(32.1)

$$\underbrace{\mu_0 \vec{j}(t) = curl\vec{B}(t)}_{\text{Ampere's law: A time varying current creates } \vec{B}(t)} \Rightarrow \underbrace{\frac{\partial \vec{B}}{\partial t} = -curl\vec{E}_L}_{\text{Faraday's law: A time varying magnetic field creates an induced (back) emf in the same loop.}}$$

$$\mu_0 I(t) = \oint_{loop\ l} \vec{B}(t)\cdot d\vec{s} = Bl \Rightarrow B(t) = \frac{\mu_0 I(t)}{l}$$ Now use Faraday's law with this B:

$$\Rightarrow \frac{d\Phi_B}{dt} = -\varepsilon(t) \Rightarrow$$

$$\varepsilon_L = -\frac{d\Phi_B}{dt} = -\frac{d}{dt}\left(\frac{\mu_0 I(t)}{l}A\right) = -\underbrace{\frac{\mu_0}{l}A}_{\text{self-inductance L}} \cdot \frac{dI}{dt}$$

(32.2) $$\boxed{\varepsilon_L = -N\frac{d\Phi_B}{dt} = -L\frac{dI}{dt}}$$

(32.3) $$\boxed{L = \frac{N\Phi_B}{I}}$$

(32.4) $$\boxed{\Delta V_R = -RI \text{ and } \varepsilon_{ind} = \Delta V_L = -L\frac{dI}{dt}}$$

(32.5) $$\boxed{L_{solenoid} = \mu_0 n^2 V}\ \boxed{U_B = \frac{1}{2}LI^2}\ \boxed{u_E = \frac{1}{2}\varepsilon_0 E^2}\ \boxed{u_B = \frac{B^2}{2\mu_0}}$$

(32.6) $$\boxed{\varepsilon_1 = -M\frac{dI_2}{dt} \text{ and } \varepsilon_2 = -M\frac{dI_1}{dt}}$$

Self inductance L:

1. A coil has an inductance of 3.00 mH, and the current in it changes from 0.200A to 1.50 A in 0.200s. Find the magnitude of the average induced emf in the coil during this time. -19.5 mV.
2. (3) A 10.0 mH inductor carries a current $I = I_{max}\sin\omega t$ with I_{max}=5.00 A and f=60Hz.What is the back emf as a function of time?

(18.8Vcos(377t)

3. (5) An inductor in the form of a solenoid contains 420 turns, is 16.0 cm in length, and has a cross-sectional area of 3.00cm^2.What uniform rate of decrease of current through the inductor induces an emf of 175E-6 V? (-0.422A/s)
4. (9) A self induced emf in a solenoid of inductance L changes in time as $\varepsilon = \varepsilon_0 e^{-kt}$ .Find the total charge that passes through the solenoid, assuming the charge is finite.($\frac{\varepsilon_0}{k^2 L}$).

RL circuits:

5. (11) A 12.0 Volt battery is connected into a series circuit containing a 10.0 Ohm resistor and a 2.00H inductor. How long will it take the current to reach 50% and 90% of its final value? (0.139s; 0.461s)
6. (17) An inductor has an inductance of 15.0 H and a resistance of 30.0 Ohm is connected across a 100-Volt battery. What is the rate of increase of the current at t=0s and at t=1.50 s. (6.67A/s; 0.332 A/s)

Energy in a magnetic field:

7. Calculate the energy associated with the magnetic field of a 200 turn solenoid in which a current of 1.75A produces a flux of 3.70E-4 Wb in each turn. (0.0648 J)
8. (25) On a clear day at a certain location, a 100V/m vertical electric field exists near the Earth's surface. At the same place, the Earth's magnetic field has a magnitude of 0.500E-4 T. Compare the energy densities of the two fields. ($u_E = 44.2n\ J/m^3; u_B = 995 \mu J / m^3$).
9. An RL circuit in which L=4.00H and R=5.00 Ohms is connected to a 22.0 Volt battery at t=0. a) What energy is stored in the inductor when the current is 0.500A b) at what rate is energy being stored in the inductor when I=1.00A; c) What power is being delivered to the circuit by the battery when I=0.500 A?

(a) U=0.500 J b) 17.0 W; c) 11.0 W

Mutual Inductance:

10. (30) Two coils are close to each other. The first coil carries a time-varying current given by $I(t) = 5.00 A e^{-0.0250t} \sin 377t$. At t=0.800s, the emf measured across the second coil is -3.20 V. What is the mutual inductance of the coils? (1.73mH).

Oscillations in an LC-circuit:

11. (38) An LC-circuit consists of a 20 mH inductor and a 0.500 μF capacitor. If the maximum instantaneous current is 0.100 A, what is the greatest potential difference across the capacitor? (20.0 V)
12. (41) A fixed inductance L=1.05E-6 H is used in series with a variable capacitor in the tuning section on a ship. What capacitance tunes the circuit to the signal from a transmitter broadcasting at 6.30MHz? (608 pF).
13. An LC-circuit (in series) with a open-close switch contains a 82.0 mH inductor and a 17.0 μF capacitor that initially carries a charge of 180 μC. The switch is open for t<0 and then closed at t=0. a) Find the frequency in Hz of the resulting oscillations. At t=1.00ms, find b) the charge on the capacitor and c) the current in the circuit. a) 135Hz b) 119 μC c)-114 mA.

RLC circuits:

14. (45) Consider an LC circuit in which L=500mH and C=0.100 μF a) What is the resonance frequency ω_0 ;b)If a resistance of 1.00 $k\Omega$ is introduced into the circuit, what is the frequency of the damped oscillations c) What is the percent difference between the frequencies? a) 4.47E3 /s; b) 4.36E3/s; c) 2.46%.