The switch has been closed for a long time. It is opened at $t = 0$.

a) Find $i_0(t)$ for $t \geq 0$

First find $i_0(0)$ just before the switch opens. Replace the inductor with a wire. Then:

$V_A = 50 \left( \frac{50}{75} \right) = 30V$

$\frac{50}{75} + 20$

$i_0(0) = \frac{V_A}{50} = 0.6A$

After the switch opens,

$\tau = \frac{L}{R} = \frac{0.02}{3 + \frac{60}{115}}$

$= 1.333 \text{ ms}$

$i_0 = I_0 e^{-\frac{t}{\tau}} = 0.6 e^{-\frac{750t}{13}} \text{ A for } t \geq 0 \text{ sec}$

b) Find $v_0(t)$ for $t \geq 0$

$V_0 = -i_0 \left( \frac{60}{115} \right) = -7.20 e^{-\frac{750t}{13}} \text{ V}$
\[ V = 160e^{-10t} \quad V \quad t > 0^+ \]
\[ i = 6.4e^{-10t} \quad A \quad t > 0 \]

A) Find \( R \)

\[ R = \frac{V}{I} = \frac{160}{6.4} = 25 \Omega \]

b) Find \( T \)

\[ T = \frac{1}{10} = 100 \text{ ms} \]

c) Find \( L \)

\[ T = \frac{L}{R} \quad ; \quad L = TR = 2.5 \text{ H} \]

d) Find initial energy stored in inductor

\[ w(0) = \frac{1}{2} LI^2 = \frac{1}{4}(2.5)(6.4)^2 = 51.2 \text{ J} \]

e) time to decrease by 60\% of \( w(0) \)

\[ w(t) = 51.2(0.4) = 20.48 \text{ J} \]

\[ 20.48 = \frac{1}{2} LI^2 \implies I = 4.0477 \text{ A} \]

\[ 4.0477 = 6.4e^{-10t} \implies t = 45.8 \text{ ms} \]
For $t < 0$:

\[ V_c(0^-) = \frac{-120 \times 121/68}{121/68 + 1.8} = -102V \]

For $t > 0$:

\[ V_c(t) = -102e^{-26t} \]

\[ P = \frac{V^2}{R} = 0.867e^{-50t} \]

a) Find how many microjoules have been dissipated in $R$ 12 ms after the switch opens.

\[ W = \int_{0}^{0.012} 0.867e^{-50t} \, dt \]

\[ W = 0.867 \left[ e^{-50t} \right]_{0}^{0.012} = 0.867 \left( e^{-60} - e^{0} \right) = 0.867 \left( 0.5498 - 1 \right) \]

\[ W = 78.24 \mu J \]

b) How long does it take to dissipate 75% of the initial stored energy?

\[ W(0) = \frac{1}{2} CV^2 = \frac{1}{2} \left( \frac{10}{68} \times 121 \right)(-102)^2 = 17.34 \text{ mJ} \]

75% of $W(0)$ is 13 mJ

\[ \int_{0}^{t} 0.867e^{-50t} \, dt = 0.13 \]

\[ \Rightarrow t = 27.73 \text{ ms} \]

\[ t = 27.73 \text{ ms} \]
Switch moves @ \( t = 0 \)

Find \( i_0(t) \) for \( t > 0 \)

Before \( t = 0 \),

\( i_c = 0 \) so \( V_c(0) = 15V \)

After

Writing KVL,

\[
15i_0 + 5i_0' + \frac{1}{c} \int i_0' dt = 0
\]

\[
20i_0 + \frac{i_0'}{c} = 0 \implies i_0 = i_0(0)e^{-\frac{t}{2C}} = \frac{i_0(0)}{c} e^{-\frac{t}{2C}}
\]

\[
V_c = \frac{1}{c} \int i_c(+) dt = \frac{1}{c} \int i_0(0)e^{-\frac{t}{2C}} dt
\]

\[
V_c = \frac{i_0(0)}{c} e^{-\frac{t}{2C}}
\]

\[
V_c(0) = 15 = \frac{i_0(0)}{c} \implies i_0(0) = -0.75A
\]

Thus

\[
i_0(t) = -0.75e^{-\frac{t}{2C}} A
\]
$V_0$ is applied to the circuit shown.

$V_c(0) = 0, 00 V$

a) Find $V_0$

$V_c(t) = V_F(1 - e^{-\frac{t}{RC}}) + V_c(0)e^{-\frac{t}{RC}}$

$V_F = 500 V$

$V_c(0) = 0$

$RC = \left(10\times10^{-9}\right)\left(400\times10^{-3}\right) = 0.004$

$V_c(t) = 500(1 - e^{-250t})$

$v_0 = v_s - v_c = 500e^{-250t}$ for $0 \leq t \leq 1ms$

$v_c = 1ms$, $V_c(1ms) = 500(1 - e^{-250(1ms)}) = 11.06 V$

$v_c(\infty) = 0$

$v_c(t) = 11.06e^{-250(t - 0.001)}$

$v_0(t) = v_s - v_c = -11.06e^{-250(t - 0.001)}$ for $t \geq 1ms$
Switch closed at \( t = 0 \)

a) Find \( \dot{i}(0) + \ddot{i}(\infty) \)

\[ \dot{i}(0) = \frac{20}{40} = 0.5A \]

\[ \dot{i}(\infty) = 0A \quad (all \ energy \ in \ dissipated) \]

b) Find \( i(t) \) for \( t \geq 0 \)

\[ i(t) = I_0 e^{-\frac{1}{L}t} = 0.5 e^{-2.5t} \quad A \]

c) Find \( t \) when \( i(t) = 100mA \)?

\[ 100mA = 0.5 e^{-2.5t} \]

\[ t = 6.44 \text{ ms} \]
The switch has been closed for a long time before opening at $t=0$.

a) Find $i_1(0^-)$ and $i_2(0^-)$

\[ i = \frac{80}{2k + 4k/12k} = 16 \text{ mA} \]

Using a current divider:

\[ i_2(0^-) = \frac{i(12k)}{4k + 12k} = \frac{3}{4} i = 12 \text{ mA} \]

\[ i_1(0^-) = \frac{i(4k)}{4k + 12k} = \frac{1}{4} i = 4 \text{ mA} \]

b) Find $i_1(0^+)$ and $i_2(0^+)$

Current cannot change instantaneously in an inductor.

So $i_1(0^-) = i_1(0^+) = 4 \text{ mA}$

Since we have a series circuit,

\[ i_2(0^+) = -i_1(0^+) = -4 \text{ mA} \]

c) Find $i_1(t)$ for $t \geq 0$

\[ i_1(t) = I_0 e^{-\frac{t}{\tau}} = 4 e^{-\frac{t}{0.025}} \text{ mA} \]

\[ i_1(t) = \begin{cases} 4 e^{-2500t} & \text{for } t \geq 0 \\ \end{cases} \]

\[ i_2(t) = \begin{cases} -4 e^{-2500t} & \text{for } t \geq 0 \\ \end{cases} \]

d) Find $i_2(t)$ for $t \geq 0$

\[ i_2(t) = -i_1(t) = -4 e^{-2500t} \text{ mA} \]

e) Explain why $i_2(0^-) \neq i_2(0^+)$

Current in an inductor cannot change instantaneously, but current in a resistor can.
The switch has been in the left position for a long time, at $t = 0$ it moves to the right position.

a) Find $V_c(t)$ for $t \geq 0$

$$V_c(t) = V_c(0) e^{-\frac{t}{RC}} V$$

The capacitor is an open circuit.

$$V_c(0) = \frac{120(10k)}{10k + 5k} = 80V$$

For $t > 0$, the capacitor discharges through the circuit shown at the right.

$$R_{eq} = (40k + 10k) || 25k = 16.67k\Omega$$

$$\tau = RC = (160 \times 10^{-9})(16.67k) = 2.667 \text{ ms}$$

$$V_c(t) = 80 e^{-375t} V$$

b) Find $i(t)$ for $t \geq 0$

Since $V_c(t) = 80 e^{-375t}$

$$i = \frac{V_c(t)}{40k + 10k} = \frac{1.6 e^{-375t}}{mA} = i(t)$$
\[ V = 72e^{-50t} \text{ V}, \ t \geq 0 \]
\[ i = 9e^{-50t} \text{ mA}, \ t \geq 0 \]

a) Find \( R \)

\[ R = \frac{V}{i} = 8 \text{ k}\Omega \]

b) Find \( C \)

\[ \frac{1}{RC} = 500 \Rightarrow C = \frac{1}{500(8 \text{ k})} = 0.25 \mu F \]

c) Find \( \tau \)

\[ \tau = \frac{1}{500} = 2 \text{ ms} \]

d) Initial energy in the capacitor

\[ w = \frac{1}{2} CV^2 \bigg|_{t=0} = \frac{1}{2}(0.25 \times 10^{-6})(72)^2 = 648 \mu J \]

e) How many microseconds to discharge 68% of the initial energy in the capacitor.

Energy left is 32% \( w = 648 \mu J = 207.36 \mu J \)

\[ w = \frac{1}{2} CV^2 \Rightarrow V = \sqrt{\frac{2w}{C}} = 40.7294 \text{ V} \]

\[ 40.7294 = 72e^{-50t} \Rightarrow t = 1.139 \text{ ms} \]