Reading assignment
Popović and Popović, Chapter 22.1, 22.2, 22.3
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]

<table>
<thead>
<tr>
<th>Region 1</th>
<th>Region 2</th>
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<tbody>
<tr>
<td>$\varepsilon_r = 9$</td>
<td>$\varepsilon_r = 1$</td>
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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 $H_f / H_i$?
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.

\[ \varepsilon_r = 1 \]

Region 1

Radar antenna

\[ \varepsilon_r = 9 \]

Region 2

Radome

\[ \varepsilon_r = 1 \]

Region 3

outside air

**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?