Interactive Lecture - Two

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Interactive web applications available at
https://apps.eeng.dcu.ie/ESOA/index.html

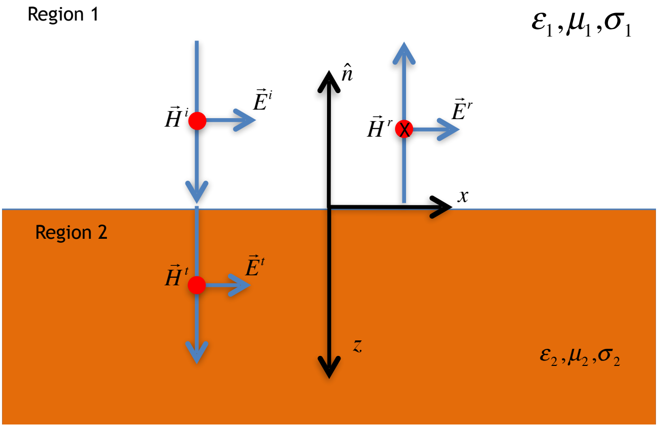
Applying boundary condition at $z = 0$ gives

Reflection Coefficient

$$\Gamma = \frac{\eta_2 - \eta_1}{\eta_2 + \eta_1}$$

Transmission Coefficient

$$T = 1 + \Gamma$$



Question One: Consider the scenario in figure (**??**). A unit amplitude plane wave is normally incident on a planar boundary between free space and a lossless medium. Given the data in the figure compute Γ, ϵ_r of the reflecting material and T.

Question Two: When a plane wave is reflected from a planar surface the transmission coefficient satisfies

$$T = 1 + \Gamma$$

A reasonable, **but incorrect**, thought would be that in order to ensure that power is conserved at the boundary that the relationship *should* be $T + \Gamma = 1$. Prove that, with $T = 1 + \Gamma$, power is conserved when the wave reflects, i.e. the total power in the incident wave is present in the reflected and transmitted waves.

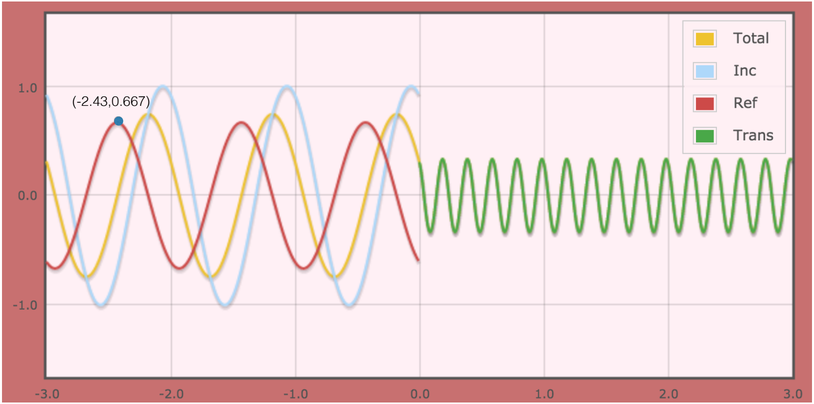
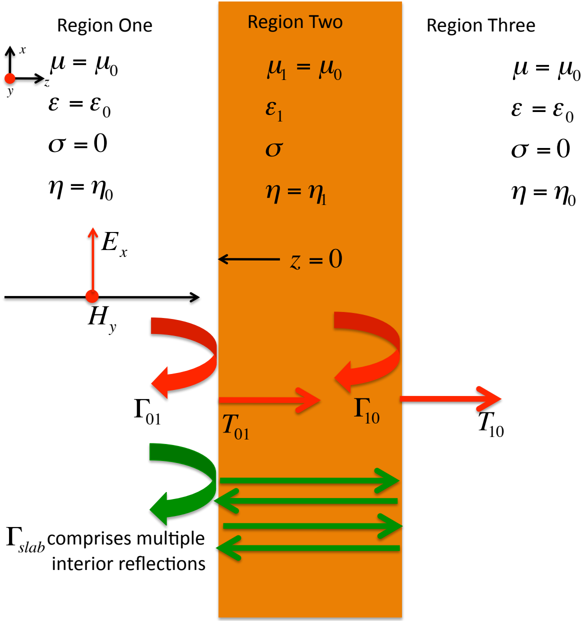


Figure: Figure for Q1

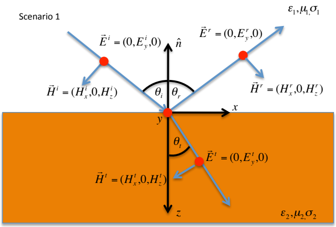
Reflection from a slab

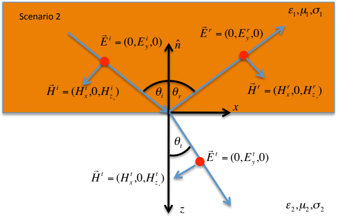


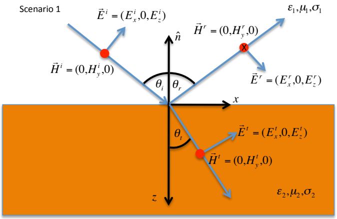
Question Three: Derive expressions for $\vec{E}$ in regions 1, 2 and 3. Use the simulator to validate your expressions.

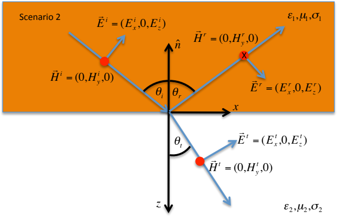
Question Four: A plane wave is normally incident on a lossless dielectric slab with permittivity ϵ_1 and thickness d. Derive an expression for $d$such that the total slab reflection coefficient equals 0.

Oblique reflection









Question Six: A perpendicularly polarised wave travelling in free space impinges on a medium with $\epsilon_r = 5$ at an angle of 45°. Compute the reflection and transmission coefficient. Does the reflection coefficient change if the wave is instead travelling from the medium $\epsilon_r = 5$ to free-space?

Question Seven: Repeat the above exercise for a parallel polarised wave.

Question Eight: At what angle will the reflection coefficient go to zero? Investigate this for both polarisations and scenarios. Where possible derive an expression for the angle that produces zero reflection (Brewster angle). Assume in all cases that $\mu = \mu_0$ for all materials

Question Nine: At what angle will the reflection coefficient go to one? Investigate this for both polarisations and scenarios. Where appropriate derive an expression for the angle that produces unity reflection (critical angle).

Question Ten: Investigate the behaviour of the reflection coefficients as the incident wave approaches grazing, ie. $\theta_i \to 90^\circ$.

Question Eleven: Derive the expressions for Γ and T for both polarisations. This can be done by enforcing continuity of the tangential components of both $\vec{E}$ and $\vec{H}$ along the boundary ($z = 0$).