PHYSICS 220 **January 30, 1996.**
Final Exam **Time: 8:00 a.m.**

1. The space between two coaxial conducting cylinders of length L = 25 cm is half-filled with a dielectric having relative dielectric constant $\varepsilon_r = 8$. The cylinders have radius 0.5 cm and 2 cm, as shown (Fig. 1) and are connected to a 100 V battery.

a- find the field E and D in the air and in the dielectric

b-Find the surface charge induced on the inner conductor at points adjacent to the air, and at points adjacent to the dielectric

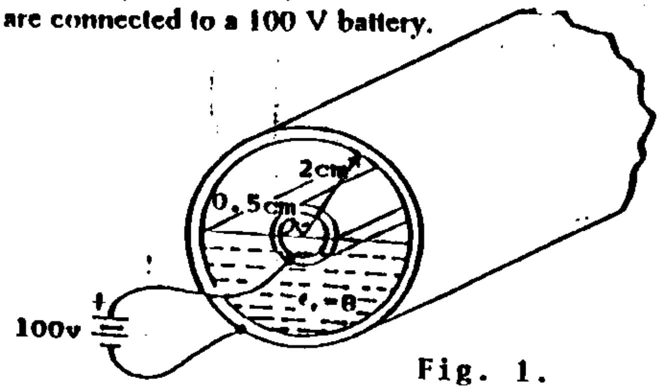


Fig. 1.

2. Two perfectly conducting coaxial cylinders of length L, inner radius a, and outer radius b are maintained at a potential difference V and enclose a material with Ohmic conductivity σ as in fig. 2.
Find the resistance of the coaxial cylinder configuration.

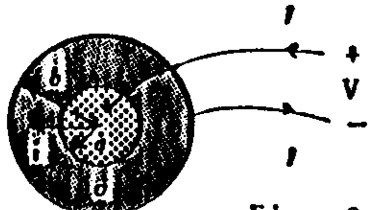


Fig. 2.

3. Calculate the force between the two current - carrying circuit fig. 3. A current I_1, flows in circular loop carrying of radius R. An infinit wire carrying a current I_2 is in the plane of the loop and at a distance d > R from the center of the loop. (Use energy method).

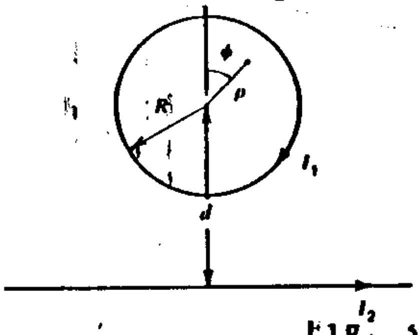


Fig. 3.

4. A uniformly charged thin disk of charge density σ, radius R, and thickness t < R rotates with angular velocity ω about the z-axis of symmetry. Calculate the B field at a point on the axis of the thin disk.

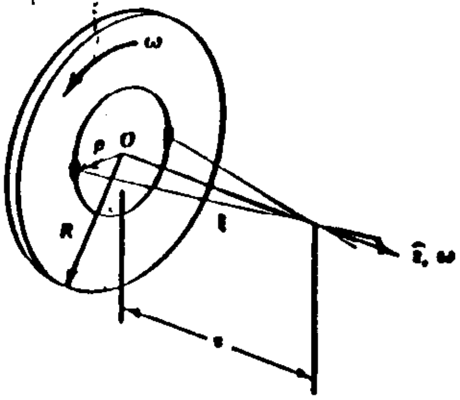
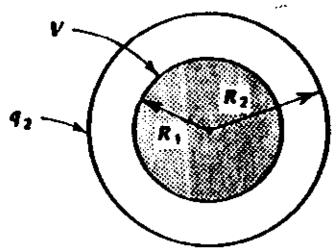


Fig. 4.

5. The inner sphere of a spherical capacitor (fig. 5) has a radius R_1; the outer concentric shell is very thin and has a radius R_2. The inner sphere is kept at a constant potential V by a battery. The outer shell is insulated and has a charge q_2.

a- Calculate the potentials ϕ_1 and ϕ_2 of the inner and outer conductors.
Calculate the electrostatic energy of the system.

b- Suppose that the inner sphere now expands to radius R_3. As a result of the expansion, the electric energy and the charge at the inner surface change.
Calculate the change in electric energy.



(fig. 5)

6. (a) show that $\int A.dl = \phi$ where ϕ is magnetic flux through a surface bounded by the circuit C.

(b) Use this result together with Ampere's law to find A at distance r both inside and outside a very long solenoid.

7. A long cylinder of radius a and permeability μ is placed in a uniform magnetic field B_0. Calculate the magnetic induction inside the cylinder.[Assume from the beginning that ϕ^* can be completely specified in terms of the cos θ cylindrical harmonics. This assumption is justified, since all boundary conditions can be satisfied in terms of the cos θ harmonics.