Assignment 1

EP3110 Electromagnetics and applications 04-08-2022

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1. The electric potential of some configuration is given by the expression $V(r) = A\frac{e^{-\lambda r}}{r}$ where A and λ are constants. Find the electric field $\vec{E}$(r), the charge density ρ(r), and the total charge Q.

2. An electron and a proton separated by a distance of 10^{-11} meter are symmetrically arranged along the *z*-axis with *z* = 0 as its bisecting plane. Determine the potential and *E* field at the position *P*(3, 4, 12).

3. Consider a plane boundary (*y* = 0) between air (region 1, $\mu_{r1} = 1$) and iron (region 2, $\mu_{r2} = 5000$). a) Assuming $\vec{B}_1 = 0.5\hat{x} - 10\hat{y}$ (mT), find $\vec{B}_2$ and the angle that $\vec{B}_2$ makes with the interface. b) Assuming $\vec{B}_2 = 10\hat{x} + 0.5\hat{y}$ (mT), find $\vec{B}_1$ and the angle that $\vec{B}_1$ makes with the normal to the interface.

4. Write the set of four Maxwell's equations (relating $\vec{E}$, $\vec{B}$, $\vec{D}$ and $\vec{H}$ fields) in linear medium as eight scalar equations a) in Cartesian coordinates, b) in cylindrical coordinates and c) in spherical coordinates.

5. Prove that the Lorentz condition for potentials is consistent with the equation of continuity.

6. Prove by direct substitution that any twice differentiable function of $(t - R\sqrt{\mu\varepsilon})$ or of $(t + R\sqrt{\mu\varepsilon})$ is a solution of the homogeneous wave equation $\frac{\partial^2 U}{\partial R^2} - \mu\varepsilon\frac{\partial^2 U}{\partial t^2} = 0$.