ECE 1050 / 60  homework # 9  Due: Fri, 2/20/04

1. Find $L_{eq}$ in each case

\[ L_1 := 1\text{ mH} \quad L_2 := 3\text{ mH} \]

2. Find the stored energy in each capacitor and/or inductor under steady-state conditions. Note: Treat caps as opens and inductors as shorts to find DC voltages and currents.

3. The current waveform shown below flows through a 10 mH inductor. Make an accurate drawing of the voltage across it. Label your graph.

4. The voltage across a 2 mH inductor is shown below. Make an accurate drawing of the inductor current. Label your graph. Assume the initial current is 0 mA.
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5. The voltage across a 1.2 mH inductor is \( v_L = 4 \cdot mV \cdot \cos(200 \cdot t) \) find \( i_L \).

6. The current through a 0.06 mH inductor is \( i_L = 20 \cdot mA \cdot \cos \left( 628 \cdot t - \frac{\pi}{4} \right) \) find \( v_L \).

7. Refer to the circuit shown. Assume that \( V_s \) is a sinusoidal input voltage whose frequency can be adjusted. At some frequency of \( V_s \) this circuit can resonate. At that frequency \( i_C(t) = -i_L(t) \). \( (i_C(t) \) is 180 degrees out-of-phase with \( i_L(t) \)).

Show that resonance occurs at this frequency:

\[
\omega_o = \frac{1}{\sqrt{L \cdot C}} \quad \text{and} \quad f_o = \frac{1}{2 \cdot \pi \sqrt{L \cdot C}}
\]

\[\begin{array}{c}
\text{C}_1 := 0.1 \mu F \\
\text{L}_1 := 10 \cdot mH \\
\text{C}_2 := 0.22 \mu F \\
\text{L}_2 := 10 \cdot mH
\end{array}\]

8. Find the resonant frequency, \( f_o \) in each case.

a) \( \text{C}_1 := 0.1 \mu F \) \\
\[\begin{array}{c}
\text{L}_1 := 10 \cdot mH \\
\text{L}_2 := 10 \cdot mH \\
\text{C}_2 := 0.22 \mu F
\end{array}\]

b) \( \text{C}_1 := 0.22 \mu F \) \\
\[\begin{array}{c}
\text{L}_1 := 10 \cdot mH \\
\text{L}_2 := 5 \cdot mH \\
\text{C}_2 := 0.22 \mu F
\end{array}\]

Answers
1. 0.75 mH  32 mH
2. a) 0.018 mJ  b) 0.072 mJ  0.036 mJ  0.08 mJ  0.04 mJ
3. -0.2 V  0.4 V  ramp to -0.267 V
4. Ramp up to 15 mA, then down to -5 mA, curves until it's flat at -9 mA, and continues to curve up to 0 mA. Flat at 0 mA from there on.
5. \( i_L = 16.7 mA \cdot \sin(200 \cdot t) \)
6. \( v_L = -0.75 \cdot mV \cdot \sin \left( 628 \cdot t - \frac{1}{4} \pi \right) \)
7. Assume a sinusoidal voltage, find \( i_C \) and \( i_L \) by integration and differentiation, and show that they are equal and opposite at the resonant frequency.
8. a) 3979 Hz  b) 3918 Hz