Reading

Textbook: *Elements of Electromagnetics*, 7th Ed.
Matthew N. O. Sadiku
Oxford University Press

Assignment: Read Chapter 10.

Lectures: Topic 7
From *Electromagnetic Field Theory*
https://empossible.net/academics/emp3302/

Scattering at an Interface

The following equation describes the electric field component of a plane wave that is incident onto an interface lying in the xy plane.

$$\vec{E}_{\text{inc}} = \left(j2.1293\hat{a}_x + j3.1625\hat{a}_y - j0.7713\hat{a}_z \right) \exp\left[-j\left(6.9003\times10^6 x - 2.5115\times10^6 y + 8.7513\times10^6 z \right) \right] \text{ V/m}$$

Problem #1 – Incident Wave Vector $\vec{k}_{\text{inc}}$

Write the wave vector for the incident wave, $\vec{k}_{\text{inc}}$.

Problem #2 – TE and TM Polarization Directions

Calculate the unit vectors $\hat{a}_{\text{TE}}$ and $\hat{a}_{\text{TM}}$ that point in the TE and TM polarization directions, respectively.

Problem #3 – Polarization

Calculate the complex amplitudes of the TE and TM polarizations. Identify the polarization of the incident wave as either linear polarization (LP), left circular polarization (LCP), right circular polarization (RCP) or elliptical polarization (EP).

Problem #4 – Reflection and Transmission Coefficients

Calculate the reflection and transmission coefficients for both TE and TM polarizations. Assume the material of the incident wave is air and the material of the transmitted wave has a refractive index of 2.75.

Problem #5 – Amplitudes of Scattered Waves

Calculate the complex amplitude of the TE and TM polarizations for both the reflected and transmitted waves.

Problem #6 – Polarization of the Reflected and Transmitted Waves

Identify the polarizations of the reflected and transmitted waves as either linear polarization (LP), left circular polarization (LCP), right circular polarization (RCP) or elliptical polarization (EP). If a polarization is identified as LP, identify if it is TE, TM, or both.

Problem #7 – Reflectance and Transmittance for TE and TM

Calculate the reflectance and transmittance coefficients for both TE and TM

polarizations. Express your answers on a percent (%) scale.

Problem #8 – Overall Reflectance R and Transmittance T

Calculate the overall reflectance R and transmittance T for this problem. Express your answers on a percent (%) scale.

Problem #9 – Verify Power Conservation

Verify that the overall reflectance R and transmittance T add to 100%.

Standing Waves

Problem #10 – Standing Wave Ratio from Refractive Index

Determine the linear standing wave ratio (SWR) and decibel standing wave ratio (SWR_{dB}) at an interface of air (n_1=1.00) to water (n_2=1.33) at normal incidence.

Problem #11 – Dielectric Constant from Standing Wave Ratio

If the SWR of an interface of air and a mystery material is 4.2 at normal incidence, what is the mystery material's dielectric constant? Assume no magnetic response.

Slabs

Problem #12 – Invisible Slab

You are given a material that has a dielectric constant of 9.0 with no magnetic response. What is the minimum, non-zero thickness a solid slab of this material needs to be in order to be invisible to an incoming 2.4 GHz plane wave at normal incidence? Assume the material has no loss.