Study Material

Text Book

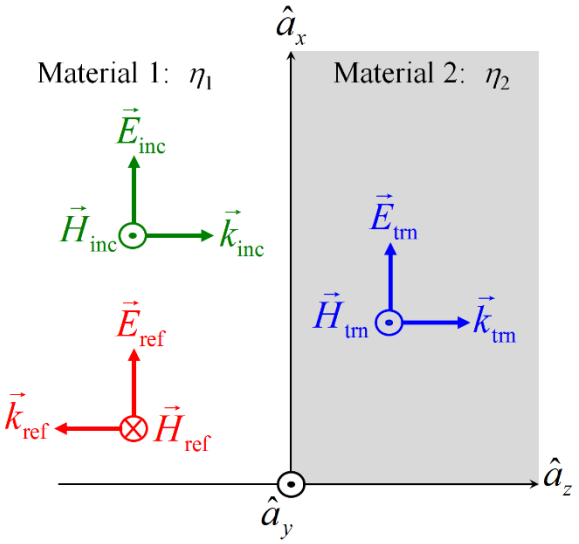
Elements of Electromagnetics, 7th Ed.
Matthew N. O. Sadiku
Oxford University Press

Study Scattering at an Interface

Read Chapter 10, pp. 502-538.

Transmission and Reflection at Normal Incidence

An electromagnetic wave is incident from Material 1 onto Material 2 at normal incidence as illustrated to the right. Answer the following problems given this geometry.



Problem #1

Write general time-domain expressions for the electric and magnetic field components for the incident, reflected, and transmitted waves shown in the figure to the right. Write the magnetic field equations in terms of electric field quantities using the concept of impedance. Do not use the reflection coefficient *r* or the transmission coefficient *t* in your answer.

Problem #2

Write time-domain expressions for the total electric field $\vec{E}_{inc} + \vec{E}_{ref}$ and the total magnetic field $\vec{H}_{inc} + \vec{H}_{ref}$ inside Material 1. Write the same expressions for Material 2. Do not use the reflection coefficient *r* or the transmission coefficient *t* in your answer.

Problem #3

Write the boundary conditions at $z = 0$ that relate the electric and magnetic field components on either side of the interface. Do not use the reflection coefficient *r* or the transmission coefficient *t* in your answer.

Problem #4

From the expressions in Problem #3, derive the reflection coefficient *r* in terms of η_1 and η_2.

Problem #5

From the expressions in Problem #3, derive the transmission coefficient *t* in terms of η_1 and η_2.

Standing Waves

Problem #6

An electromagnetic wave propagating through air is incident on water (n = 1.33) at normal incidence. Calculate the standing wave ratio (SWR) in decibels assuming the water does not have a magnetic response.

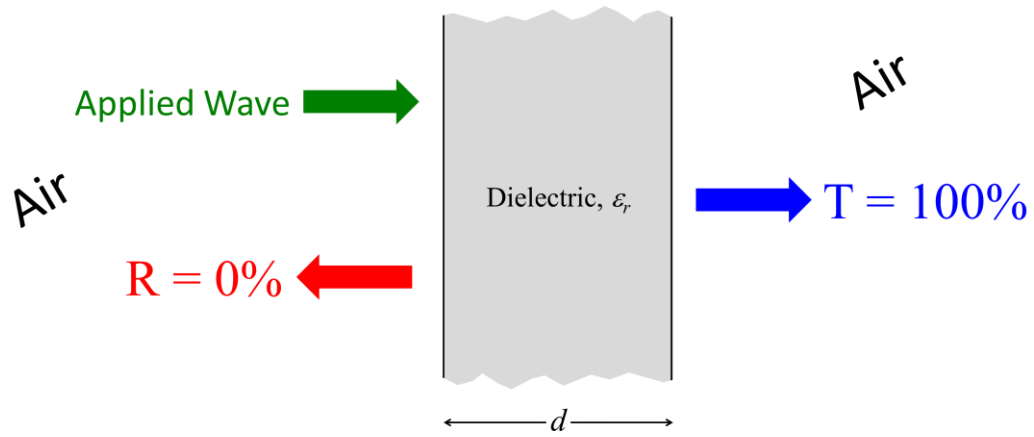
Problem #7

What side of the interface does the standing wave exist?

Problem #8

In an experiment, an electromagnetic wave is reflected from the surface of a unknown material in air at normal incidence. The standing wave ratio is measured to be 4.2. Assuming the material does not have a magnetic response, what is the materials dielectric constant?

Dielectric Slab



Problem #9

How thick d should the dielectric slab (ε_r = 9.0) show above be made so that it is transparent to a 2.4 GHz wave in air?