Fall 2001 **EXAM 3** **Physics 208** **Dr. Youngblood**

1. A coil of diameter 1 cm and length 3 cm contains 60 turns. Assume it is an ideal solenoid.

7 Points (a) What is its inductance?

6 Points (b) It is hooked in series with a 3MΩ resistor. What is the time constant of this circuit?

6 Points (c) A 30V battery is hooked to the circuit described in (b). After 10 minutes, what is the energy stored in the inductor?

6 Points (d) This inductor is now hooked in parallel with a capacitor. What value of C is required so that the resonant frequency f = 100 MHz? Assume the inductor has zero resistance.

7 Points 2. (a) A model-train transformer plugs into 120 V ac, and draws 0.80 A while supplying 15 A to the train. What voltage is present across the tracks?

6 Points (b) A simple generator has a 500-loop square coil 15.0 cm on a side. How fast must it turn in a 0.350-T field to produce a 120-V peak output?

6 Points (c) The counter emf in a motor is 72 V when operating at 1250 rpm. What would be the counter emf at 2500 rpm if the magnetic field is unchanged?

6 Points (d) If the electric field in an EM wave has a peak value of 0.62×10^{-4} V/m, what is the peak value of the magnetic field strength?

3. Suppose a 60-kW radio station emits EM waves uniformly in all directions.

9 Points (a) How much energy per second crosses a 1.0-m^2 area 20 m from the transmitting antenna?

8 Points (b) What is the rms magnitude of the **E** field at this point, assuming the station is operating at full power?

8 Points (c) What is the voltage induced in a 1.5-m-long vertical car antenna at this distance?

4. Suppose a conducting rod (mass m, resistance R) rests on two frictionless and resistanceless parallel rails a distance l apart in a uniform magnetic field **B** ($\perp$ to the rails and the rod). At $t = 0$, the rod is at rest and a source of emf ($\mathscr{E}_0$) is connected to the points a and b.

5 Points (a) Write the equation for the current in the rod when it has attained a velocity v.

5 Points (b) Write the equation for the force on the rod when it has attained a velocity v.

10 Points (c) Derive an expression for the velocity of the rod as a function of time.

5 Points (d) What is the velocity of the rod after a long time (assume it is still on the rails and in the magnetic field)?