SNS COLLEGE OF ENGINEERING

(Autonomous)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

19EC502 – TRANSMISSION LINES AND ANTENNAS

III YEAR/ V SEMESTER

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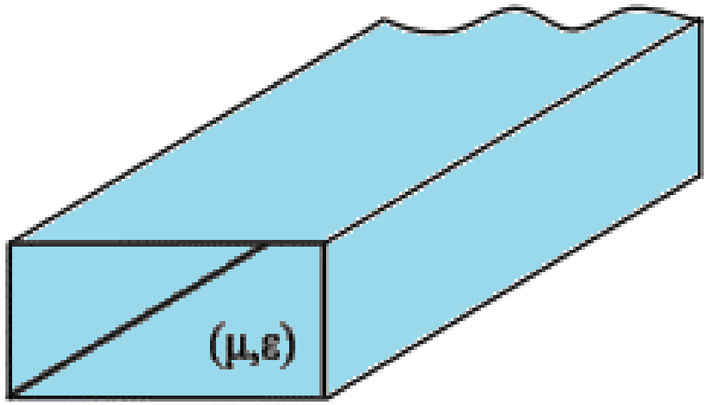
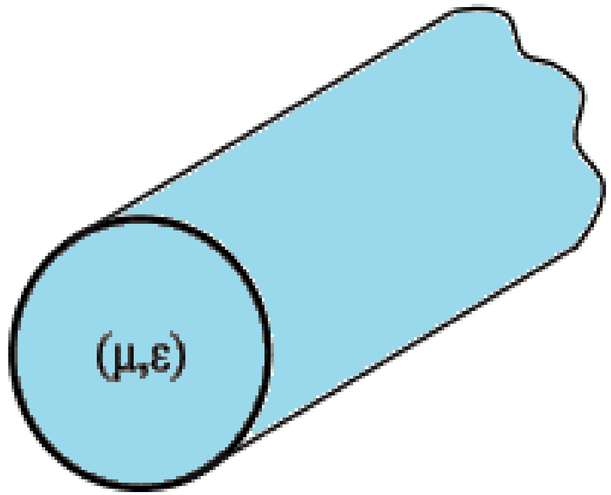
UNIT 2 – GUIDED WAVES

TOPIC – TM & TE WAVES IN CIRCULAR WAVEGUIDES

WHAT DO YOU INFER FROM THESE DIAGRAMS ?



Rectangular Waveguide



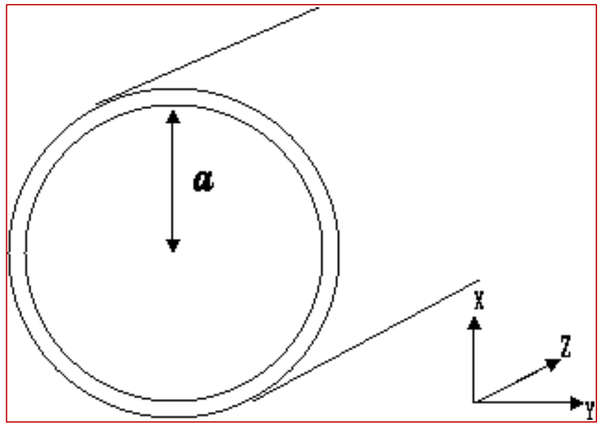
Circular Waveguide

CIRCULAR WAVEGUIDES -ADVANTAGES

- The circular waveguide are easier to manufacture than rectangular waveguides and are easier to join.
- The TM01 modes are rotationally symmetrical and hence rotation of polarization can be overcome.
- TE01 mode in circular for long distance waveguide transmission.

CIRCULAR WAVEGUIDES –TE & TM MODES

- Figure shows a cylindrical waveguide which is simply a hollow tube with circular cross section of radius ***a*** and extending along the Z direction.
- There are two sets of modes, TE and TM modes, which can propagate in a cylindrical waveguide.



TE & TM MODE – FIELD ANALYSIS

From Maxwell's Equations

$\hat{z}$

$$\frac{1}{\rho}\frac{\partial E_z}{\partial \phi} \pm j\beta_z E_\phi = -j\omega\mu H_\rho$$

$$\mp j\beta_z E_\rho - \frac{\partial E_z}{\partial \rho} = -j\omega\mu H_\phi$$

$$\frac{1}{\rho}\frac{\partial}{\partial \rho}\left(\rho \overline{E_\phi}\right) - \frac{1}{\rho}\frac{\partial E_\rho}{\partial \phi} = -j\omega\mu H_z$$

$$\frac{1}{\rho}\frac{\partial H_z}{\partial \phi} \pm j\beta_z H_\phi = j\omega\varepsilon E_\rho$$

$$\mp j\beta_z H_\rho - \frac{\partial H_z}{\partial \rho} = j\omega\varepsilon E_\phi$$

$$\frac{1}{\rho}\frac{\partial}{\partial \rho}\left(\rho H_\phi\right) - \frac{1}{\rho}\frac{\partial H_z}{\partial \phi} = j\omega\varepsilon E_z$$

TE & TM MODE – FIELD ANALYSIS

The ρ and ϕ components can be expressed in terms of Ez and Hz as $\hat{z}$

$$E_\rho = \frac{1}{\beta_z^2 - \beta^2}\left[\pm j\beta_z \frac{\partial E_z}{\partial \rho} + \frac{j\omega\mu}{\rho}\frac{\partial H_z}{\partial \phi}\right]$$

$$E_\phi = -\frac{1}{\beta_z^2 - \beta^2}\left[\mp j\frac{\beta_z}{\rho}\frac{\partial E_z}{\partial \phi} + j\omega\mu\frac{\partial H_z}{\partial \rho}\right]$$

$$H_\rho = -\frac{1}{\beta_z^2 - \beta^2}\left[\frac{j\omega\varepsilon}{\rho}\frac{\partial E_z}{\partial \phi} \mp j\beta_z \frac{\partial H_z}{\partial \rho}\right]$$

$$H_\phi = \frac{1}{\beta_z^2 - \beta^2}\left[j\omega\varepsilon\frac{\partial E_z}{\partial \rho} \pm j\frac{\beta_z}{\rho}\frac{\partial H_z}{\partial \phi}\right]$$

CIRCULAR WAVEGUIDES -APPLICATIONS

- Rotating joints in radars to connect the horn antenna feeding a paraboloid reflector (which must rotate for tracking).
- TE01 mode is suitable for long distance waveguide transmission above 10GHz.
- Short and medium distance broad band communication (cold replace/share coaxial and microwave links).
- radar.

CIRCULAR WAVEGUIDES -APPLICATIONS

- It is used where the transmission or reception is in the range of microwave frequencies.
- It is also used for handling the high power of energy. It is mostly used in the airborne