

PHYSICS 1020

Homework #6

(Due March 27, 2017)

1. Suppose you have a coil of 12 turns of wire of diameter 15 cm. The coil is in an external uniform magnetic field, and the direction of the magnetic field is perpendicular to the plane of the coils. Suppose further that the external magnetic field changes in magnitude from $B = 500 \mu\text{T}$ to $B = 800 \mu\text{T}$ in a time of 0.15 seconds. What is the emf induced in the coil?
2. What is the inductance of a solenoid, whose turns are circular and of diameter 4.00 cm, that has a winding of 12 turns per centimeter, and a total length of 14 cm? Assume the space inside the solenoid is filled with iron, whose relative permeability is 5000.
3. Suppose you have four identical inductors of the kind described in Problem 2. What is the equivalent inductance if they are connected (a) in series, and (b) in parallel?
4. Suppose a 100Ω resistor, a $500 \mu\text{F}$ capacitor, and a 25 mH inductor are connected in parallel to a sinusoidal voltage source of frequency 50 Hz. Find the equivalent impedance of the combination. Use electrical engineering notation: $j = \sqrt{-1}$. Also, note that the reciprocal of a complex number $z = a + bj$ is given by

$$\frac{1}{z} = \frac{a - bj}{a^2 + b^2}$$

5. Suppose you wish to build a crystal radio receiver using a tuned LC circuit. You already have a 1 pF capacitor to use as the capacitor, and you're going to make your own inductor by winding turns of wire around a paper towel tube (which you'll leave as an air-filled tube). The tube has a diameter of 4.50 cm, and you're able to wind the wire so that you have 12 turns per centimeter along the tube. You want to design the LC circuit so that its resonating frequency is in the middle of the AM broadcast band, at $f = 1000 \text{ kHz}$. How many turns of wire (total) should you wind onto the paper towel tube to make your inductor?