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EXPERIMENT - 1

<u>Aim</u> - To study the field pattern of various modes inside a rectangular waveguide.

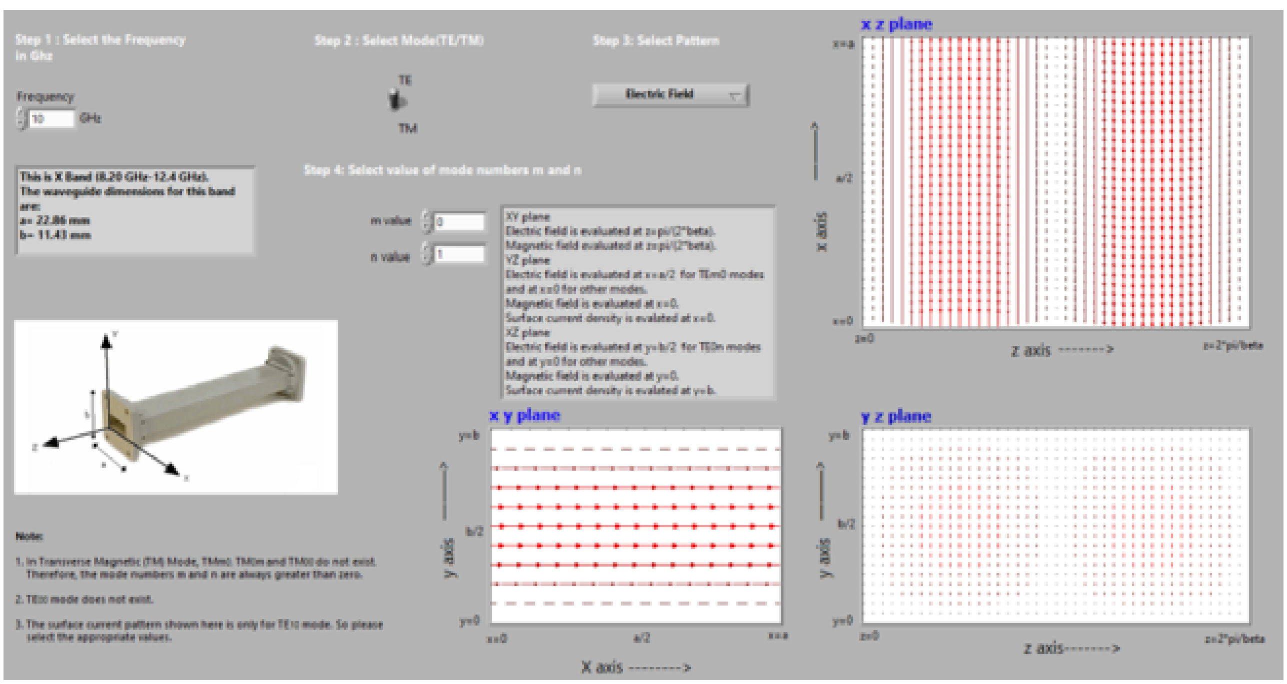
<u>Results and Discussion</u> -

1. TE_{00} Mode

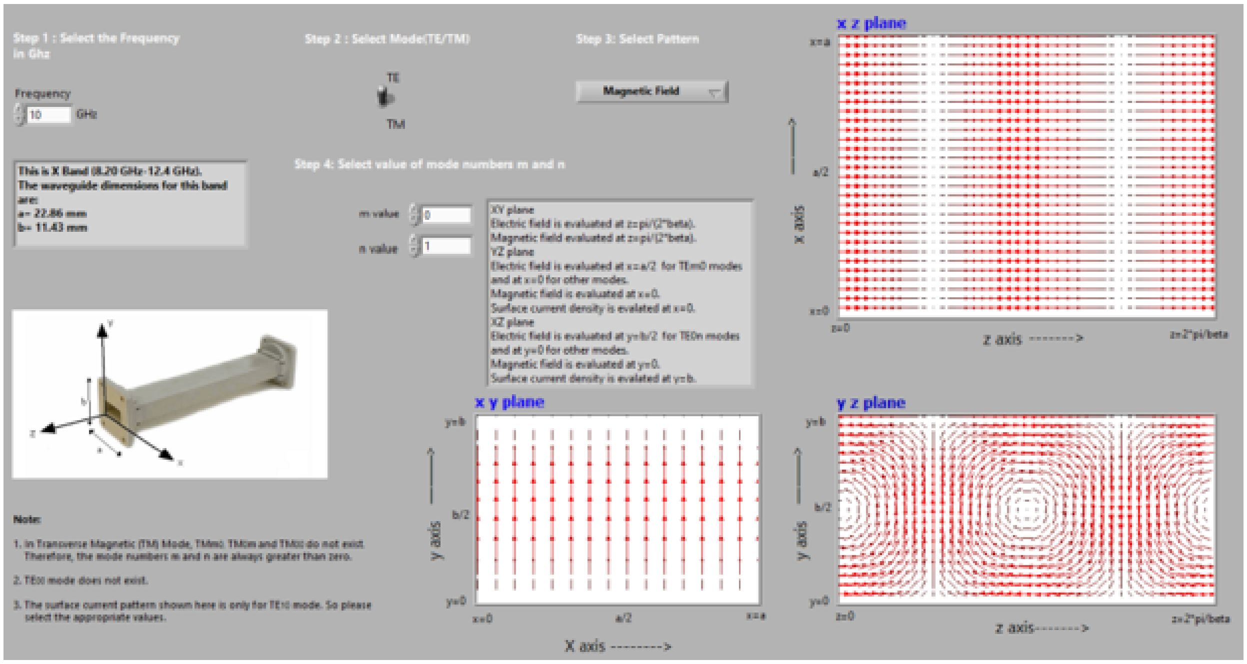
This mode does not exist as the field equations in the rectangular waveguide for Transverse Electric (TE) become zero for m = n = 0.

2. TE_{01} Mode

The electric field E_x exists, and E_y = 0.

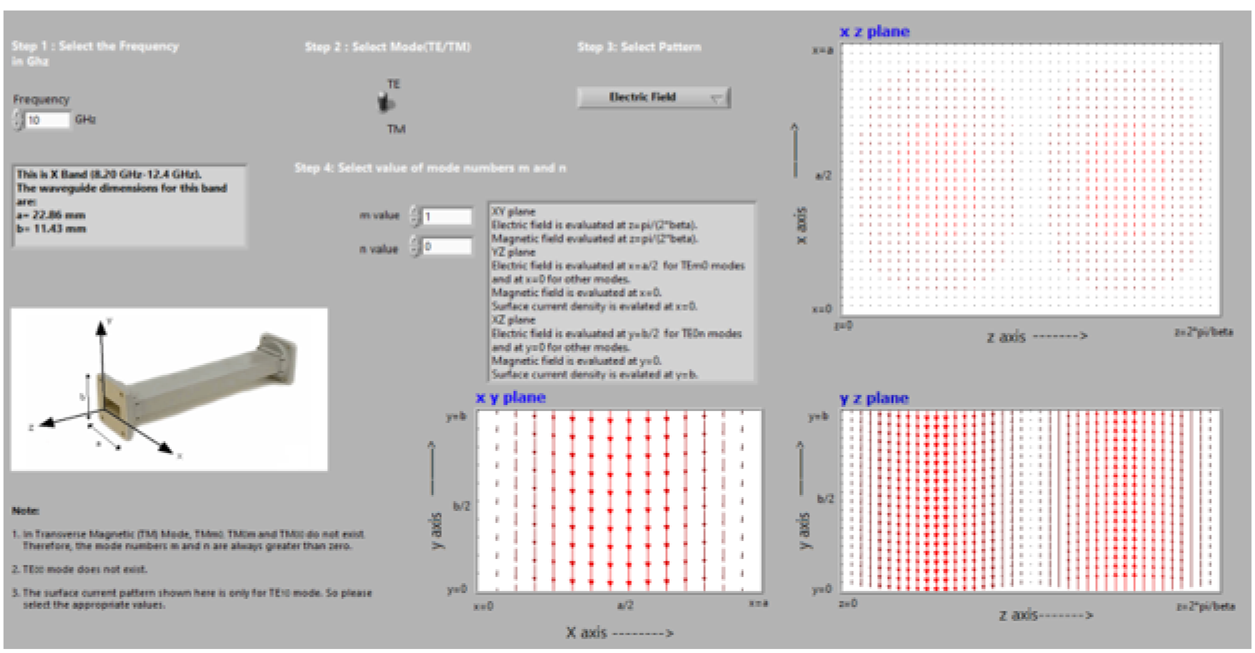


$H_x = 0$, and magnetic fields H_y and H_z exist.

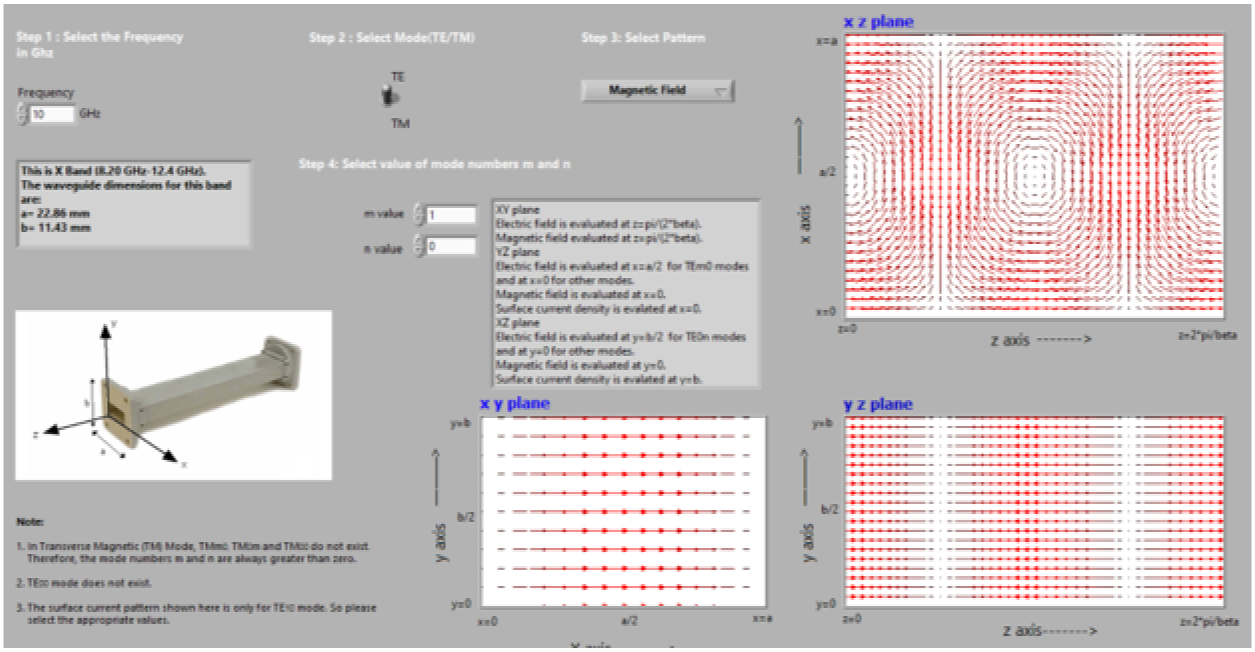


3. TE_{10} Mode

The electric field E_y exists. $E_x = E_z = 0$.

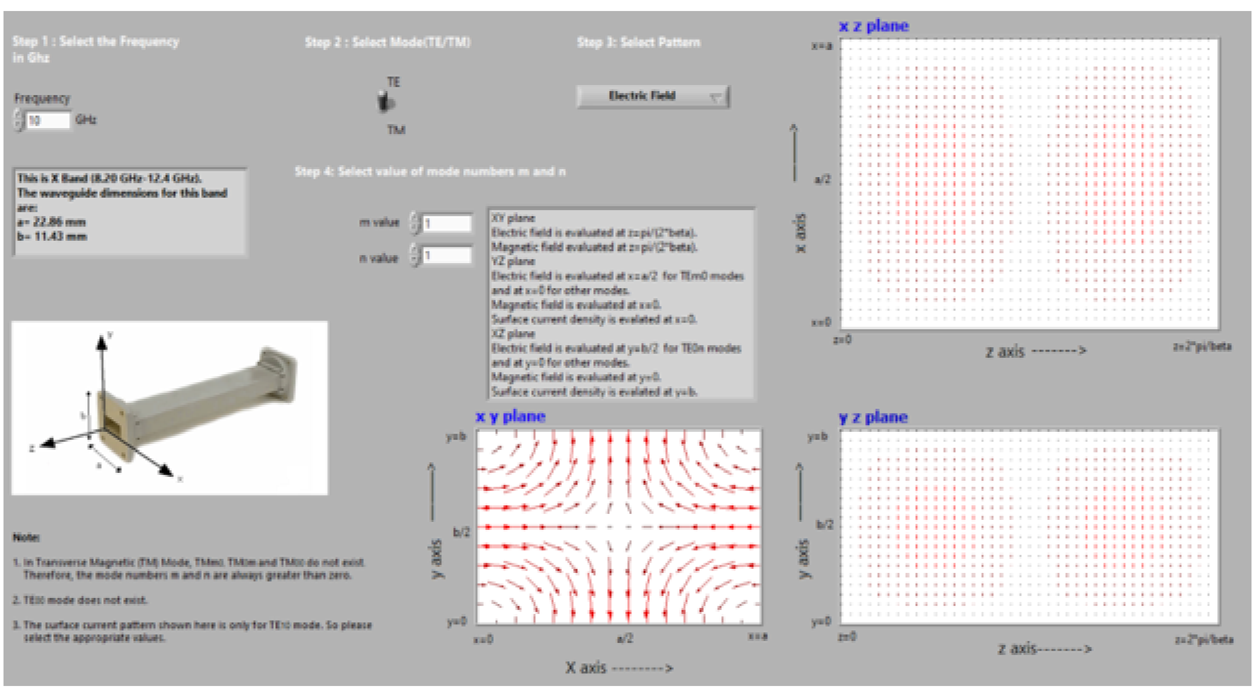


The magnetic field H_x exists. $H_y = H_z = 0$.

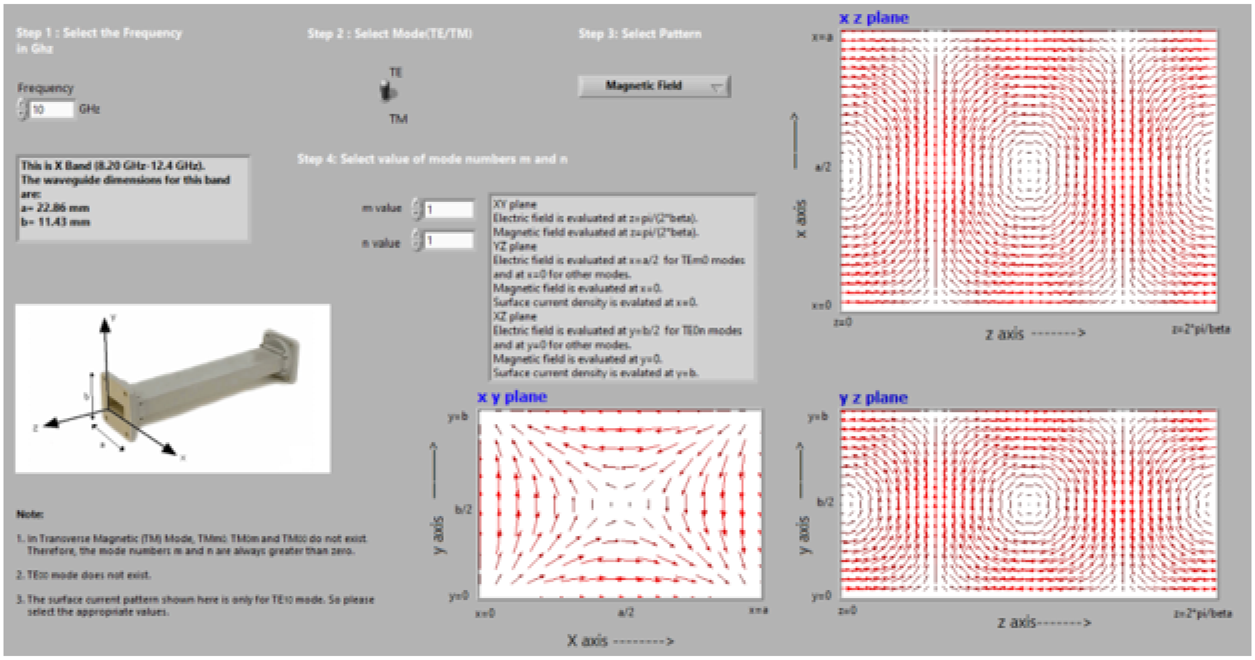


4. TE_{11} Mode

The electric fields E_x and E_y exist. $E_z = 0$.



The magnetic fields H_x, H_y and H_z all exist.



5. TM_{00} Mode

This mode does not exist as the field equations in the rectangular waveguide for Transverse Magnetic (TM) become zero for m = n = 0.

6. TM_{01} Mode

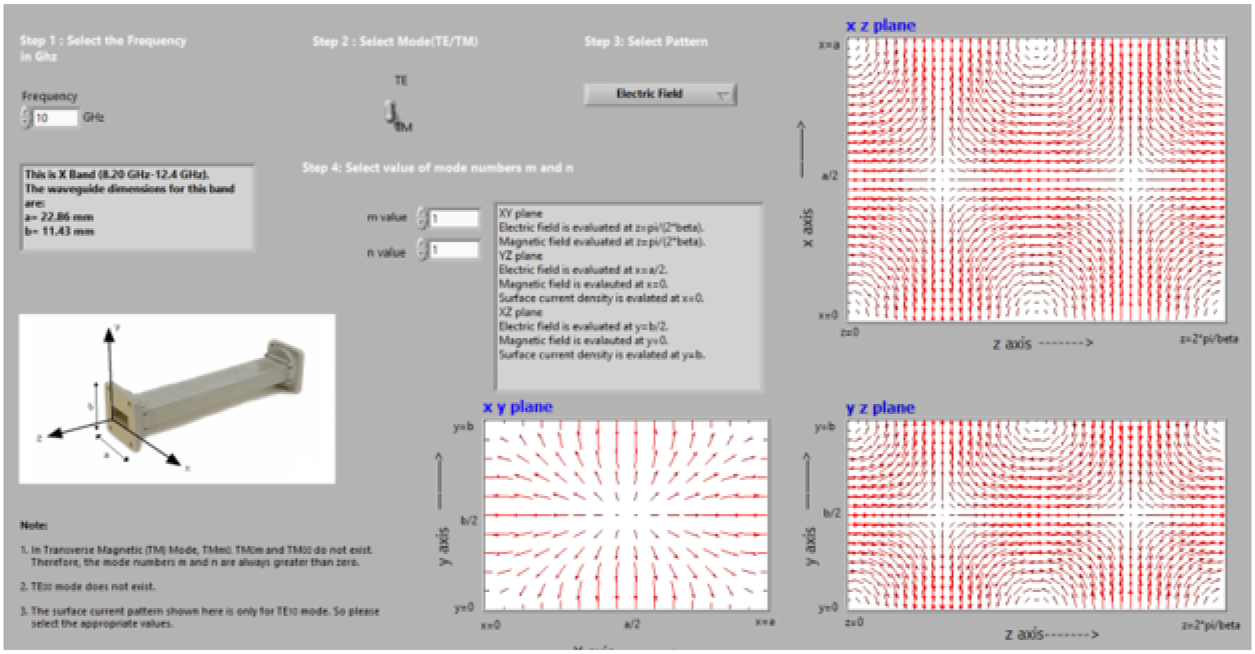
This mode does not exist as the field equations in the rectangular waveguide for Transverse Magnetic (TM) become zero for m = 0 and n = 1.

7. TM_{10} Mode

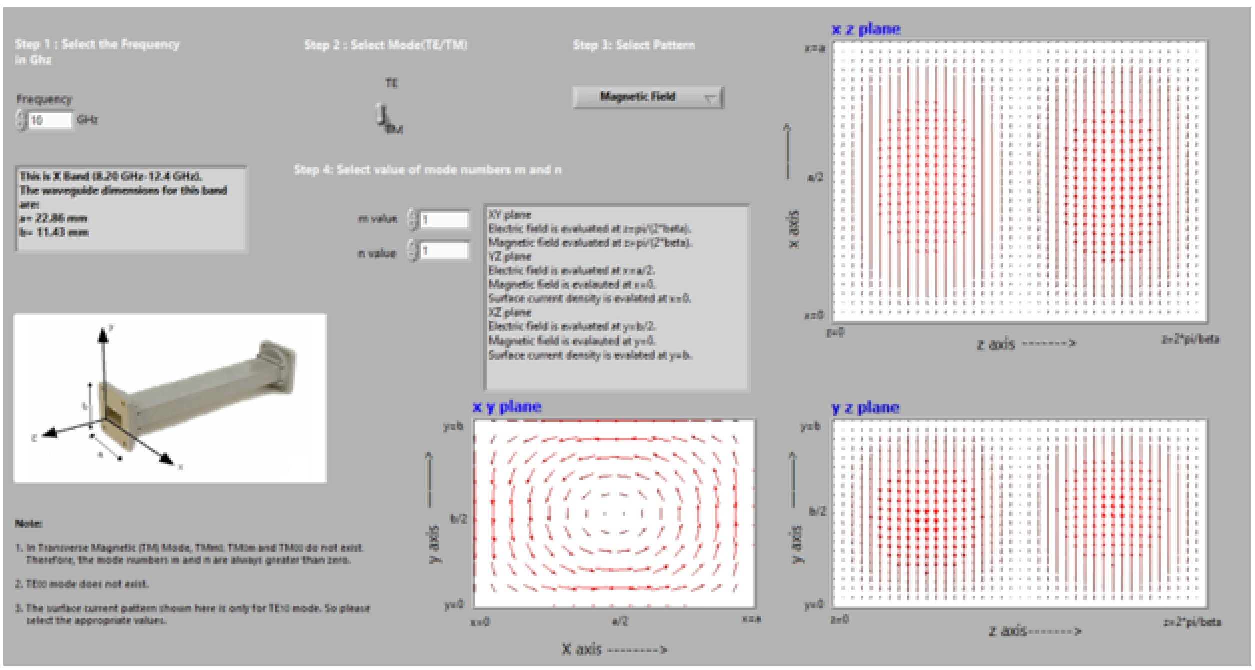
This mode does not exist as the field equations in the rectangular waveguide for Transverse Magnetic (TM) become zero for m = 1 and n = 0.

8. TM_{11} Mode

The electric fields E_x, E_y and E_z all exist.



The magnetic fields H_x and H_y exist. $H_z = 0$.



Conclusions -

The Field Equations for Transverse Electric (TE) :

$$E_x = \frac{j\omega\mu}{h^2}\left(\frac{n\pi}{b}\right) cos\left(\frac{m\pi x}{a}\right) sin\left(\frac{n\pi y}{b}\right)$$

$$E_y = \frac{-j\omega\mu}{h^2}\left(\frac{m\pi}{a}\right) sin\left(\frac{m\pi x}{a}\right) cos\left(\frac{n\pi y}{b}\right)$$

$$E_z = 0$$

$$H_x = \frac{j\beta}{h^2}\left(\frac{m\pi}{a}\right) sin\left(\frac{m\pi x}{a}\right) cos\left(\frac{n\pi y}{b}\right)$$

$$H_y = \frac{j\beta}{h^2}\left(\frac{n\pi}{b}\right) cos\left(\frac{m\pi x}{a}\right) sin\left(\frac{n\pi y}{b}\right)$$

$$H_z = cos\left(\frac{m\pi x}{a}\right) sin\left(\frac{n\pi y}{b}\right)$$

The Field Equations for Transverse Magnetic (TM) :

$$E_x = \frac{-j\beta}{h^2}\left(\frac{m\pi}{a}\right) cos\left(\frac{m\pi x}{a}\right) sin\left(\frac{n\pi y}{b}\right)$$

$$E_y = \frac{-j\beta}{h^2}\left(\frac{n\pi}{b}\right) sin\left(\frac{m\pi x}{a}\right) cos\left(\frac{n\pi y}{b}\right)$$

$$E_z = sin\left(\frac{m\pi x}{a}\right) sin\left(\frac{n\pi y}{b}\right)$$

$$H_x = \frac{j\omega\varepsilon}{h^2}\left(\frac{n\pi}{b}\right) sin\left(\frac{m\pi x}{a}\right) cos\left(\frac{n\pi y}{b}\right)$$

$$H_y = \frac{-j\omega\varepsilon}{h^2}\left(\frac{m\pi}{a}\right) cos\left(\frac{m\pi x}{a}\right) sin\left(\frac{n\pi y}{b}\right)$$

$$H_z = 0$$

1. TE_{00} mode does not exist in waveguide as all the field components of Electric Field become zero.

2. TM_{00}, TM_{01} and TM_{10} modes do not exist. In Transverse Magnetic mode, if one of the m or n values become zero, the mode will not exist, as all field components vanish.

3. The dominant mode in a particular waveguide is the mode having lowest frequency.

4. The dominant mode in a particular waveguide is the mode having the lowest cutoff frequency. The cutoff frequency is given by

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

where a > b, The TE_{10} mode has the lowest cutoff frequency and hence is the dominant mode of the rectangular waveguide. Only the dominant mode has a sinusoidal dependence upon y and thus possesses fields that are periodic in y and "dominate" the field pattern far away from the source, at distances larger than the transverse dimensions of the waveguide.