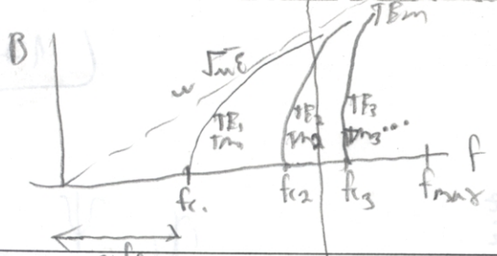

← Dispersion diagram

Georgia Institute of Technology
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MEMORANDUM

ECE 3065
18.1

~~Date:~~

LECTURE 18

~~To:~~
~~From:~~
~~Subject:~~

PARALLEL-PLATE WAVEGUIDE WITH LOSSES

Dielectric filling: $\varepsilon' \to \varepsilon' - j\varepsilon'' = \varepsilon' - j\frac{\sigma}{\omega}$

$$\gamma_{TEM} = j\omega\sqrt{\mu(\varepsilon' - j\varepsilon'')}$$

$\frac{\varepsilon''}{\varepsilon'} << 1$ (low-loss dielectric) $\overset{\text{Taylor}}{\Longleftrightarrow}$ $(\alpha_d)_{TEM} \simeq \frac{\omega\sqrt{\mu\varepsilon'}}{2}\frac{\varepsilon''}{\varepsilon'}$ (1st order Approx)

$$\gamma_{TM,TE} = \left[\left(\frac{m\pi}{a}\right)^2 - \omega^2\mu(\varepsilon' - j\varepsilon'')\right]^{1/2} \approx$$

$$\approx \left[\left(\frac{m\pi}{a}\right)^2 - \omega^2\mu\varepsilon'\right]^{1/2}\left\{1 + \frac{j\omega^2\mu\varepsilon''}{2}\left[\left(\frac{m\pi}{a}\right)^2 - \omega^2\mu\varepsilon'\right]^{-1}\right.$$

For $\omega > \omega_c \Rightarrow (\alpha_d)_{TM,TE}$ (same for both modes) $= \frac{\omega\sqrt{\mu\varepsilon'}\,(\varepsilon''/\varepsilon')}{2\sqrt{1-(\omega_c/\omega)^2}}$ ← ε mgs of dielectric filling

$\omega = \omega_c \to \alpha = \infty$

$\omega >> \omega_c \to \alpha \simeq \alpha(TEM)$

↳ correction term to TEM

How about finite conductivity of the plates?

Ignored, when the plane boundaries are made of much better conducting material than the intervening dielectric region!!

$\bar{S}_{av} = \frac{E_0^2}{2\eta}$

Power transfer for TEM: $(W_T)_{TEM} = \frac{E_0^2}{2\eta}(aw)$ (per unit length)