

Lecture 19.

Lecture objectives.

- To derive expressions for transmitted and reflected power at a junction between two media of different impedance z .
- To consider energy conservation in the special cases discussed in lecture 18.
- To understand the concept of impedance matching at an interface in significant detail.
- To derive and manipulate reflection and transmission coefficients (in terms of z), for the case of a quarter-wave transformer (impedance matching case), so that zero reflection is produced.

Post-lecture tasks.

- The wave equation for the electric field component of the electromagnetic wave in dielectrics is

$$\frac{\partial^2 E_x}{\partial z^2} \frac{1}{\epsilon\mu} = \frac{\partial^2 E_x}{\partial t^2} \quad (\text{careful how you interpret this equation!})$$

where the permeability and permittivity are μ and ϵ respectively.

- Write down a wave function E_x which satisfies this equation and specify the direction of the wave propagation.
- Express the phase velocity v of this wave in terms of μ and ϵ and calculate the refractive index $n=c/v$ for a dielectric with $\mu = \mu_0$ and $\epsilon = 10\epsilon_0$.
- The characteristic impedance of dielectrics to electromagnetic waves is

$$Z = (\mu / \epsilon)^{1/2}$$

The reflection coefficient for incident light passing from a medium with impedance Z_1 to a medium with impedance Z_2 is

$$R = \frac{Z_1 - Z_2}{Z_1 + Z_2}$$

- For the dielectric with μ and ϵ given above, calculate the transmission coefficient for incident light coming from free space and having a wavelength of 400 nm.
- Calculate the thickness of the anti-reflective coating for such a dielectric.