Seminar 12: Lectures 28-30

Mutual Inductance:

1. Determine the mutual inductance per unit length between two long solenoids, one inside the other, whose radii are r_1 and r_2 ($r_2 < r_1$) and whose turns per unit length are n_1 and n_2. The value for the permeability of free space (μ_0) is $4\pi \times 10^{-7}\,\mathrm{T \cdot m/A}$.

Self-Inductance:

2. There is a solenoid with an inductance $0.285\ \mathrm{mH}$, a length of $36\ \mathrm{cm}$, and a cross-sectional area $6 \times 10^{-4}\ \mathrm{m^2}$. (a) Find the number of turns of the solenoid. (b) Suppose at a specific time the emf is $-12.5\ \mathrm{mV}$, find the rate of change of the current at that time.

   Note you can use the following formula to calculate the inductance of a Solenoid $L = \frac{\mu_0 N^2 A}{l}$

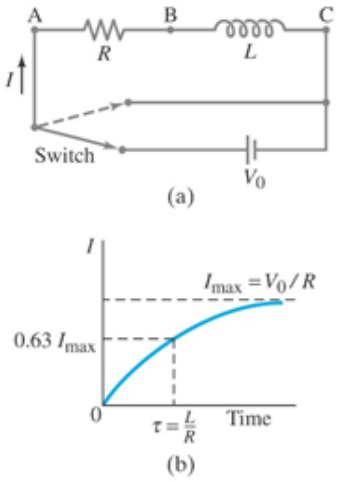
3. Ignoring any mutual inductance, what is the equivalent inductance of two inductors connected (*a*) in series, (*b*) in parallel?

Magnetic Energy Storage:

4. Typical large values for electric and magnetic fields attained in laboratories are about 1.0×10^4 V/m and 2.0 T. (a) Determine the energy density for each field and compare. (*b*) What magnitude electric field would be needed to produce the same energy density as the 2.0 T magnetic field? The value for the permeability of free space (μ_0) is $4\pi \times 10^{-7}\,\mathrm{T \cdot m/A}$, and the value for the permittivity of free space ε_0 is $8.85 \times 10^{-12}\,\mathrm{C^2/N \cdot m^2}$.

LR Circuits:

5. After how many time constants does the current in the figure below reach within (*a*) 5.0%, (*b*) 1.0%, and (c) 0.10% of its maximum value?



LC Circuits and Oscillations:

6. A 425-pF capacitor is charged to 135 V and then quickly connected to a 175 mH inductor. Determine (a) the frequency of oscillation, (b) the peak value of the current, and (c) the maximum energy stored in the magnetic field of the inductor.

LC Oscillations with Resistance:

7. How much resistance must be added to a pure *LC* circuit (L = 350 mH, C = 1800 pF) to change the oscillator's frequency by 0.25%? Will it be increased or decreased?

AC Circuits; Reactance:

8. What is the reactance of a 9.2 μF capacitor at a frequency of (*a*) 60.0 Hz, (*b*) l.00 MHz?

9. What is the inductance L of the primary of a transformer whose input is 110 V at 60 Hz and the current drawn is 3.1 A? Assume no current in the secondary.

LRC Series AC Circuit:

10. For a 120 V, 60 Hz voltage, a current of 70 mA passing through the body for 1.0 s could be lethal. What must be the impedance of the body for this to occur?

11. A 75 W lightbulb is designed to operate with an applied ac voltage of 120 V rms. The bulb is placed in series with an inductor L, and this series combination is then connected to a 60 Hz 240 V rms voltage source. For the bulb to operate properly, determine the required value for L. Assume the bulb has resistance R and negligible inductance.

Resonance in AC Circuit:

12. An *LRC* circuit has L = 4.15 mH and R = 3.80 kΩ. (a) What value must C have to produce resonance at 33.0 kHz? (*b*) What will be the maximum current at resonance if the peak external voltage is 136 V?