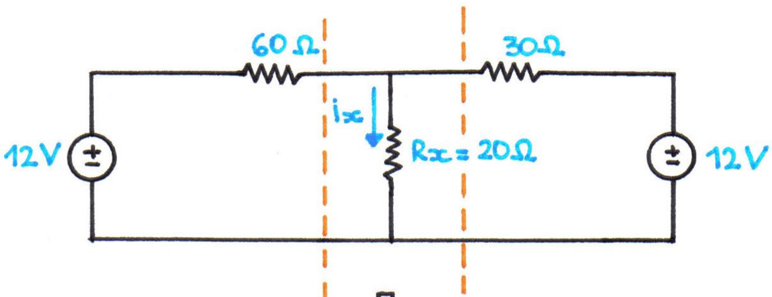
(2) − 3·(1) ⇨ $-17R_3 - 3(R_3) = -30 - 3\cdot(10)$ ⇨ $R_3 = 3\Omega$

substituting in (1) ⇨ $R_2 = 7\Omega$

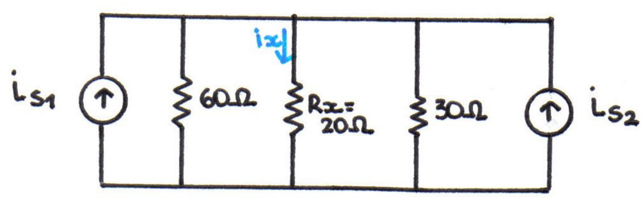
Problem#8: Problem 2-56 textbook

Use source transformation to find i_x.





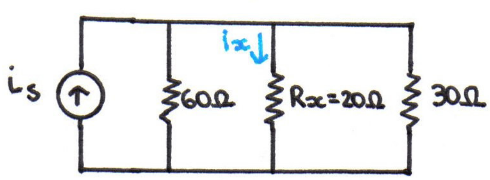
Use source transformation to find i_x



source transformation

$$i_{s1} = \frac{12}{60}\ \text{A} = 0.2\ \text{A}$$

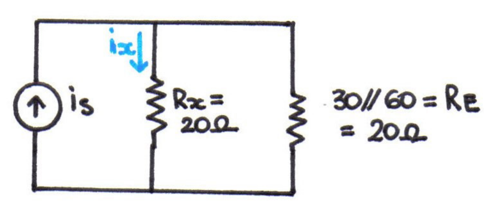
$$i_{s2} = \frac{12}{30}\ \text{A} = 0.4\ \text{A}$$



composite source

$$i_s = i_{s1} + i_{s2} = 0.2 + 0.4 = 0.6\ \text{A}$$

Since $30 // 60 = \dfrac{30 \cdot 60}{30 + 60} = 20\Omega$

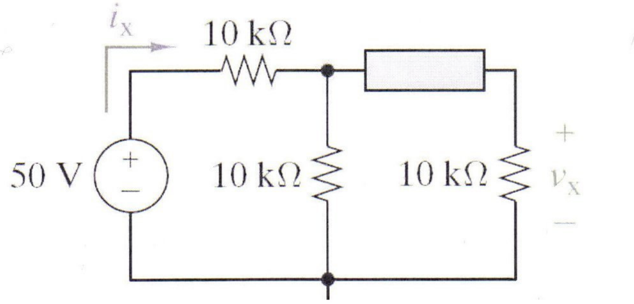


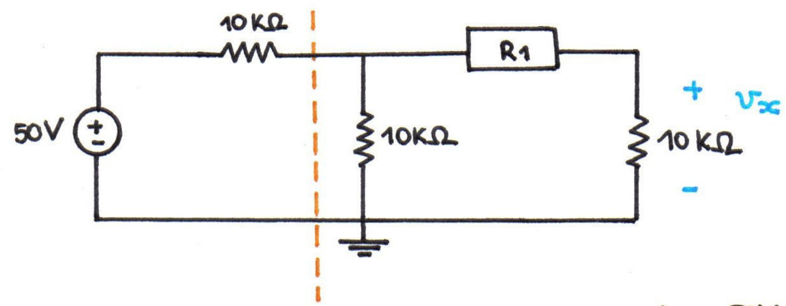
then $R_E = R_x$ and thus

$$\underline{\underline{i_x}} = \frac{i_s}{2} = \underline{\underline{0.3\ \text{A}}}$$

Problem#9: Problem 2-60 textbook

The box in the circuit is a resistor whose value can be anywhere between 8 kΩ and 80 kΩ. Write a MATLAB program to find the range of values of v_x using circuit reduction.



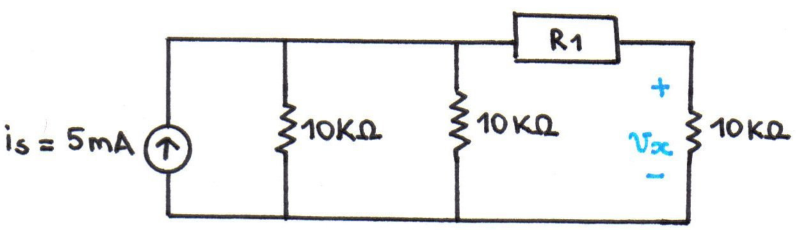


$8\ K\Omega \leq R_1 \leq 80\ K\Omega$

Use circuit reduction to find the range of values of v_x

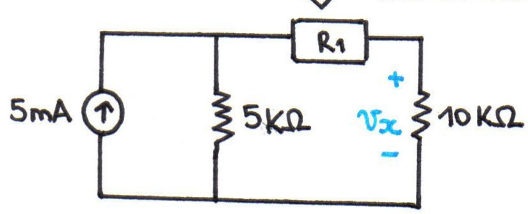
⇩ SOURCE TRANSFORMATION

$$i_s = \frac{50V}{10K\Omega} = 5mA$$

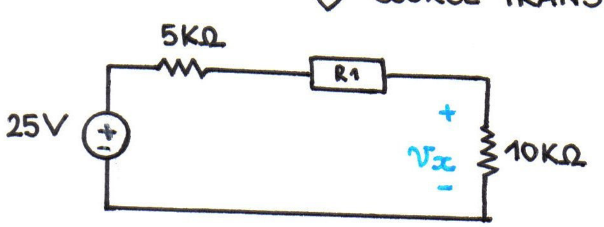


$$10 // 10 = \frac{10 \cdot 10}{10 + 10} = 5K\Omega$$

⇩ RESISTORS CONNECTED IN //



⇩ SOURCE TRANSFORMATION $\quad v = 5 \cdot 10^{-3} \cdot 5 \cdot 10^{3} = 25V$



$8K\Omega \leq R_1 \leq 80K\Omega$

Applying the voltage division rule

$R_1 = 8K\Omega \Rightarrow \quad v_x = \left(\frac{10}{5+8+10}\right) \cdot 25 = \underline{\underline{10.87\ V}}$

$R_1 = 80\ K\Omega \Rightarrow \quad v_x = \left(\frac{10}{5+80+10}\right) \cdot 25 = \underline{\underline{2.6316\ V}}$