In class Tutorial 8 additional solution

Question 1

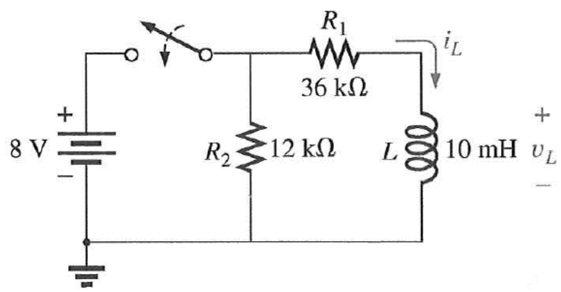
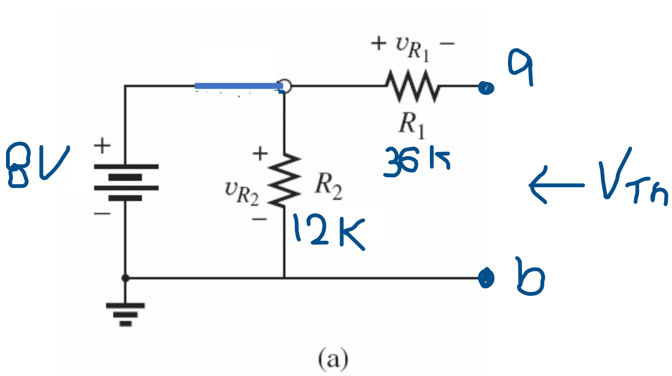


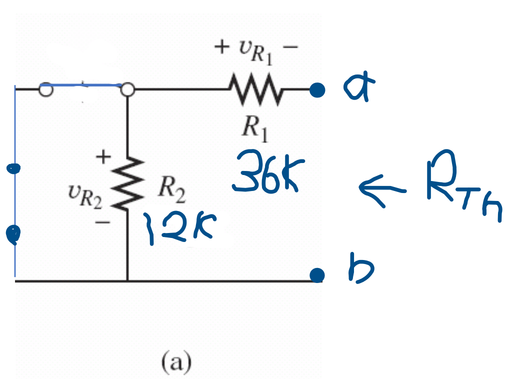
FIG. 85

To find V_{Th}:

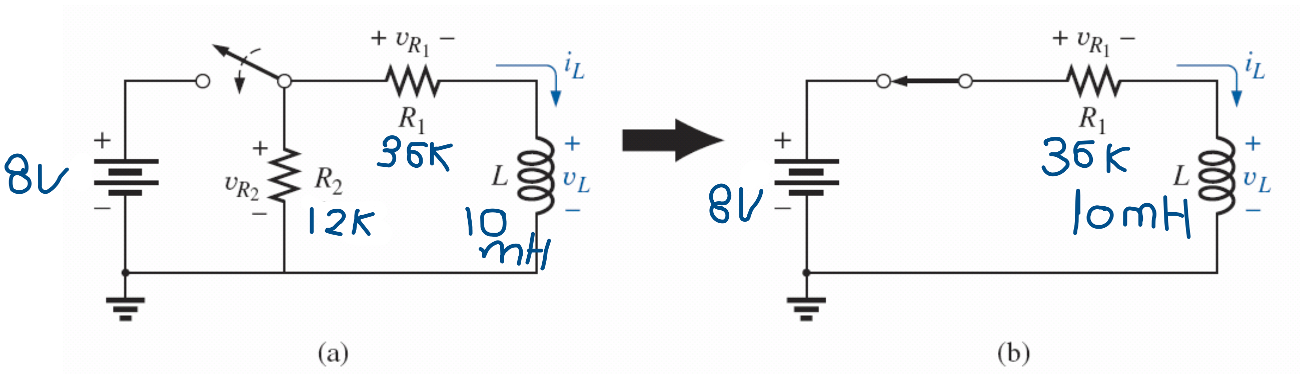


$$V_{Th} = 8V$$

To find R_{Th}:



$$R_{Th} = R_1 = 36\ K\Omega$$



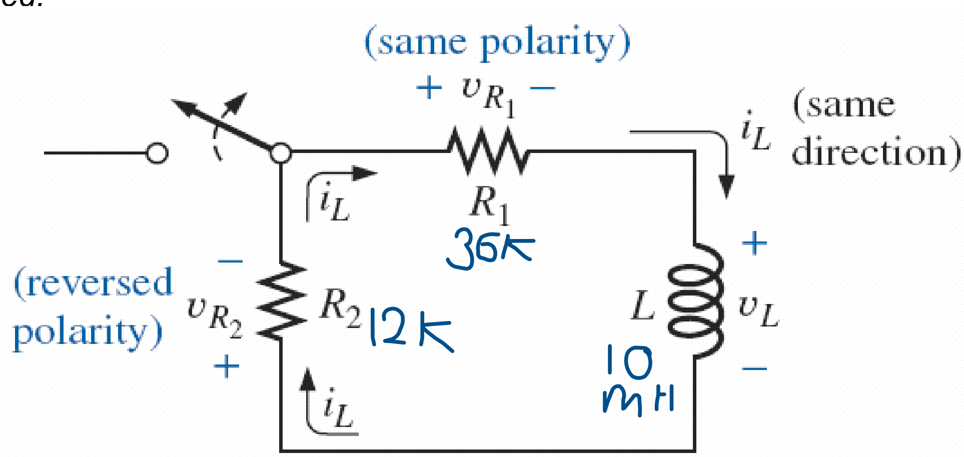
$$\tau = \frac{L}{R} = \frac{10\ mH}{36\ K} = 0.278\ \mu s$$

$$i_L = \frac{E}{R_1}\left(1 - e^{-\frac{t}{0.278\ \mu s}}\right)$$

$$i_L = \frac{8\ V}{36\ K}\left(1 - e^{-\frac{t}{0.278\ \mu s}}\right) = 0.222\ mA\left(1 - e^{-\frac{t}{0.278\ \mu s}}\right)$$

$$V_L = E\left(e^{-\frac{t}{0.278\ \mu s}}\right) = 8\ V\left(e^{-\frac{t}{0.278\ \mu s}}\right)$$

the instant the switch is opened.



After steady state, the current reaches the maximum. When we open the switch, the current in the inductor will not change. The voltage across the inductor will change. According to Faraday, when we open the switch there will be a change in the current, there will be induced voltage in inductor. Polarity of induced voltage will be opposite.

$$\tau' = \frac{L}{R_1 + R_2} = \frac{10\ mH}{12K + 36K} = 0.208\mu s$$

$$I_{L_{max}} = \frac{E}{R_1} = \frac{8\ V}{36\ K} = 0.222\ mA$$

$$I_L = I_{L_{max}}\left(e^{-\frac{t}{\tau_{new}}}\right) = 0.222\ mA\left(e^{-\frac{t}{0.208\mu s}}\right)$$

Using KVL

$$V_{L_{max}} = -V_{R_{1max}} - V_{R_{2max}}$$

$$V_{L_{max}} = -(i_{L_{max}}R_1 + i_{L_{max}}R_2)$$

$$V_{L_{max}} = -i_{L_{max}}(R_1 + R_2)$$ ✓

$$V_{L_{max}} = -\frac{E}{R_1}(R_1 + R_2)$$

or

$$V_{L_{max}} = -E\,\frac{(R_1 + R_2)}{R_1} = -E\left(1 + \frac{R_2}{R_1}\right)$$

Hence, we can use:

$$V_{L_{max}} = -i_{L_{max}}(R_1 + R_2) = -(0.222\ mA)(48k\Omega) = -10.66\ V$$

$$V_L = V_{L_{max}}\left(e^{-\frac{t}{0.208\mu s}}\right) = -10.66\ V\left(e^{-\frac{t}{0.208\mu s}}\right)$$