PHYS 114 - 2^{nd} MIDTERM
25 April 2006

Name and Surname:
Student ID:
Department:
Signature:

Each question worth 20 points. You should show your work. You will lose points if you do not put the right units and put the vector signs for vectors.

1. Consider a charge moving inside the magnetic field of a solenoid. In the reference frame of the solenoid, the charge will feel a magnetic force changing its direction of motion. In a reference frame in which the charge will be momentarily stationary, it will not feel a net magnetic force. But in this frame also it should be accelerating since otherwise the two descriptions of the motion of the particle will not be consistent. Discuss.

2. How does paramagnetism, ferromagnetism and dia magnetism arise? Discuss the physical processes that lead to these phenomena.

3. Consider a pure LC circuit in the form of a perfect circle of radius R. (ignore the deviations due to the inductor and the capacitor). Assume that this circuit is immersed in a uniform time dependent magnetic filed with the time dependence $B(t) = B_0 \sin(\omega t)$ such that the plane of the circuit is perpendicular to the magnetic field. What will be the time dependent current in the circuit after a sufficiently long time?

4. Calculate the induced electric field (its direction and magnitude) inside a uniform solenoid that carries a time dependent current $I(t) = I_0 \sin(\omega t)$ (the solenoid makes n turns per unit length).

5. Consider an infinite wire in the form of an infinitely long cylinder of radius R. Suppose inside the wire current density is uniformly distributed and is given by J. Find the magnetic field everywhere in space.

6. *Bonus Question*
   Consider the long tube which we had seen in the first few lectures of this term: There is a long metallic tube. If you put a piece of non-magnetized metal in it, it falls down fast, but if you put a magnet made of the same material and of the same shape in it, it falls down slowly (in fact, it reaches a limit velocity) Discuss. (Model the magnet as a short solenoid. Suppose that inside the magnet, the magnetic field is uniform with the flux passing through the opening Φ. Let A be the cross sectional area of the magnet and L the length of the magnet.) (A quantitative response will gain you even more extra points, but a detailed qualitative description will also be sufficient for 20 points)