PHYS 1512: Week 6

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Equations

$$\mathcal{E} = -N\frac{\Delta\Phi}{\Delta t} \quad \text{(Lenz's Law)} \qquad (1)$$

$$I = \frac{V - \mathcal{E}}{R} \quad \text{(Electric motor)} \qquad (2)$$

$$\frac{I_s}{I_p} = \frac{N_p}{N_s} \quad \text{(Transformers)} \qquad (3)$$

$$\frac{V_s}{V_p} = \frac{N_s}{N_p} \qquad (4)$$

$$V_{rms} = I_{rms}X_C \quad \text{(Reactance)} \qquad (5)$$

$$V_{rms} = I_{rms}X_L \qquad (6)$$

$$X_C = \frac{1}{\omega C} \qquad (7)$$

$$X_L = \omega L \qquad (8)$$

(Recall: $\omega = 2\pi f$)

Question #1

Applied Physics

Imagine a thin wire that is 0.5m long. You bend it into a series of loops, each with a radius of r $= \frac{1}{40\pi}$m. You secure these loops into a ring then place the ring in a perpendicular magnetic field that increases linearly for $t = 5s$. Hooking up a multimeter to the ends of the wire, you see it reads $I = 0.8A$. What is the resistance (R) of the wire if $\Delta B = .1T$?

Question #2

Electric Generators

A motor is designed to operate on 117V and draws a current of 12.2A when it first starts up. At its normal operating speed, the motor draws a current of 2.30A. Find:

a) the resistance of the armature coil

b) the back emf developed at normal speed

Question #3

Transformers

Your Laptop needs a much smaller voltage than what a wall socket outputs (Usually 120V AC in the US). Therefore a transformer is plugged into the socket and adjusts the voltage to the required amount. If you laptop battery is rated at 9.0V and needs a current of 225mA to charge them, determine:
a)The turn ratio
b) The current coming from the wall socket
c) average power delivered by the wall and average power sent to the batteries

Question #4

Challenge Problem: Capacitive Reactance

A capacitor with capacitance C_1 is connected across the terminals of an AC generator. Without changing the voltage of frequency of the generator, a second capacitor (C_2) is added in series with the first one. As a result, the current delivered by the generator decrease by a factor of three. Suppose that the second capacitor had been added in parallel with the first one, instead of in series. By what factor would the current delivered by the generator have increased?

Question #5

Inductive Reactance

A 30.0 mH inductor has a reactance of 2.1 $k\Omega$

a) What is the frequency of the AC current that passes through the inductor?

b) What is the capacitance of the capacitor that has the same reactance at this frequency?

c) If the frequency is tripled, so that the reactances of the inductor and capacitor are no longer equal. What are the new reactances of the capacitor and inductor?