EE-IITB

EE301-TUTORIAL 3

Tutorial 3

1. Region 1, $z < 0$, and region 2, $z > 0$, are both perfect dielectrics ($\mu = \mu_0$, ε and loss less). A uniform plane wave traveling in the $\mathbf{a}_z$ direction has a radian frequency of 3×10^{10} rad/s. Its wavelengths in the two regions are $\lambda_1 = 5$ cm and $\lambda_2 = 3$ cm. What percentage of the energy incident on the boundary is (*a*) reflected; (*b*) transmitted? (*c*) What is the standing wave ratio in region 1?

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2. A plane wave propagates in free space and encounters a perfect conductor. The frequency of the wave is 1 GHz and its amplitude is 1 V/m. The electric field intensity is directed in the x direction and the wave propagates in the z direction, as shown in Figure 1.
Calculate the electric and magnetic field intensities everywhere to the left of the conductor's surface.

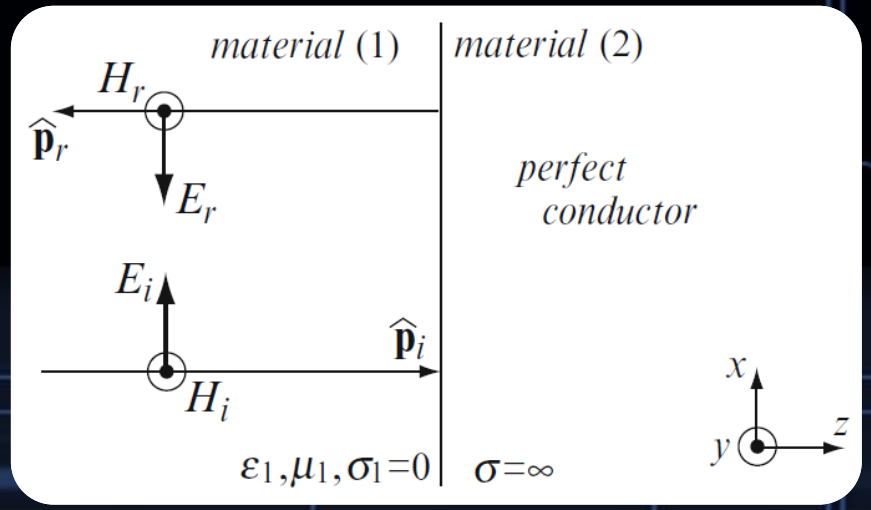

Figure 1.

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3. A plane wave with parallel polarization is incident on the interface between a perfect dielectric and free space, at 28^0 from within the dielectric. The dielectric has permeability of free space and relative permittivity $\varepsilon_r = 4$.

Calculate:

(a) The reflection and transmission coefficients at the interface.

(b) The critical angle.

(c) The Brewster's angle if $\varepsilon_{r1} = \varepsilon_{r2}$

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4. A uniform plane wave travelling (With $|E| = 10^{-3}$ V/m) in free space is incident on a semi-infinite lossless medium with a dielectric constant of 1.44. Determine the values of the reflection coefficient, transmission coefficient, incident and transmitted power, and travelling wave and standing wave parts in the incident medium.

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5. A uniform plane wave with perpendicular polarization travelling in free space having a power density of 10 W/m^2 is incident at an air-dielectric ($\varepsilon_r = 25$) interface with an incident angle of 45^o. Find the amplitude of the electric field, the magnetic field at a distance of 1 m on either side of the interface. Consider the frequency of wave as 100 MHz.

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6. Consider a parallel polarized electromagnetic wave radiated from a submerged submarine impinges on a water-air interface. Assuming the zero conductivity for water and $\varepsilon_r = 81$. Calculate the value of the incidence angle for which reflected power is zero

(a) Repeat the above problem considering the wave radiated from an aircraft impinges on an air-water interface. Also, assume that the conductivity of air is zero.

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7. A perpendicularly polarized plane wave at 100 GHz impinges on a flat metallic reflector at an angle of incidence α. The incident electric field intensity is in the positive x direction, has amplitude 100 V/m, and propagates in free space. Assume the incident magnetic field intensity has components in the positive y and negative z directions and that the interface coincides with the x-y plane.

Calculate: The surface current density as a function of the incidence angle α on the surface of the conductor. Plot its magnitude and show for what values of the incidence angle the current density is maximum and for what values itis minimum.