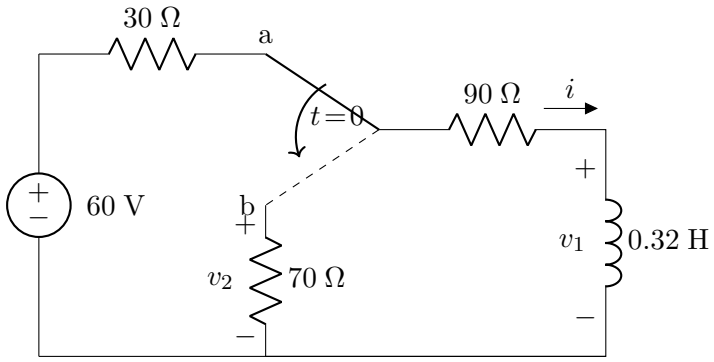
ECE 2260 quiz02

Name: SOLUTIONS

In the circuit below, the switch has been in the a position for a long time. At $t=0$ the switch is thrown from position a to position b. Solve for the current $i_L(t)$ through the inductor and the voltage $v_2(t)$ across the 70 Ω resistor.



Solution: First, we need the current through the inductor at $t=0^-$. With the switch at position a for a long time, the inductor acts as a short circuit. The current through the inductor is then

$$i_L(0^-)=500 \text{ mA}$$

When the switch moves to position b, we can find the Thevenin equivalent resistance seen by the inductor to find the time constant of the circuit. Turning off the voltage source and looking back into the circuit from the inductor terminals, we have

$$R_{\text{th}}=160 \ \Omega$$

This gives a time constant of

$$\tau=\frac{L}{R_{\text{th}}}=2 \text{ ms}$$

The current through the inductor for $t\geq 0$ is then

$$i_L(t)=\begin{cases}500 \text{ mA} & t<0\\ 500e^{-t/(2 \text{ ms})}\text{mA} & t\geq 0\end{cases}$$

Once we have the current expression, we can find the voltage across the 70 Ω resistor

$$v_2(t)=-i_L(t)\cdot R=-500e^{-t/(2 \text{ ms})}\text{mA}\cdot 70 \ \Omega=-35e^{-t/(2 \text{ ms})} \text{ V}.$$

A more complete expression for $v_2(t)$ is then

$$v_2(t)=\begin{cases}0 \text{ V} & t<0\\ -35e^{-t/(2 \text{ ms})}\text{V} & t\geq 0\end{cases}$$