Physics 8.03 Vibrations and Waves

Lecture 17

EM waves meet dielectrics

Last time: waveguides

- Single hollow conductor
- TE or TM mode, but not TEM

$$\vec{E} = \hat{y} E_0 \sin\left(\frac{m\pi x}{a}\right) \mathrm{e}^{j(\omega t - k_z z)}$$

$$\vec{B} = -\hat{x}\left(\frac{k_z E_0}{\omega}\right)\sin\left(\frac{m\pi x}{a}\right)\mathrm{e}^{j(\omega t - k_z z)} + \hat{z} j\left(\frac{k_x E_0}{\omega}\right)\cos\left(\frac{m\pi x}{a}\right)\mathrm{e}^{j(\omega t - k_z z)}$$

- Not a plane wave any more!
- Dispersion

Last time: wave guides

- $E_y = \mathrm{f}(y)$

$$E_y = E_0 \sin\left(\frac{m\pi x}{a}\right)\cos\left(\frac{n\pi y}{b}\right)\cos(\omega t - k_z z)$$

$$E_x = E_0 \cos\left(\frac{m\pi x}{a}\right)\sin\left(\frac{n\pi y}{b}\right)\cos(\omega t - k_z z)$$

$$E_z = 0$$

$$\omega_{mn}^{cut-off} = \sqrt{\left(\frac{m\pi}{a}\right)^2 + \left(\frac{n\pi}{b}\right)^2}$$

Each mode has its own cut-off frequency

Dielectrics

- Polarization and magnetization
  - ➔ index of refraction
  - ➔ modify Maxwell's equations
  - ➔ modify wave velocity
- Law of reflection and refraction (Snell)
- Reflection and transmission amplitudes