MAWLANA BHASHANI SCIENCE AND TECHNOLOGY UNIVERSITY

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Assignment

Department of : Information and Communication Technology

Assignment No : 01

Name of the assignment : Modes of Propagation in Rectangular Waveguide

Course Title : Microwave Engineering

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Assignment 1 : Modes of Propagation in a Rectangular waveguide.

A rectangular waveguide is a hollow metalic structure that guides electromagnetic waves. Unlike transmission lines, waveguides primarily support TE (Transverse Electric) and TM (Transverse Magnetic) modes because both electric and magnetic fields cannot be completely transverse in a hollow waveguide without conductors carring current.

Types of Modes in a Rectangular Waveguide :

① TE (Transverse Electric) Modes :-

→ In TE modes, the electric field has no component in the direction of propagation ($E_z = 0$).

→ Only the transverse components (E_x, E_y) exists, while the magnetic field has a longitudinal component $H_z \neq 0$.

→ Modes are denoted as TE_{mn} where :

- m = number of half-wave variations along the wider dimention (a).
- n = number of half-wave variations along the narrower dimention (b).

→ The cut-off frequency for TE modes is:

$$f_c = \frac{c}{2}\sqrt{\left(\frac{m}{a}\right)^2 + \left(\frac{n}{b}\right)^2}$$

where a and b are the waveguide dimentions, and c is the speed of light.

→ The dominant mode in a rectangular waveguide is TE_{10} (lowes cutoff frequency).

② TM (Transverse Magnetic) modes:

→ In TM modes, the magnetic field has no component in the direction of propagation ($H_z = 0$).

→ The electric field has a longitudinal component ($E_z \neq 0$).

→ Modes are denoted as TM_{mn}.

→ Same cutoff frequency equation as TE:

$$f_c = \frac{c}{2}\sqrt{\left(\frac{m}{a}\right)^2 + \left(\frac{n}{b}\right)^2}$$

→ There is no TM_{20} mode (it does not satisfy boundary conditions).

(3) TEM (Transverse Electromagnetic) modes:

→ In TEM modes, both electric (E) and magnetic (H) fields are entirely transverse to the direction of propagation ($E_z = H_z = 0$).

→ Rectangular waveguide cannot support TEM modes because they require two conductors (like coaxial cables or parallel plates).

→ Therefore, only TE and TM modes exists in rectangular waveguide.