

Phys 3330 Electricity & Magnetism II

Spring 2019

Assignment #1 – complete by Friday February 1st 2019

Review of Electricity & Magnetism I

1. A dielectric sphere of radius R has a charge density given by $\rho = \rho_0 r^2 \sin(2\pi r/R)$. The sphere itself is made from a linear, isotropic, and homogeneous material of dielectric constant ϵ . Find the electric field both inside and outside the sphere.
2. What is the difference between the terms ‘conduction current’ and ‘displacement current’?
3. Show that the continuity equation ($\text{div}\mathbf{J} = \partial\rho/\partial t$) is not an independent equation, but instead is a natural consequence of Maxwell's equations. (Hint: start with Ampere's Law.)
4. A square loop of side a lies in the x - y plane ($x, y \geq 0$), with one corner at the origin and its sides parallel to the coordinate axes. There is a magnetic field $\mathbf{B} = \alpha y^3 t^2 \mathbf{k}$, where α is a constant. Find the induced emf in the loop.
5. A semi-infinitely long wire ($-\infty \leq z \leq 0$) carries a current I . Calculate the magnetic field at the point $(a, 0, b)$.
6. The x - y plane forms the boundary between two media whose dielectric constants are $\epsilon_1 = 3.6$ and $\epsilon_2 = 2.1$. Just inside the first medium the electric field is given by $\mathbf{E}_1 = 3000 \mathbf{i} + 1500 \mathbf{j} + 2500 \mathbf{k}$. What is the field just inside the second medium?