PHYS 333 Test 3 Review

November 17, 2006

Linear Dielectric

Consider infinite parallel plates, one at $z = 0$ with charge density σ and the other at $z = d$ with charge density $-\sigma$.

In between the plates is a linear dielectric (so $\mathbf{P} = \epsilon_0 \chi_e \mathbf{E}$) whose susceptibility varies with distance as $\chi_e = 2z$.

Find $\mathbf{D}$,$\mathbf{E}$, $\mathbf{P}$, and the bound charge.

Magnetic Forces and Biot-Savart

On the board is shown a segment of a current loop, and a positively charged particle with a particular velocity.

Determine the direction of the force on the particle, or if the force is zero.

Ampere's Law

A current flows down a cylindrical tube of radius a oriented along the z-axis. The current density is given by $\mathbf{J} = ks\,\hat{\mathbf{z}}$.

Determine $\mathbf{B}$.

Vector Potential

Same setup as before:

A current flows down a cylindrical tube of radius a oriented along the z-axis. The current density is given by $\mathbf{J} = ks\,\hat{\mathbf{z}}$.

Determine $\mathbf{A}$.

Boundary Conditions

Derive the magnetic field just inside a circular solenoid (current I, n turns per length) by treating the current as a surface current $\mathbf{K}$ in the $\hat{\phi}$ direction.

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Can you give a one-line argument why this field inside must be uniform?

Magnetic Dipoles and Magnetization

A long circular cylinder of radius a has a magnetization $\mathbf{M} = ks\,\hat{\phi}$. Determine the bound currents and magnetic field inside and outside the cylinder.