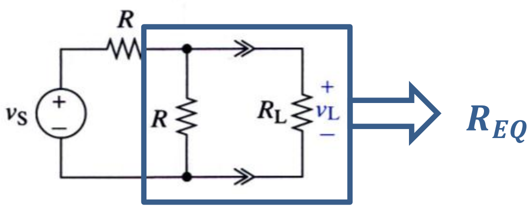
MAE140 Win12 HW2 Solutions

T R & T, 2.41, 2.42, 2.44, 2.50, 2.52, 2.53, 2.58, 3.36, 3.39, 3.41

2-41



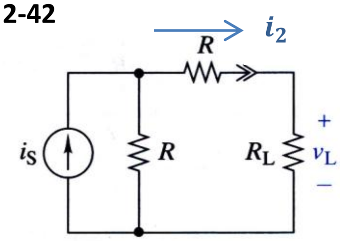
R and R_L are in parallel. Since voltages across parallel elements are equal, the unknown voltage v_L appears across both. We first define an equivalent resistance $R_{EQ} = R||R_L$ as

$$R_{EQ} = \frac{RR_L}{R + R_L}$$

We write the voltage division rule in terms of R_{EQ} as

$$v_L = \left(\frac{R_{EQ}}{R_{EQ} + R}\right) v_s = \left(\frac{R_L}{2R_L + R}\right) v_s$$

2-42



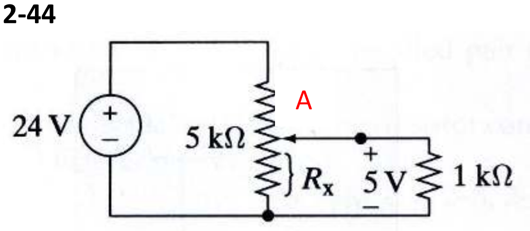
As shown in the figure, R is in series with R_L. The currents pass them are equal. We can use two path divider circuit rule.

$$i_2 = \left(\frac{R}{2R + R_L}\right) i_s$$

Then using Ohm's Law, we can get

$$v_L = i_2 R_L = \left(\frac{RR_L}{2R + R_L}\right) i_s = 12.5\, mV$$

2-44

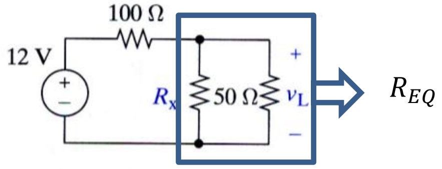


Use KCL at node A, we can obtain,

$$\frac{(24-5)V}{(5-R_X)k\Omega} - \frac{5V}{R_X} - \frac{5V}{1k\Omega} = 0 \quad \Rightarrow \quad 5R_X^2 - R_X - 25 = 0$$

Choose the positive root of the equation, we can get $R_X \approx 2.34k\Omega$.

2-50

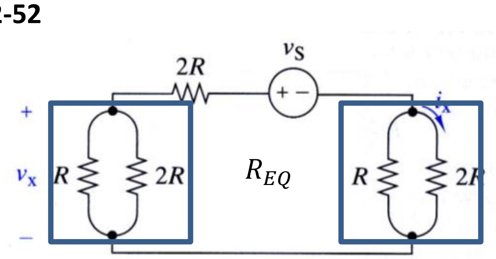


R_X is in parallel with 50Ω. We can write $R_{EQ} = \frac{50R_X}{50+R_X}$.
Then we can calculate

$$v_L = \frac{12}{100 + R_{EQ}} R_{EQ} = \frac{12R_X}{100 + 3R_X}$$

When $v_L = 2V$, we can get $R_X = 16.67\Omega$.
When $v_L = 4V$, we can find the equation $\frac{12R_X}{100+3R_X} = 4$, so $R_X = \infty$.
When $v_L = 6V$, it's impossible to find R_X, since resistance must be positive.

2-52

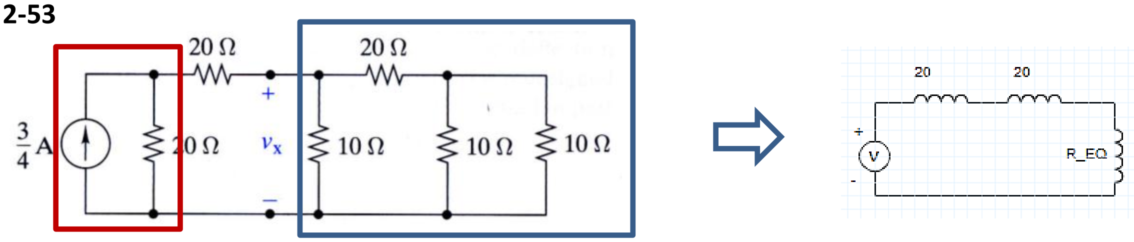


We can get $R_{EQ} = \frac{R \cdot 2R}{R+2R} = \frac{2}{3}R$.
It's easy to see that

$$v_X = -\frac{R_{EQ}}{2R + 2R_{EQ}} v_s = -\frac{v_s}{5}$$
$$i_X = -\frac{v_X}{2R} = -\frac{v_s}{10R}$$

Please pay attention to the direction of the voltage and current. I got the wrong answer in the discussion session. Sorry for that.

2-53



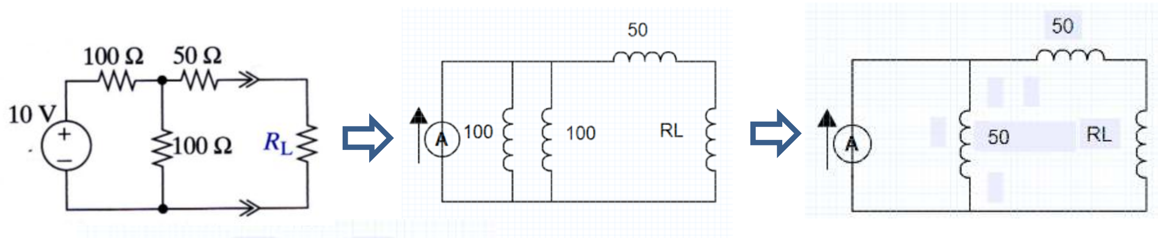
Recall the knowledge of equivalent circuits. We can get the figure RHS, where

$$v = \frac{3}{4} \times 20 = 15V, \quad R_{EQ} = \frac{50}{7}\Omega$$

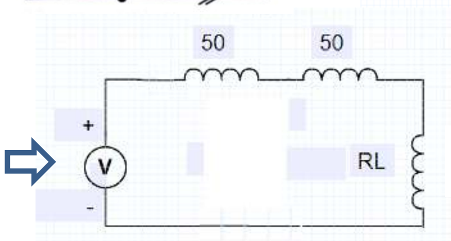
So

$$v_X = \frac{v}{20 + 20 + R_{EQ}} R_{EQ} = 2.27\ V$$

2-58



$$i = \frac{10V}{100\Omega} = 0.1A$$



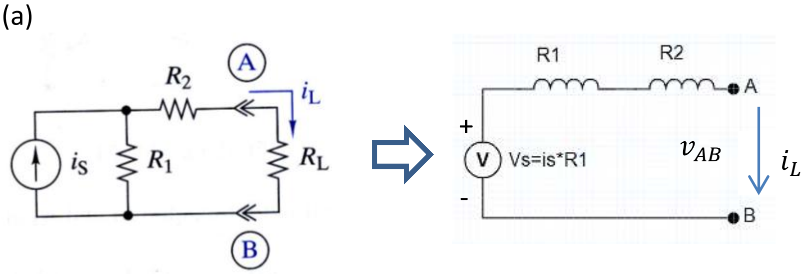
$$v = i \times 50\Omega = 5V$$

Then we can find the equation

$$\frac{5V}{50\Omega + 50\Omega + R_L} = 40\ mA \quad \Rightarrow \quad R_L = 25\Omega$$

3-36

(a)



(b)

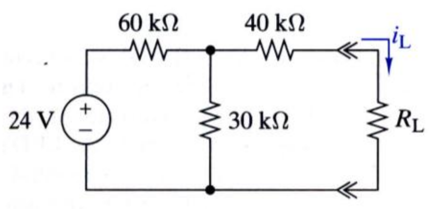
$$i_L = \frac{v_s}{R_1 + R_2 + R_{AB}} = \frac{i_s R_1}{R_1 + R_2 + R_{AB}}$$

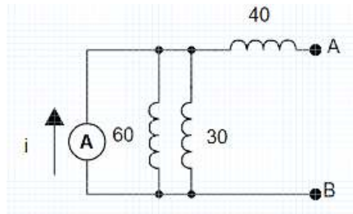
(c)

Using current division, we can get

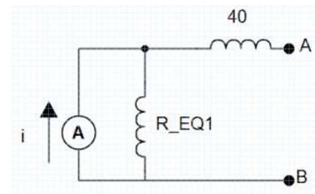
$$i_L = \frac{R_1}{R_1 + R_2 + R_{AB}} i_s$$

3-39

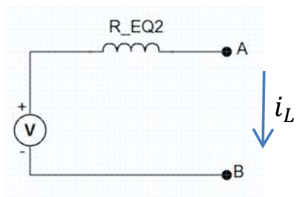




$$i = \frac{24V}{60k\Omega} = 0.4mA$$



$$R_{EQ1} = 60||30 = 20k\Omega$$



$$v_T = iR_{EQ1} = 8V$$

$$R_{EQ2} = R_{EQ1} + 40k\Omega = 60k\Omega$$

$$i_L = \frac{v_T}{R_{EQ2} + R_L}$$

$$\boxed{\begin{array}{c} R_L = 50k\Omega \Rightarrow P = i_L^2 R_L \approx 0.26\,mW \\ R_L = 200\,k\Omega \Rightarrow P \approx 0.19mW \end{array}}$$

3-41

As we did in 3-39, we can get similar results.

$$i = \frac{15V}{3\,k\Omega} = 5\,mA, \quad R_{EQL} = 3k\Omega||6k\Omega = 2k\Omega \Rightarrow v_T = iR_{EQL} = 10V$$

$$R_{EQR} = 1.2k\Omega + 1k\Omega||4k\Omega = 2\text{k}\Omega \quad \Rightarrow \quad v_X = \frac{v_T}{R_{EQL} + R_{EQR}} R_{EQR} = 2.5V$$