

THE UNIVERSITY OF BRITISH COLUMBIA
Department of Electrical and Computer Engineering

EECE 311 – Electromagnetic Fields & Waves
2025 W1

Example Problems
Chapter 12 – Plane Wave Reflection and Dispersion

The purpose of these nine example problems is to help you master some of fundamental techniques used to analyze the behaviour of plane waves at boundaries between material media. Answers should be short and to the point. Use sketches to explain your solution as required. Clarity, conciseness, and presentation all count.

- 12.2 The plane $z = 0$ defines the boundary between two dielectrics. For $z < 0$, $\epsilon_{r1} = 9$, $\epsilon''_{r1} = 0$, and $\mu_1 = \mu_0$. For $z > 0$, $\epsilon_{r2} = 3$, $\epsilon''_{r2} = 0$, and $\mu_2 = \mu_0$. Let $E_{x1}^+ = 10 \cos(\omega t - 15z)$ V/m and find (a) ω ; (b) $\langle S_1^+ \rangle$; (c) $\langle S_1^- \rangle$; (d) $\langle S_2^+ \rangle$.

Given:

Sought:

Steps:

- 12.3 A uniform plane wave in region 1 is normally incident on the planar boundary separating regions 1 and 2. If $\epsilon''_1 = \epsilon''_2 = 0$, while $\epsilon'_1 = \mu_{r1}^3$ and $\epsilon'_2 = \mu_{r2}^3$, find the ratio $\epsilon'_{r2}/\epsilon'_{r1}$, if 20 percent of the energy in the incident wave is reflected at the boundary. There are two possible answers.

Given:

Sought:

Steps:

- 12.8 A wave starts at point a , propagates 1 m through a lossy dielectric rated at 0.1 dB/cm, reflects at normal incidence at a boundary at which $\Gamma = 0.3 + j0.4$, and then returns to point a . Calculate the ratio of the final power to the incident power after this round trip, and specify the overall loss in decibels.

Given:

Sought:

Steps:

12.9 Region 1, $z < 0$, and region 2, $z > 0$, are both perfect dielectrics ($\mu = \mu_0$, $\epsilon'' = 0$). A uniform plane wave traveling in the \mathbf{a}_z direction has a radian frequency of 3×10^{10} rad/s. Its wavelengths in the two regions are $\lambda_1 = 5$ cm and $\lambda_2 = 3$ cm. What percentage of the energy incident on the boundary is (a) reflected; (b) transmitted? (c) What is the standing wave ratio in region 1?

Given:

Sought:

Steps:

12.11 A 150-MHz uniform plane wave is normally incident from air onto a material whose intrinsic impedance is unknown. Measurements yield a standing wave ratio of 3 and the appearance of an electric field minimum at 0.3 wavelengths in front of the interface. Determine the impedance of the unknown material.

Given:

Sought:

Steps:

12.12 A 50-MHz uniform plane wave is normally incident from air onto the surface of a calm ocean. For seawater, $\sigma = 4$ S/m, and $\epsilon'_r = 78$. (a) Determine the fractions of the incident power that are reflected and transmitted. (b) Qualitatively, how (if at all) will these answers change as the frequency is increased?

Given:

Sought:

Steps:

12.13 A right-circularly polarized plane wave in air is normally incident from air onto a semi-infinite slab of Plexiglas ($\epsilon_r' = 3.45, \epsilon_r'' = 0$). Calculate the fractions of the incident power that are reflected and transmitted. Also, describe the polarizations of the reflected and transmitted waves.

Given:

Sought:

Steps:

12.18 A uniform plane wave is normally incident onto a slab of glass ($n = 1.45$) whose back surface is in contact with a perfect conductor. Determine the reflective phase shift at the front surface of the glass if the glass thickness is (a) $\lambda/2$; (b) $\lambda/4$; (c) $\lambda/8$.

Given:

Sought:

Steps:

12.21 A right-circularly polarized plane wave in air is incident at Brewster's angle onto a semi-infinite slab of Plexiglas ($\epsilon_r' = 3.45, \epsilon_r'' = 0$). (a) Determine the fractions of the incident power that are reflected and transmitted. (b) Describe the polarizations of the reflected and transmitted waves.

Given:

Sought:

Steps: