SP 212 Worksheet
Ch. 31.1, LC Oscillations

1) When coupled to speakers, oscillating LC circuits can be used to produce sound. What inductance \( L \) must be used with a \( C = 6.0 \mu F \) capacitor to produce an audible frequency of 11 kHz?

\[
\omega = \frac{1}{\sqrt{LC}}, \quad f = \frac{\omega}{2\pi}, \quad \text{so} \quad f = \frac{1}{2\pi \sqrt{LC}} = \frac{1}{2\pi \sqrt{L \times 6.0 \times 10^{-6} F}} = 11 \times 10^3 \text{ Hz},
\]

so \( L = 3.5 \times 10^{-8} \text{ H} \)

For problems 2-3: At a given time in an oscillating LC circuit, 75% of the total energy is stored in the inductor.

2) What multiple of the capacitor's maximum charge is on the capacitor at this time?

\[
\frac{75\% \text{ in inductor}}{25\% \text{ in capacitor}} = \frac{q}{\frac{q_{\text{max}}}{2C}} = \frac{q_{\text{max}}}{2C} \quad u_{\text{tot}} = \frac{q_{\text{max}}}{2C} \quad u_{\text{c}} = 0.25 \quad \Rightarrow \quad u_{\text{c}} = \frac{q}{2C}
\]

\[
\frac{u_{\text{c}}}{u_{\text{tot}}} = \frac{\frac{q}{2C}}{\frac{q_{\text{max}}}{2C}} = \frac{q}{q_{\text{max}}} = 0.25, \quad \text{so} \quad q = 0.25 q_{\text{max}}, \quad \text{so} \quad q = \frac{1}{4} q_{\text{max}}, \quad \text{so}
\]

3) What multiple of the maximum current is moving through the inductor at this time?

\[
U_{\text{tot}} = \frac{1}{2} L i_{\text{max}}^2 \quad U_L = 0.75 U_{\text{tot}}, \quad i_{\text{max}} = 0.75 i_{\text{max}}, \quad \text{so} \quad i = 0.75 i_{\text{max}}, \quad \text{so}
\]

For problems 4-5: In an oscillating LC circuit, \( L = 3.96 \times 10^{-3} \text{ H} \) and \( C = 3.72 \times 10^{-6} \text{ F} \). At \( t = 0 \) the charge on the capacitor is zero and the current is 2.97 A.

4) What is the period \( T \) of this oscillator?

\[
\omega = \frac{1}{\sqrt{LC}}, \quad T = \frac{2\pi}{\omega}, \quad \text{so} \quad T = 2\pi \sqrt{LC} = 7.6 \times 10^{-4} \text{ s}
\]

5) At what time will the energy stored in the capacitor reach its maximum value?

\[
U = \frac{q^2}{2C}, \quad \text{so} \quad U \text{ is max when } q \text{ is max. Also when } q \text{ is max, } \frac{dU}{dt} = 0
\]

\[
\therefore \frac{q}{2} = \text{max}.
\]

Thus, at \( t = \frac{T}{4} = 1.9 \times 10^{-4} \text{ s} \)

the energy stored in the capacitor will reach its max value.