Engineering 6813 Tutorial 5 (Time-Varying Fields) Fall, 2009

1. Consider the ideal dielectric region defined by $|x|$, $|y|$, $|z| \leq 1$ in which the relative permittivity and permeability are 5 and 4, respectively. The displacement current density is $\vec{J}_d = 20\cos(1.5\times 10^8 t - bx)\,\hat{y}\ \mu\text{A/m}^2$. (a) Determine the electric flux density and the electric field intensity. (b) Find $\vec{B}$ and $\vec{H}$ (c) Determine the value of b. Assume no dc fields are present.

2. The potential $\underset{\sim}{V}$ in the dielectric at a distance r from the centre of a spherical capacitor, whose inner and outer surfaces have radii of a and b, respectively, and which is connected to a source voltage of $v = V_0 \sin \omega t$, is given by

$$\underset{\sim}{V} = v \frac{\frac{1}{r} - \frac{1}{b}}{\frac{1}{a} - \frac{1}{b}} \, .$$

For the ideal dielectric, the relative permittivity and permeability are ϵ_r and unity, respectively. Find the total displacement current through the dielectric and compare it with the source current as determined from circuit analysis.