Chapter 30.1-30.3 - Inductance

Physics 207

Problem 1 A solenoidal coil with 25 turns of wire is wound tightly around another coil with 300 turns. The inner solenoid is 25.0 cm long and has a diameter of 2.00 cm. At a certain time, the current in the inner solenoid is 0.120 A and is increasing at a rate of 1.75 kA/s. What is the mutual inductance of this system? What is the emf induced in the outer solenoid due to the changing current in the inner solenoid?

Problem 2 An inductor used in a dc power supply has an inductance of 12.0 H and a resistance of 180 Ω. It carries a current of 0.500 A. What is the energy stored in the magnetic field? At what rate is thermal energy being dissipated in the inductor? Does this mean the magnetic-field energy is decreasing with time?

Problem 3 A long, straight solenoid has 800 turns. When the current in the solenoid is 2.90 A, the average flux through each turn is 3.25 mWb. What is the rate of change of the current if the emf is 6.20 mV?

Problem 4 A region of vacuum contains both a uniform electric field with magnitude E and a uniform magnetic field with magnitude B. (a) What is the ratio E/B if the energy density for the magnetic field equals the energy density for the electric field? (b) If $E = 500$ V/m what is B in teslas, if the magnetic-field and electric-field energy densities are equal?

Problem 5 A coil has 400 turns and self-inductance 7.50 mH. The current in the coil varies with time according to $i(t) = 0.680 \cos\left(\frac{\pi t}{0.025}\right)$. What is the maximum emf induced in the coil? What is the maximum average flux through each turn of the coil? At $t = 0.0180$ s, what is the magnitude of the induced emf?

Problem 6 The following is designed to show how similar the approaches are between Gauss's Law, Ampere's law for both conduction and displacement current and Faraday's law for induced electric fields. So covers more of Chapter 29 than 30.

Part (a) An insulating sphere with radius R has a charge density given by $\rho(r) = \rho_0 r$. What is the electric field generated by the charge distribution for both $r < R$ and $r > R$?
Part (b) A current is traveling through a cylindrical wire which has radius R with a current density given by $j(r) = j_0 r$. What is the magnetic field generated by this current for both $r < R$ and $r > R$?
Part (c) An electric field exists in a region of empty space with the function $E(r,t) = E_0 rt$ for $r < R$ and $E(r,t) = 0$ for $r > R$. What is the induced magnetic field for $r < R$ and $r > R$?
Part (d) A magnetic field exists in a region of empty space with the function $B(r,t) = B_0 rt$ for $r < R$ and $B(r,t) = 0$ for $r > R$. What is the induced electric field for $r < R$ and $r > R$?