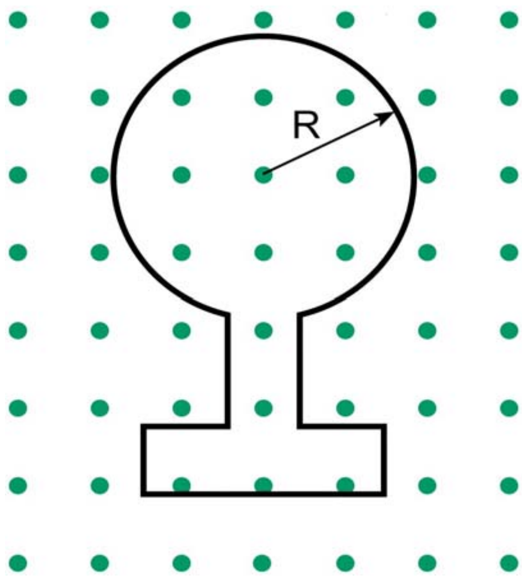
Final Exam, Phyx 135-2 **Name ____________________________________**

1) A very long solenoid with 10 turns of wire per cm and a radius of 7.0 cm is carrying a current of 20 mA. In the exact center of the solenoid is a very long straight wire that is carrying a current of 6.0 A.

a) (6 points) At what radius from the center will the direction of the net magnetic field be at 45 degrees to the axial direction?

b) (4 points) What is the magnitude of the magnetic field at that radius?



2a) (10 points) A wire is setting in a uniform magnetic field. The normal to the area of the wire is parallel to the magnetic field. The wire is bent into the shape of a circle with a radius of R = 2.3 m, connected to a rectangle of width 1 m and height 2 m, connected to a rectangle of width 3 m and height 0.8 m. (You may ignore any overlap between the circle and the rectangles.) Then the magnetic field begins to change at a rate of 6 T / minute. If the resistance of the wire is 4 Ω, what is the current in the wire?

2b) (5 points) Suppose I hold the magnetic field in Part 2a constant at 2.4 T, and instead begin to shrink only the radius of the circular part of the wire at a rate of 1.5 cm/sec. What would be the current in the wire then (at the instant I began shrinking it)?

3a) (5 points) A generator with an adjustable frequency of oscillation is wired in series to an inductor of L = 2.5 mH and a capacitor of C = 3.0 μF. The rms emf of the generator is 110 volts. At what frequency (cycles per second) does the generator produce the largest possible current amplitude in the circuit?

3b) (5 points) Suppose that the circuit in Problem 3 has a resistance of 25 Ω. What would be the average power dissipated by the circuit at ω = 8000 rad/sec?

4) (5 points) I have a laser pointer that produces 3 mW of light. The pointer has a mass of 100 grams. If I accidently left the pointer on and lost it while space-walking (i.e., if I left the laser pointer in a weightless, frictionless environment), how fast would the pointer be moving two hours later?

5) A length of wire 30 meters long is wound into a circular coil with N = 4 turns. The coil is placed into an 8 T magnetic field at an angle of 35 degrees (between the normal to the coil and the field). If a current of 6 mA is running through the coil, then:

a) (5 points) What is the magnetic moment of the coil?

b) (5 points) What torque is acting on the coil?

6) (10 points) Suppose you have a uniform ball of radius $R = 5$ cm and charge $Q = 0.002$ coulomb. (The charge is evenly distributed throughout the sphere.) What would be the electric field inside the ball at a radius of $r = 2$ cm?

Multiple Choice Questions. (2 points each) Please use capital letters for your answers.

_____ 6) The magnetic field of the planet Jupiter is:
A) Created by a solid ball of metallic hydrogen.
B) Created by the rotation of the planet.
C) Created by the liquid convection of metallic hydrogen.
D) Created by magnetic monopoles.
E) Both B and C
F) Both A and B

_____ 7) A current-carrying loop of wire is placed into a uniform magnetic field at an angle of 45 degrees. It has no commutator. The loop will:
A) Spin continuously.
B) Remain still.
C) Flip left or right 90 degrees depending on the direction of the current in the wire.
D) Rotate 45 degrees.
E) Oscillate between 45 degrees and 0 degrees.
F) Rotate 180 degrees.

_____ 8) If two long, straight current-carrying wires are placed parallel to each other, they will:
A) Attract each other if the currents are in the same direction.
B) Repel each other if the currents are in the same direction.
C) Always attract.
D) Always repel.
E) Attract each other if the currents are in opposite directions.
F) May attract, depending on the current direction, but never repel.

_____ 9) A transformer can:
A) Only work with DC current.
B) Only work with AC current.
C) Work with either AC or DC current.
D) Step voltages up with DC current.
E) Only work efficiently with AC current at high voltages.
F) Produce negative voltages.

_____ 10) The so-called “displacement current” is:
A) Neither a displacement nor a current.
B) Only produced by RLC circuits.
C) Only created by a changing electric flux.
D) Only created by a changing magnetic flux.
E) Only created by electromagnetic waves.
F) Another name for Faraday induction.

Useful Equations (Boldface underline type indicates a vector)

$\underline{\mathbf{F}} = q\underline{\mathbf{v}} \times \underline{\mathbf{B}}$ | $r = mv/qB$ | $T = 2\pi m/qB$

$\underline{\mathbf{F}} = i\underline{\mathbf{L}} \times \underline{\mathbf{B}}$

$\underline{\boldsymbol{\tau}} = \underline{\boldsymbol{\mu}} \times \underline{\mathbf{B}}$ | $\mu = NiA$ | $U = -\underline{\boldsymbol{\mu}} \cdot \underline{\mathbf{B}}$

$\mu_o = 4\pi \times 10^{-7}$ | $\oint \underline{\mathbf{E}} \cdot \underline{\mathbf{dA}} = q_{enc} / \varepsilon_o$ | $\varepsilon_0 = 8.85 \times 10^{-12}$

$B = \mu_o i / 2\pi r$ | $B = \mu_o i \, \phi / 4\pi r$

$F_{ba} = \mu_o L i_a i_b / 2\pi d$

$\oint \underline{\mathbf{B}} \cdot \underline{\mathbf{ds}} = \mu_o \, i_{enc}$

$B = \mu_o i n$ | $B = \mu_o i N / 2\pi r$

$\Phi_B = \int \underline{\mathbf{B}} \cdot \underline{\mathbf{dA}} = BA \cos\theta$

$emf = - d\Phi_B/dt$ | $emf = \oint \underline{\mathbf{E}} \cdot \underline{\mathbf{ds}}$

$L = N\Phi_B / I$ | $L / l = \mu_o n^2 A$

$i = (emf/R)[1 - \exp(-t/\tau_L)]$ | $i = i_o \exp(-t/\tau_L)$ | $\tau_L = L/R$

$U = ½ Li^2$ | $U = ½ B^2/\mu_o$ | $U = ½ q^2/C$

$\omega^2 = 1/LC$ | $\omega = 2\pi f$

$X_C = 1/\omega C$ | $X_L = \omega L$ | $V_{rms} = I_{rms} Z$

$Z^2 = R^2 + (X_L - X_C)^2$ | $\tan\phi = (X_L - X_C)/R$

$P_{ave} = I_{rms}^2 R$

$V_S = (N_S/N_P)V_P$

$\oint \underline{\mathbf{B}} \cdot \underline{\mathbf{dA}} = 0$ | $\oint \underline{\mathbf{B}} \cdot \underline{\mathbf{ds}} = \mu_o(\varepsilon_o \, d\Phi/dt + i)$

$c^2 = E/B = 1/\mu_o \varepsilon_o$

$I = E^2/c\mu_o$

$F = P/c$