Normal Incidence Reflection

Reading assignment
Ulaby, 8-1
Connor and Salon, Unit X (On Waves & Materials)

Problem 1 - Normal incidence reflection - conductors
A 10 GHz plane wave has an electric field magnitude of 100 V/m and propagates in the $a_z$ direction through a perfect dielectric with $\varepsilon_r = 9$. $E$ is in the $a_x$ direction.

a. What are the incident $E$ and $H$ phasors?
b. At $z = 0$, the wave strikes a perfect conductor. What are the reflected $E$ and $H$ phasors?
c. Use the boundary conditions to find the surface current density in the conductor.
d. Draw the standing wave pattern for $E$ and $H$ (include numbers for amplitude and position).
e. Simulate this case with sing_bnd.m by using a large imaginary dielectric for region 2.
f. Calculate the total $E$ and $H$. (phasor & time domain form).

Problem 2 - Normal incidence reflection - dielectrics
The same wave as in problem 1 strikes a dielectric-air boundary at $z=0$ as shown below.

![Diagram of dielectric-air boundary](image)

a. Find the reflection and transmission coefficients.
b. What are the reflected and transmitted electric field phasors?
c. What are the reflected and transmitted $H$ phasors? What is $H_t/H_i$?
d. What is the standing wave ratio in the dielectric? Sketch the standing wave pattern for $E$ and $H$. Run sing_bnd.m for this problem.
e. What is the average power density of the incident, reflected, and transmitted waves?
Problem 3 - Normal incidence - multiple boundaries

A 10 GHz radar transmitter is used in the configuration shown below. Note that the radome-outside air boundary is identical to the boundary examined in Problem 2.

\[ \varepsilon_r = 1 \]

\[ \varepsilon_r = 9 \]

\[ \varepsilon_r = 1 \]

Radar antenna

radome

outside air

Region 1

Region 2

Region 3

a. What is \(|E|/|H|\) at the \(z=0\) boundary of Problem 2? (equivalent to the region 2-3 boundary in this problem). Compare it with the value in air.

b. Now refer to the full radome problem. Where can you put the left boundary so that \(|E|/|H|\) in the radome matches that in the air on the left? For mechanical reasons, the radome must be more than 2 cm thick.

c. What is \(\Gamma\) for this value of \(d\)?

d. What is \(\Gamma\) if \(d\) is 0.2 mm thinner than designed?