

ECE221S – Quiz 3B – Wednesday, March 5, 2003

Family Name, Given Name(s)

Student Number

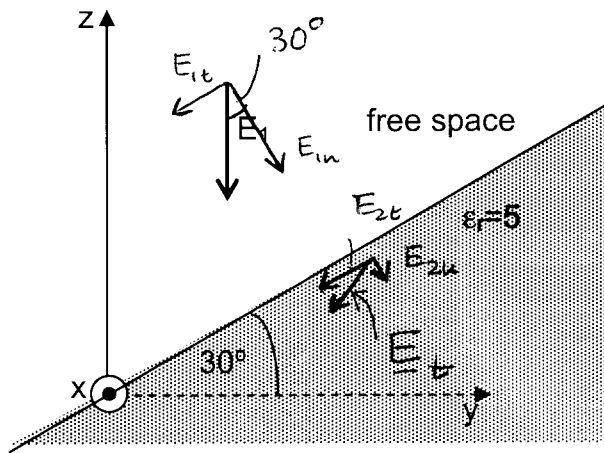
Please insert your name in full and your student number.

In a Cartesian coordinate system the space below a plane that is rotated from the x-y-plane around the x-axis by 30° towards the z-axis, is filled with a dielectric with permittivity $\epsilon_r=5$. (See diagram below.) The region above this plane is free space and the electric field there is $\underline{E}_1 = -E_0 \cdot \hat{z}$.

- Find the components tangential and normal to the boundary of \underline{E}_1 in free space.
- Calculate the components tangential and normal to the boundary of the electric field \underline{E}_2 in the dielectric.
- Sketch the electric field vector \underline{E}_2 in the diagram below.

Useful equations: $E_{1t} = E_{2t}$ $D_{2n} - D_{1n} = \rho_s$ (normal is from material 1 to 2).

*(This should read: $D_{1n} - D_{2n} = \rho_s$)
sorry!*



$$(a) \quad E_{1t} = E_0 \sin(30^\circ) = \frac{1}{2} E_0, \quad E_{1n} = E_0 \cos(30^\circ) = \frac{\sqrt{3}}{2} E_0 = 0.866 E_0$$

$$(b) \quad E_{1t} = E_{2t} = \frac{1}{2} E_0$$

$$\rho_s = 0 \rightarrow D_{2n} = D_{1n} \rightarrow \epsilon_2 E_{2n} = \epsilon_1 E_{1n}$$

$$\rightarrow E_{2n} = \frac{\epsilon_0}{5 \epsilon_0} E_{1n} = \frac{1}{5} E_{1n} = 0.173 E_0$$

$$|\underline{E}_2| = \sqrt{\left(\frac{1}{2}\right)^2 + \left(\frac{1}{5}\right)^2} E_0 = 0.54 E_0$$