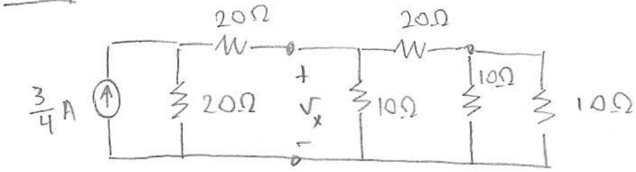
2-53



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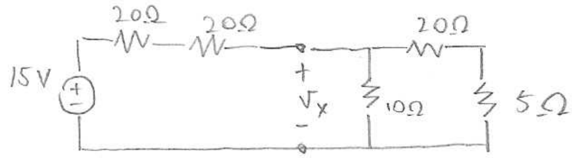

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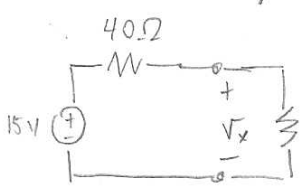

$$\frac{10 \times 25}{10 + 25} = \frac{250}{35}$$

$$V_x = 15 \times \frac{250/3}{40 + 250/3}$$

$$\boxed{V_x \approx 2.273}$$

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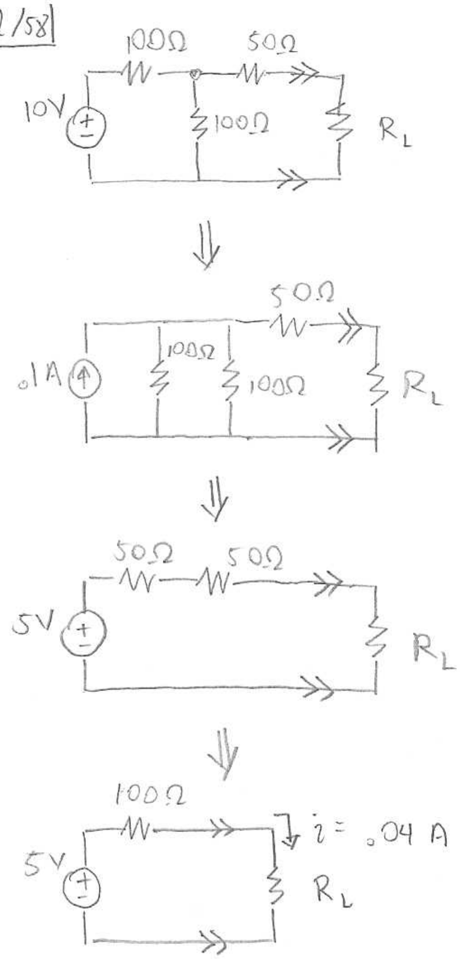

KVL: $-5 + .04 \times 100 + .04 \times R_L = 0$

$R_L = 125 - 100\ \Omega$

$\boxed{R_L = 25\ \Omega}$

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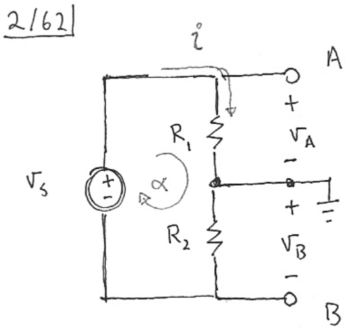


$$v_A = i R_1$$

$$v_B = - i R_2$$

KVL @ α

$$v_s - v_A + v_B = 0$$

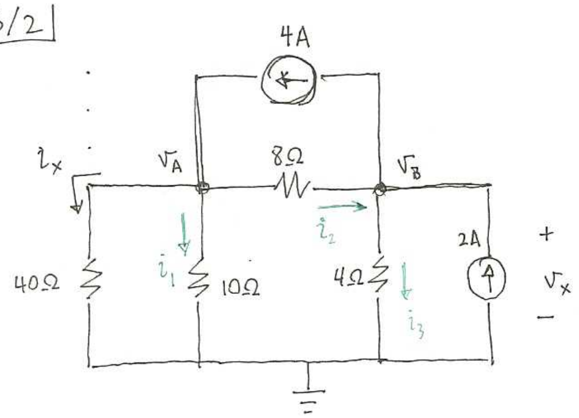
$$v_s - i R_1 - i R_2 = 0$$

$$i = \frac{v_s}{R_1 + R_2}$$

$$\therefore \quad v_A = v_s \frac{R_1}{R_1 + R_2}$$

$$v_B = - v_s \frac{R_2}{R_1 + R_2}$$

3/2



KCL@A: $4 - i_x - i_1 - i_2 = 0$
KCL@B: $i_2 - i_3 + 2 - 4 = 0$

$$i_x = \frac{V_A}{40}$$
$$i_1 = \frac{V_A}{10}$$
$$i_2 = \frac{V_A - V_B}{8}$$
$$i_3 = \frac{V_B}{4}$$

KCL@A: $\frac{V_A}{40} + \frac{V_A}{10} + \frac{V_A}{8} - \frac{V_B}{8} = 4$

KCL@B: $\frac{V_A}{8} - \frac{V_B}{8} - \frac{V_B}{4} = 2$

$$\begin{bmatrix} \frac{1}{40} + \frac{1}{10} + \frac{1}{8} & -\frac{1}{8} \\ \frac{1}{8} & -\frac{1}{8} - \frac{1}{4} \end{bmatrix} \begin{pmatrix} V_A \\ V_B \end{pmatrix} = \begin{pmatrix} 4 \\ 2 \end{pmatrix}$$

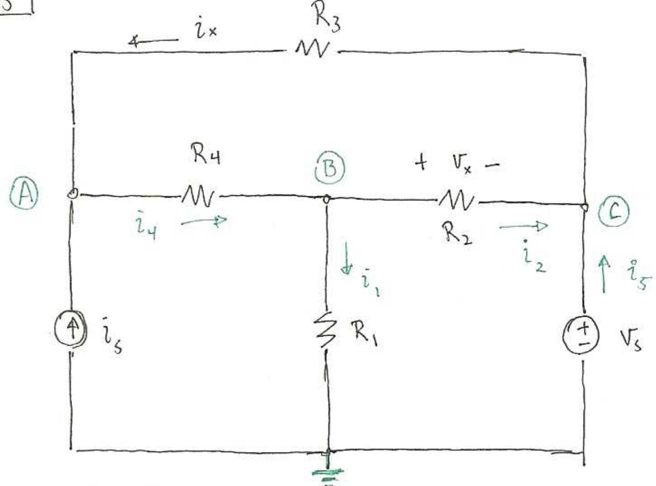
$V_A = 16$ V

$V_B = 0$ V

$\therefore i_x = .4$ A

$V_x = 0$ V

3/5



Step 1: Label!

Step 2: Set-up nodal equations

KCL@A

$i_s + i_x - i_4 = 0 \quad (1)$

KCL@B

$i_4 - i_1 - i_2 = 0 \quad (2)$

* KCL @C is only necessary if you want to solve for i_5

$$i_1 = \frac{\varphi_B}{R_1} \qquad i_2 = \frac{\varphi_B - \varphi_C}{R_2} \qquad i_4 = \frac{\varphi_A - \varphi_B}{R_4} \qquad i_x = \frac{\varphi_C - \varphi_A}{R_3}$$

$\varphi_C = v_s$

$$(1) \Rightarrow \underbrace{\frac{v_s}{R_3} - \frac{\varphi_A}{R_3}}_{i_x} \underbrace{- \frac{\varphi_A}{R_4} + \frac{\varphi_B}{R_4}}_{-i_4} = -i_s$$

$$(2) \Rightarrow \underbrace{\frac{\varphi_A}{R_4} - \frac{\varphi_B}{R_4}}_{i_4} \underbrace{- \frac{\varphi_B}{R_1}}_{-i_1} \underbrace{- \frac{\varphi_B}{R_2} + \frac{v_s}{R_2}}_{-i_2} = 0$$

Step 3: Arrange terms into a matrix equation

$$\begin{bmatrix} -\frac{1}{R_3} - \frac{1}{R_4} & \frac{1}{R_4} \\ \frac{1}{R_4} & -\frac{1}{R_1} - \frac{1}{R_2} - \frac{1}{R_4} \end{bmatrix} \begin{pmatrix} \varphi_A \\ \varphi_B \end{pmatrix} = \begin{pmatrix} -i_s - \frac{v_s}{R_3} \\ -\frac{v_s}{R_2} \end{pmatrix}$$

$$\left.\begin{aligned} \varphi_A &= 28\text{ V} \\ \varphi_B &= 16\text{ V} \end{aligned}\right\} \qquad \begin{aligned} i_x &= \frac{v_s - \varphi_A}{R_3} = -.8\text{ mA} \\ v_x &= \varphi_B - v_s = -4\text{ V} \end{aligned}$$

$$\boxed{\begin{aligned} i_x &= -.8\text{ mA} \\ v_x &= -4\text{ V} \end{aligned}}$$

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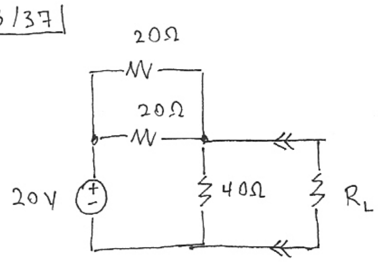
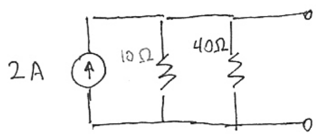


* easier to do by source transformations



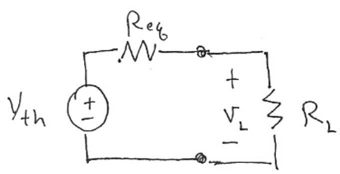
$I_N = 2A$

$R_{eq} = \frac{10 \times 40}{10 + 40} \ \Omega$

$R_{eq} = 8\ \Omega$

$V_{th} = I_N \times R_{eq} = 2 \times 8$

$V_{th} = 16\ V$



$V_L = V_{th} \times \frac{R_L}{R_{eq} + R_L}$

R_L	V_L
5Ω	6.15 V
10Ω	8.89 V
50Ω	13.8 V

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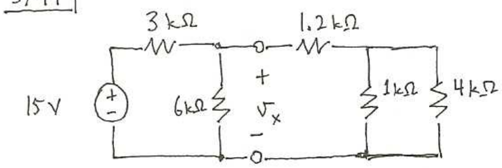
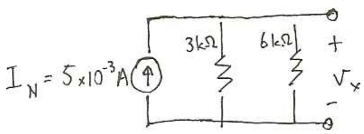


Thévenin eq. LHS

* easier to do by source transformations (rather than by using SC/OC tests)

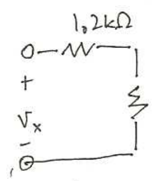


$$R_{eq} = \frac{3 \times 6}{3+6} \text{ k}\Omega = \boxed{2\text{k}\Omega = R_{eq(LHS)}}$$

$$V_{th} = I_N \times R_{eq} = 5 \times 10^{-3} \times 2 \times 10^{3} = \boxed{10\text{ V} = V_{th}}$$

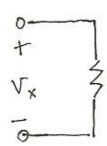
Thévenin eq. RHS

* When there is not an independent source, the OC & SC tests will fail. Treat this as an equivalent resistance problem.



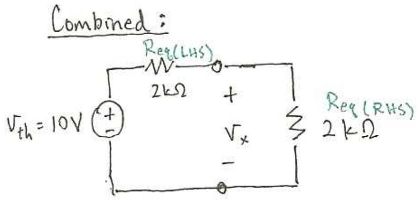
$$\frac{1 \times 4}{1+4} = .8 \text{ k}\Omega$$

⇓



$\boxed{2\text{k}\Omega = R_{eq(RHS)}}$

Combined:



$$V_x = V_{th} \times \frac{R_{eq(RHS)}}{R_{eq(LHS)} + R_{eq(RHS)}} = 10 \times \frac{2}{4} \Rightarrow \boxed{V_x = 5\text{ V}}$$