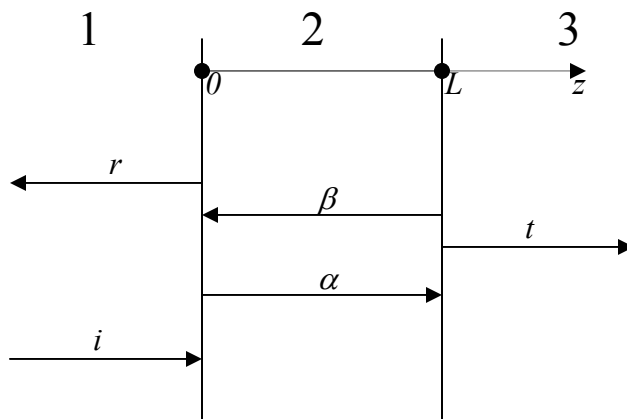


ECE 275B
Homework #1

- 1) (10 pts.) Verdeyen problem 1.5
- 2) (10 pts.) Photons:
 - A) What is the typical power consumed by a light bulb? If all of the energy from the wall plug went into creating optical photons, roughly how many photons per second would be created?
 - B) The energy flow from sunlight at the surface of the earth is about 1000 W/m^2 . The distance from the Earth to the sun is about 10^{11} m . Roughly how many photons per second are generated by the sun?
- 3) (10 pts.) In class, we claimed that $\vec{\nabla} \cdot \vec{b} = 0$ is a “law” of physics. Sketch a vector field \vec{b} that violates this condition. Such a field has never been observed in nature.
- 4) (50 pts.) A plane wave traveling in a medium of impedance Z_1 is normally incident at $z=0$ on a second medium of impedance Z_2 . The second medium has thickness L and behind it is another medium of impedance Z_3 , which occupies the rest of space.
 - A) Show that the ratio of the reflected and incident electric field amplitudes in the incident medium is given by

$$\frac{E_r}{E_i} = \frac{Z_2(Z_3 - Z_1) \cos(k_2 L) - i(Z_2^2 - Z_1 Z_3) \sin(k_2 L)}{Z_2(Z_3 + Z_1) \cos(k_2 L) - i(Z_2^2 + Z_1 Z_3) \sin(k_2 L)}$$
 (You will need the five *resultant* waves indicated, that is, the situation is in its final steady state. Remember: the boundary conditions must be satisfied at both boundaries simultaneously.)
 - B) Show that if $Z_1 \neq Z_3$, the reflected wave will be zero when L equals an odd multiple of a quarter wavelength in medium 2 and $Z_2 = (Z_1 Z_3)^{1/2}$.
 - C) Find the corresponding conditions for zero reflected wave when $Z_1 = Z_3 \neq Z_2$.
 - D) Red light is normally incident in a vacuum upon a large slab of nonmagnetic glass of index of refraction 1.5. If the glass is to be coated with a layer of nonmagnetic material in order that the light not be reflected, find the required index of refraction and minimum thickness of the coating.
 - E) Is E_r/E_i ever = 1? If so, when?
 - F) Assume medium 2 is glass ($n_2=1.5$) and medium 1,3 are vacuum ($n_1=n_3=1$). *Sketch* the transmitted power vs. frequency. Hint: The power reflected is $|E_r/E_i|^2$, and the transmitted power is $1 - |E_r/E_i|^2$. How would the plot change if medium 2 was GaAs?



- 5) (10 pts.) In class we derived the wave equation for e . Derive the wave equation for b : $\nabla^2 \vec{b} = \mu_0 \epsilon_0 \frac{\partial^2 \vec{b}}{\partial t^2}$
- 6) (10 pts.) Prove the boundary conditions Verdeyen eqns. 1.9.1 a-d. Hint: Start from Maxwell's equations, and then use the Stoke's theorem and Gauss' theorem.