6-5 Soln)

A) From class discussion,

$$I(t) = \frac{\mathcal{E}_B}{R} e^{-\frac{tR}{L}}$$

$$\frac{IR}{\mathcal{E}_B} = e^{-\frac{tR}{L}}$$

$$\ln\left(\frac{IR}{\mathcal{E}_B}\right) = -\frac{tR}{L}$$

$$L = -\frac{tR}{\ln\left(\frac{IR}{\mathcal{E}_B}\right)} = -\frac{0.005(15)}{\ln\left(\frac{0.2(15)}{12}\right)} = 0.054\ \mathrm{H}\ .$$

B)

$$\tau_L = \frac{L}{R} = \frac{0.054}{15} = 0.0036\ \mathrm{sec}\ .$$

C)

We know the current; the voltage across the resistor is given by Ohm's relationship:

$$V_R = IR = R\frac{\mathcal{E}_B}{R} e^{-\frac{tR}{L}} = \mathcal{E}_B e^{-\frac{tR}{L}}\ .$$

Then,

$$\frac{V_R}{\mathcal{E}_B} = e^{-\frac{tR}{L}}$$

$$\ln\left(\frac{V_R}{\mathcal{E}_B}\right) = -\frac{tR}{L}$$

$$t = -\frac{L}{R}\ln\left(\frac{V_R}{\mathcal{E}_B}\right) = -\frac{0.054}{R15}\ln\left(\frac{4}{12}\right) = 0.0040\ \mathrm{seconds}.$$

Since it requires one time constant to fall to 1/e or 0.37 of the initial value, this makes sense. It should be a bit longer than 0.0036 seconds.