INDIAN INSTITUTE OF SPACE SCIENCE & TECHNOLOGY

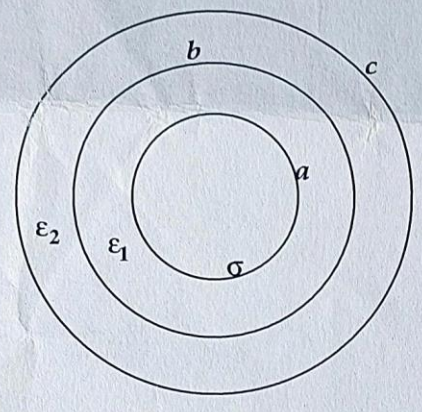
B. Tech(I Year) **Physics - II (PH121)** **Quiz 2**

2 June 2022 **Duration:1 Hrs** **Full Marks: 20**

Answer all questions(All questions carry equal marks)

1. A dielectric cube of side a, centered at the origin, has polarization $\mathbf{P} = k\mathbf{r}$, where k is a constant. Find all the bound charges in the dielectric and show that they all add to zero.

2. The cross section of a wire is shown below. A metal wire of radius a is surrounded y two layers of linear dielectric material with dielectric constant ϵ_1 and ϵ_2, and radius b and c, respectively. This is followed by an outer metal tube of inner radius c. The inner metal has a surface charge density σ residing on its surface. Find $\mathbf{D}$, $\mathbf{E}$ and $\mathbf{P}$ in all the regions.



3. a) A small magnet placed at the origin, with it moment along $\hat{\mathbf{z}}$, produces a magnetic field $\mathbf{B} = -0.001\hat{\mathbf{z}}$ at $(1, 0, 0)$ (units are SI). Find (approximate) $\mathbf{B}$ at $(0, 0, 1)$ and at $(1, 1, 1)$, and the magnetic moment of the small magnet.

   b) Which of the following vector fields can possibly be magnetostatic fields? Identify the current density in the case(s) where it is:

   i. $\mathbf{B_1} = y\cos(ax)\hat{\mathbf{x}} + (y + e^{-x})\hat{\mathbf{z}}$, where a is a constant.

   ii. $\mathbf{B_2} = \frac{1}{s}\hat{\mathbf{s}}$ (in cylindrical coordinates).

   iii. $\mathbf{B_3} = r^2 \sin\theta\hat{\phi}$.

4. A infinitely long solenoid type coil is made of reasonably pure copper wire (99 percent copper 1 percent gold) of thickness 0.5 mm. The coil is tightly wound so that 5 mm length of coil has exactly 10 loops. The coil is of radius 0.5 cm. Assume that we are able to close the circuit through a resistor R and a source supplying voltage V, so that current I flows in the circuit. What is the $\vec{B}$ field inside and outside the coil? What is the vector potential $\vec{A}$ outside the coil?