Plane Waves

Electrical Engineering

The uniform plane wave: geometry, speed, impedance and what a dielectric does to it.

A uniform plane wave has E and H at right angles to each other and to the direction of travel.

$$v = 1/\sqrt{(\mu\varepsilon)} \cdot \eta = \sqrt{(\mu/\varepsilon)} \cdot \lambda = v/f$$

Free space

$c \approx 3 \times 10^8$ m/s

$1/\sqrt{(\mu_o\varepsilon_o)}$.

Free-space impedance

$\eta_o \approx 377\ \Omega$

Ratio E to H.

Relative ε of 4

Speed halves

√4 = 2.

THE COMMON MISTAKE

× **Assuming frequency changes inside a dielectric**

✓ **Speed and wavelength change, frequency does not**

Frequency is fixed by the source. Inside a dielectric both speed and wavelength fall by the square root of relative permittivity.

In a lossy medium the wave decays as exp(−αz), E and H drift out of phase, and the wave impedance becomes complex.