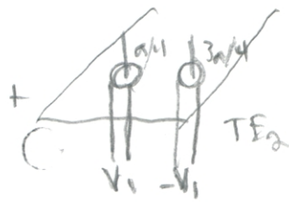
LECTURE 21

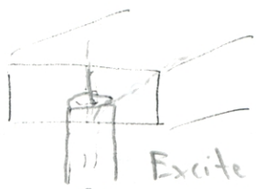
EXCITATION AND RECEPTION OF WAVES IN WAVEGUIDES

1) Probe or antenna excitation:

to the direction of $\bar{E}$-field and near a max of the spatial mode distribution.

Impedance has to be matched (Higher-order modes introduce a parasitic reactance) localized around excitation





Matching to:

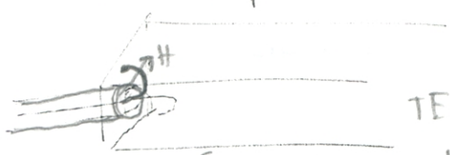
Real part + Imag. Part

propagmode higher-order modes

(coax → WG transition excitation (E) no leakage

2) Loop excitation:

oriented in a plane normal to $\bar{H}$ of the mode pattern



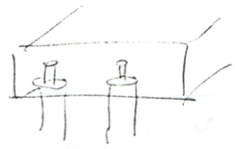
(coax → WG transition excitation (H))

3) Mode coupling from another guide (through hole/iris):

Have to have some common field component over aperture

4) Higher-order Modes:

Combine as many exciting sources as required at proper positioning



REACTIVE/EVANESCENT WAVES BELOW CUTOFF

(-) Applied to waveguide attenuators

(-) Affect the performance of WG discontinuities

Below cutoff → only attenuation and no phase shift

Purely imginary $Z_{TE}/Z_{TM} = jX$ → no energy propagation $w<w_c$ $w>w_c$ $Z_{TE/TM} = R$ propagation

NOT A DISSIPATIVE ATTENUATION, IT IS REACTIVE

(II Rejected Band in Filters) → Energy is not lost, but is reflected back to the source.

Below cutoff for ideal WG's

$$\gamma = \alpha = k_c \sqrt{1 - \left(\frac{f}{f_c}\right)^2} \qquad \frac{f}{f_c} \ll 1 \approx \frac{2\pi}{\lambda_c}$$

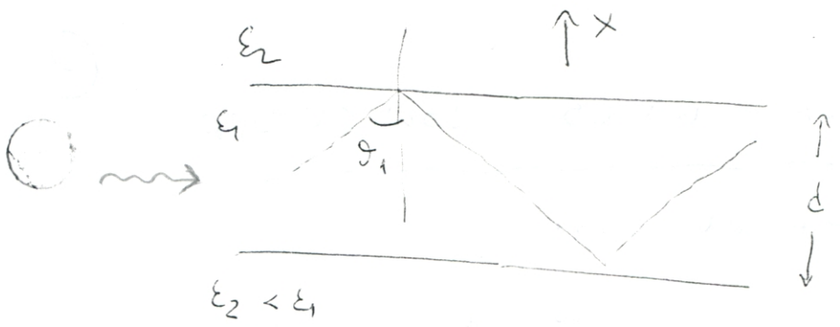
$k_c = \frac{2\pi}{\lambda_c}$

$\alpha \neq$ frequency if $f \ll f_c$

The presence of losses change β from zero to a small, but finite value.

DIELECTRIC WAVEGUIDES

Dielectric rods can guide EM energy if surrounded by a dielectric of lower permittivity.



All energy is reflected from the interface if incidence angle $\vartheta_1 >> \vartheta_c = \sin^{-1}\left(\sqrt{\frac{\varepsilon_2}{\varepsilon_1}}\right)$ (for $\mu_1 = \mu_2$)

Evanescent fields will be developed in the dielectric of region 2

$$\alpha_x = \frac{\omega}{c}\sqrt{\varepsilon_{r_2}}\left[\frac{\varepsilon_1}{\varepsilon_2}\sin^2\vartheta_1 - 1\right]^{1/2}$$

Phase constant along the guide:

$$\beta = k_{1z} = k_1 \sin\vartheta_1$$

Cutoff for the dielectric guide at $\vartheta_1 = \vartheta_c \Rightarrow \beta = k_2$

For steeper angles ($\vartheta_i < \vartheta_c$) some energy transmission to dielectric ε_2.