<u>PHYS306 Homework#2 (Due on 10Feb2022)</u>

Q#1:

a) A very long solenoid of radius a, with n turns per unit length, carries a current I_s. A circular ring of radius $b \gg a$ and resistance R is coaxial with the solenoid. When the current in the solenoid is decreased, a current Ir is induced in the ring. Calculate I_r in terms of $\frac{dI_s}{dt}$.

b) The power $I_r^2 R$ delivered to the ring must have come from the solenoid. Confirm this by calculating the Poynting vector just outside the solenoid and finding the power carried out by the electromagnetic field.

Q#2:

A sphere of radius R carries a uniform polarization $\vec{P}$ and a uniform magnetization $\vec{M}$ (not necessarily in the same direction). Find the electromagnetic momentum of this configuration.

Q#3: Calculate the force of attraction between the norther and southern hemispheres of a uniformly charged spinning spherical shell of radius R, angular velocity ω, and surface charge density σ.

Q#4: Consider two equal point charges q, separated by a distance 2a. Construct the plane equidistant from the two charges. By integrating Maxwell's stress tensor over this plane, determine the force of one charge on the other.

Q#5: Suppose there is an electric charge q_e and a **magnetic monopole** q_m. The field of the electric charge is: $\vec{E} = \frac{1}{4\pi\epsilon_o}\frac{q_e}{\Delta r^2}\Delta\hat{r}$ And the field of magnetic monopole is: $\vec{B} = \frac{\mu_o}{4\pi}\frac{q_m}{\Delta r^2}\Delta\hat{r}$. Find the total angular momentum stored in the fields, if the two charges are separated by a distance d.

Q#6: A point charge q is a distance a>R from the axis of an infinite solenoid of radius R and n turns per unit length which is carrying current I. Find the linear momentum and the angular momentum in the fields.

Q#7:

Imagine an iron sphere of radius R that carries a charge Q and a uniform magnetization $\vec{M} = M\hat{k}$. The sphere is initially at rest.

(a) Compute the angular momentum stored in the electromagnetic fields.

(b) Suppose the sphere is gradually demagnetized by heating it up past the Curie point. Use Faraday's law to determine the induced electric field, find the torque this field exerts on the sphere, and calculate the total angular momentum imparted to the sphere in the course of the demagnetization.

(c) Suppose instead of demagnetization the sphere was discharged by connected a ground wire to the north pole. Assume the current flows over the surface in such a way that the charge density remains uniform. Determine the torque on the sphere and calculate the total angular momentum imparted to the sphere in the course of the discharge.