Name : ADITYA SINGH
Roll No : 2K19/EP/005

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EXPERIMENT - 2

Aim - To study the field pattern of various modes inside a rectangular cavity.

Results and Discussion -

1. **TE_{000}, TE_{010}, TE_{100}, TE_{110} Mode**

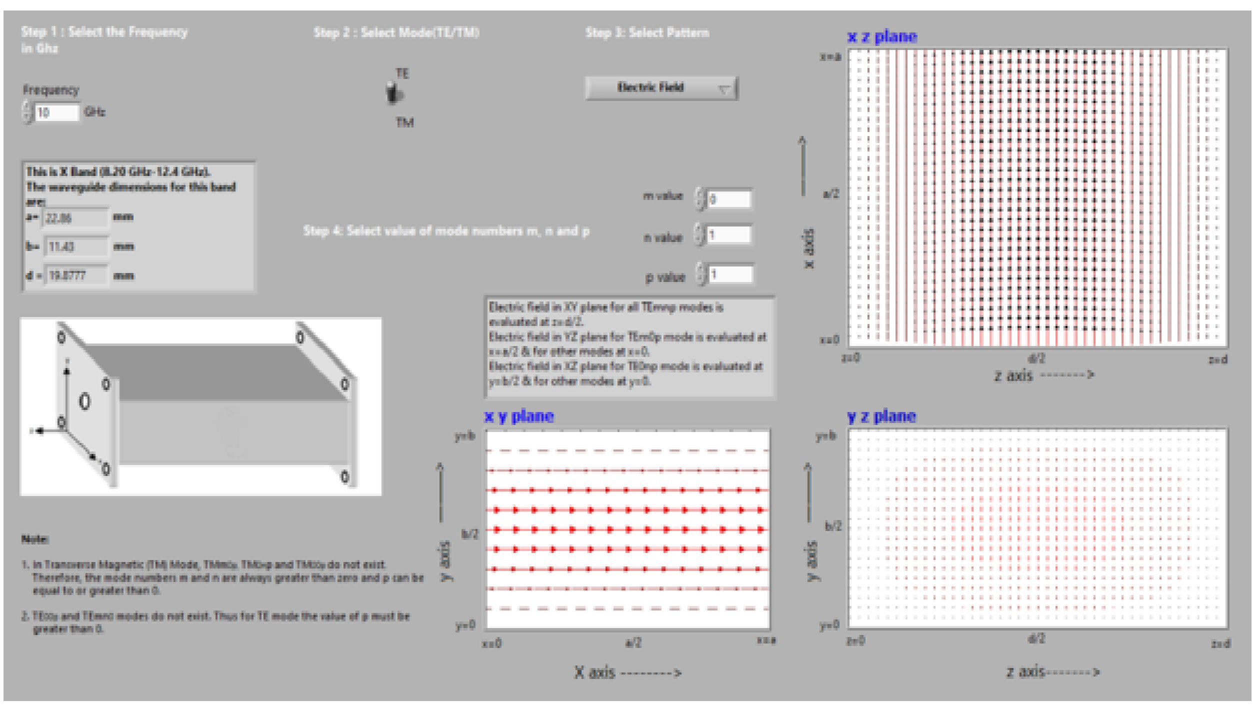
   This mode does not exist as the field equations in the rectangular waveguide for Transverse Electric (TE) become zero for p = 0.

2. **TE_{001} Mode**

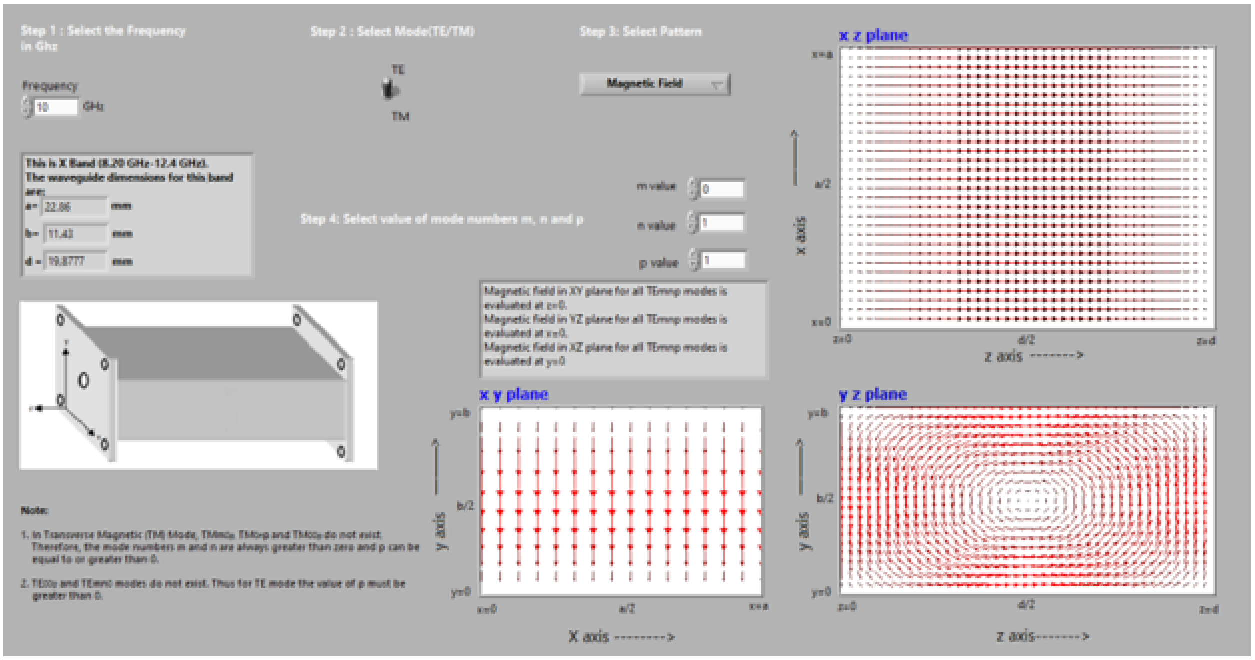
   This mode does not exist as the field equations in the rectangular waveguide for Transverse Electric (TE) become zero when m = n = 0.

3. **TE_{011} Mode**

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

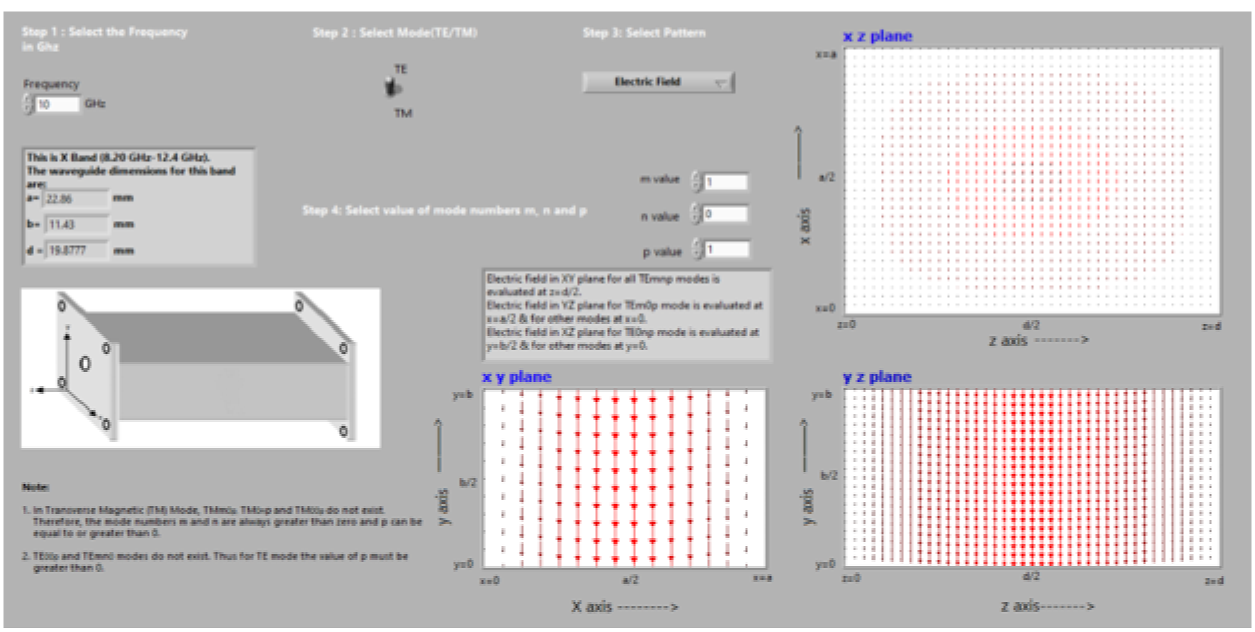


H_x = 0, and magnetic fields H_y and H_z exist.

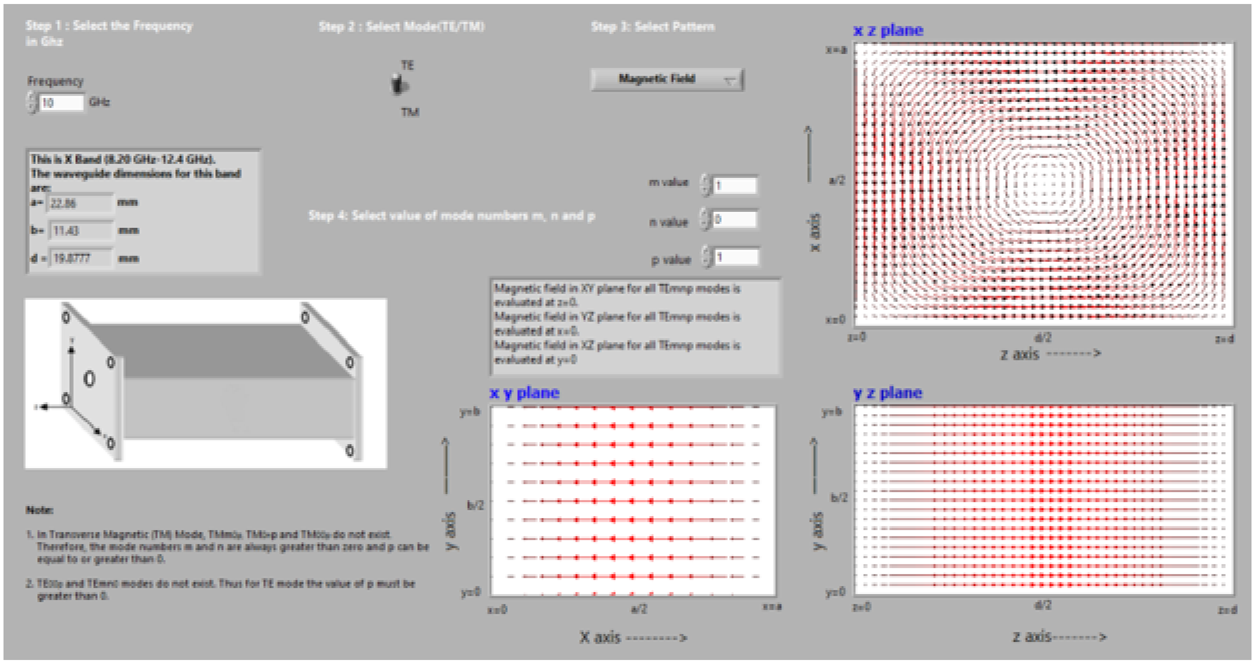


4. TE_{101} Mode

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

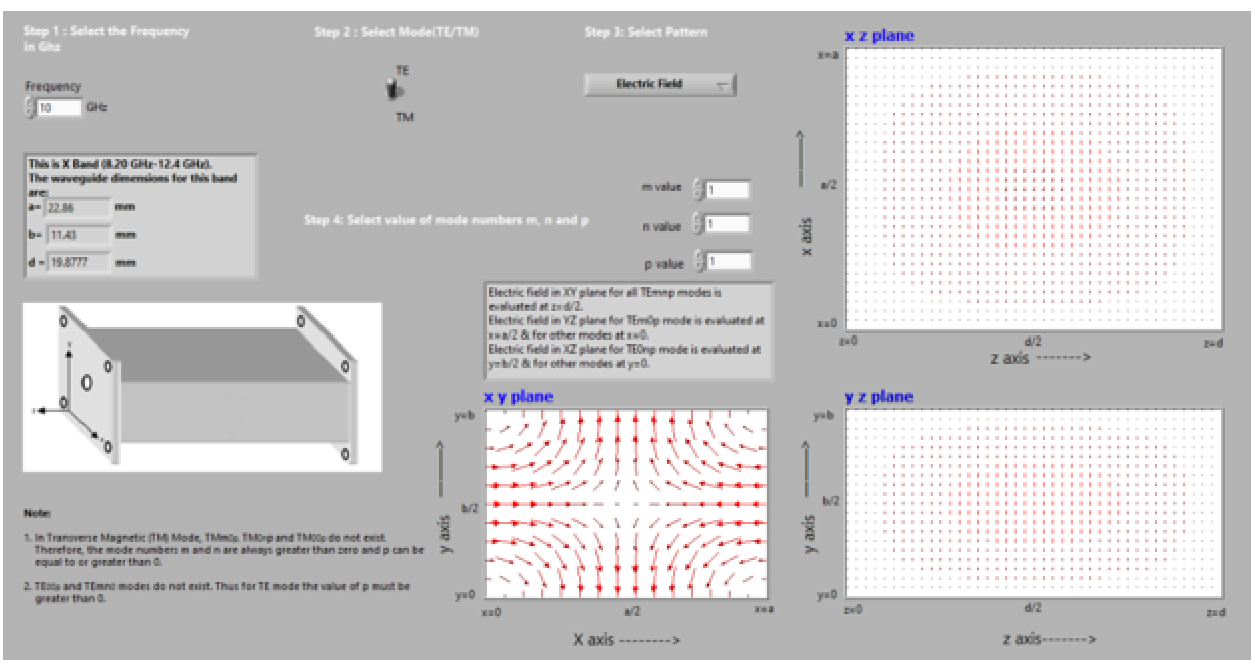


The magnetic field H_x exists. $H_y = H_z = 0$.

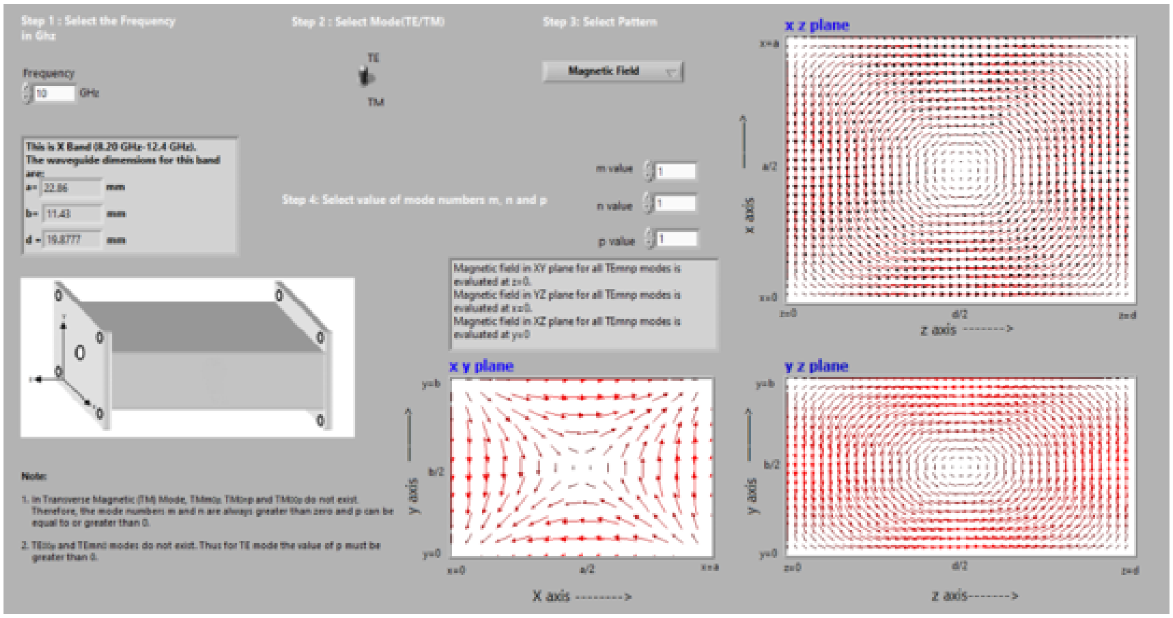


5. TE_{111} Mode

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



The magnetic fields H_x, H_y and H_z all exist.

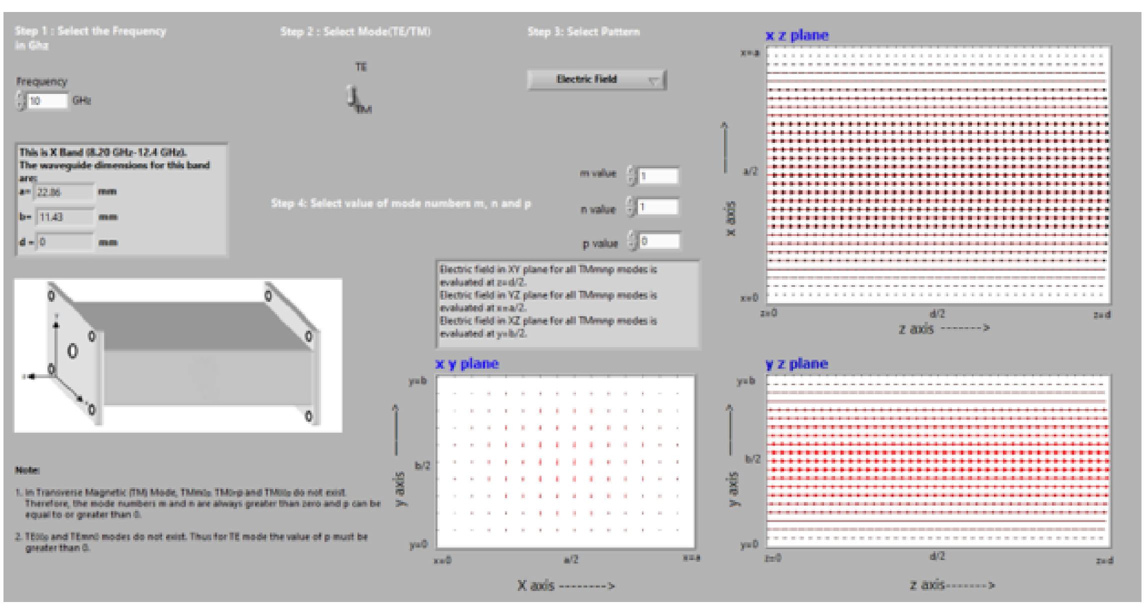


6. TM_{00p}, TM_{01p}, TM_{10p} Mode

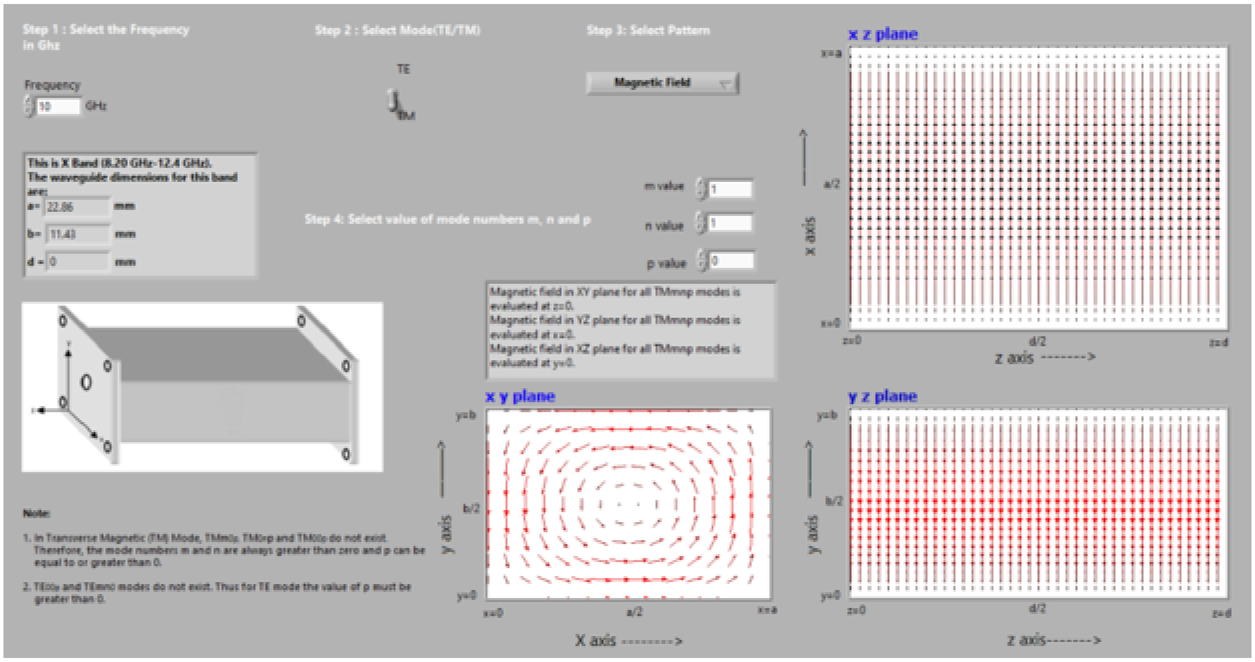
TM Mode does not depend on the value of p. This mode does not exist as the field equations in the rectangular waveguide for Transverse Magnetic (TM) become zero for any value of p.

7. TM_{110} Mode

The electric fields E_x, E_y and E_z all exist.

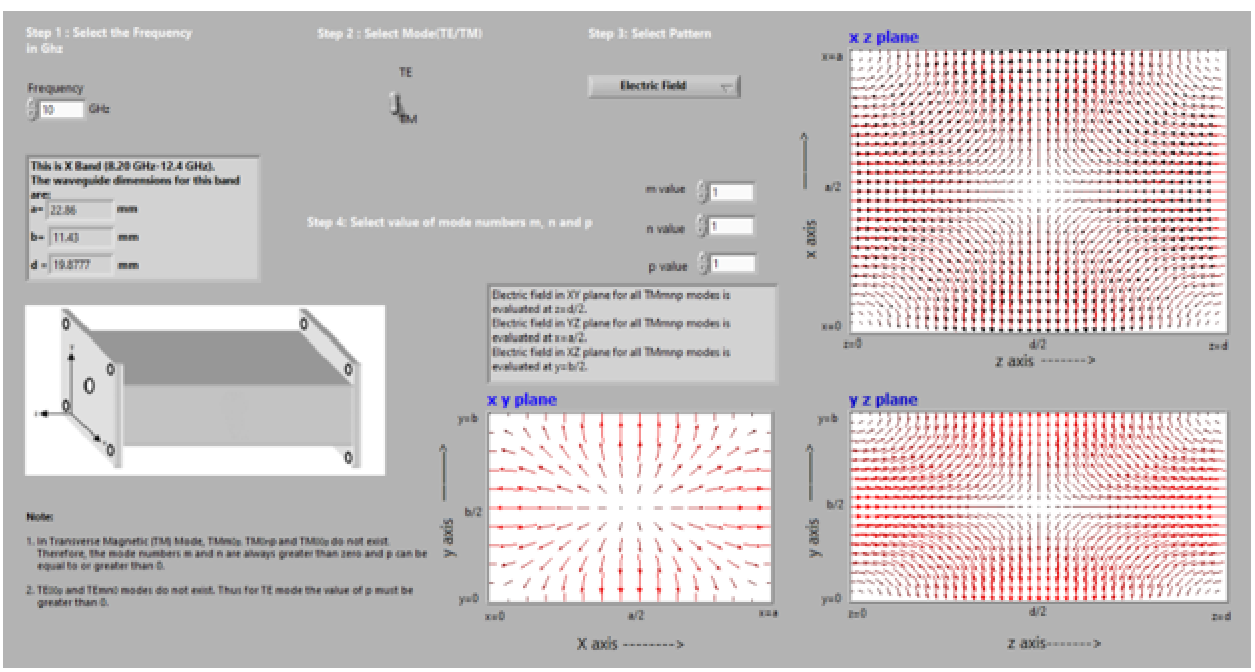


The magnetic fields H_x and H_y exist. $H_z = 0$.

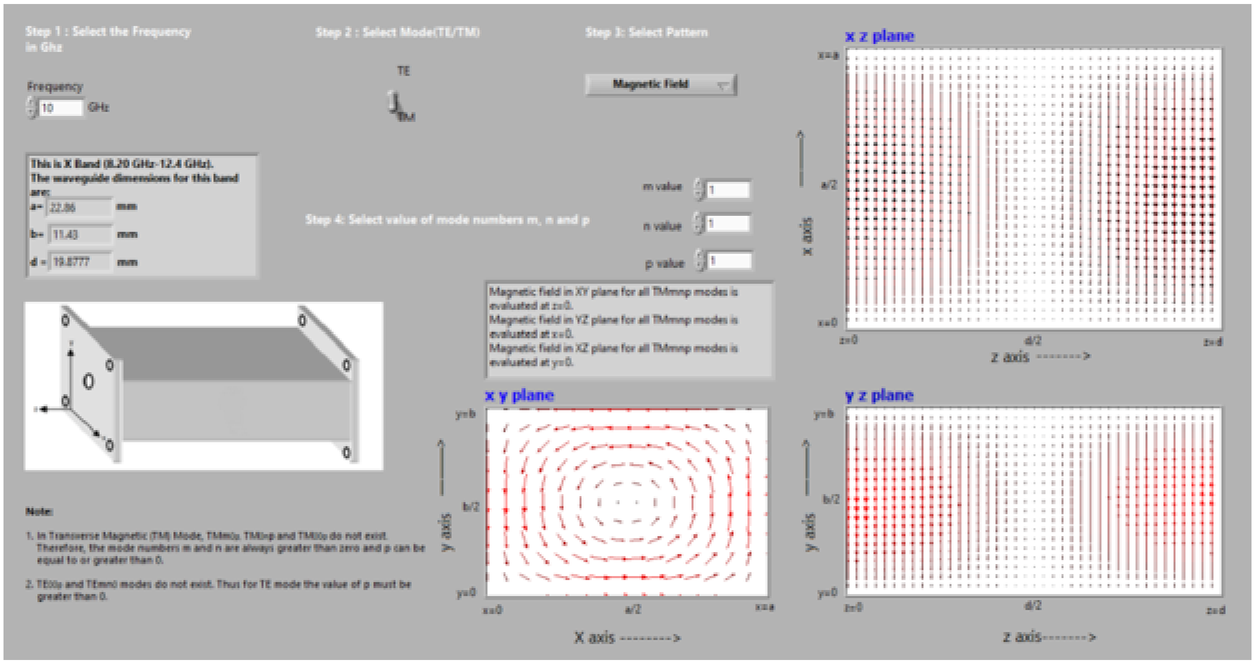


8. TM_{111} Mode

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) :

$$
\begin{cases}
H_z(x,y,z) = H_0 \cos(\frac{m\pi}{a}x)\cos(\frac{n\pi}{b}y)\sin(\frac{p\pi}{d}z) \\
E_x(x,y,z) = \frac{j\omega\mu}{h^2}(\frac{n\pi}{b})H_0 \cos(\frac{m\pi}{a}x)\sin(\frac{n\pi}{b}y)\sin(\frac{p\pi}{d}z) \\
E_y(x,y,z) = -\frac{j\omega\mu}{h^2}(\frac{m\pi}{a})H_0 \sin(\frac{m\pi}{a}x)\cos(\frac{n\pi}{b}y)\sin(\frac{p\pi}{d}z) \\
H_x(x,y,z) = -\frac{1}{h^2}(\frac{m\pi}{a})(\frac{p\pi}{d})H_0 \sin(\frac{m\pi}{a}x)\cos(\frac{n\pi}{b}y)\cos(\frac{p\pi}{d}z) \\
H_y(x,y,z) = -\frac{1}{h^2}(\frac{n\pi}{b})(\frac{p\pi}{d})H_0 \cos(\frac{m\pi}{a}x)\sin(\frac{n\pi}{b}y)\cos(\frac{p\pi}{d}z)
\end{cases}
$$

The Field Equations for Transverse Magnetic (TM) :

$$
\begin{cases}
E_z(x,y,z) = E_0 \sin(\frac{m\pi}{a}x)\sin(\frac{n\pi}{b}y)\cos(\frac{p\pi}{d}z) \\
E_x(x,y,z) = -\frac{1}{h^2}(\frac{m\pi}{a})(\frac{p\pi}{d})E_0 \cos(\frac{m\pi}{a}x)\sin(\frac{n\pi}{b}y)\sin(\frac{p\pi}{d}z) \\
E_y(x,y,z) = -\frac{1}{h^2}(\frac{n\pi}{b})(\frac{p\pi}{d})E_0 \sin(\frac{m\pi}{a}x)\cos(\frac{n\pi}{b}y)\sin(\frac{p\pi}{d}z) \\
H_x(x,y,z) = \frac{j\omega\varepsilon}{h^2}(\frac{n\pi}{b})E_0 \sin(\frac{m\pi}{a}x)\cos(\frac{n\pi}{b}y)\cos(\frac{p\pi}{d}z) \\
H_y(x,y,z) = -\frac{j\omega\varepsilon}{h^2}(\frac{m\pi}{a})E_0 \cos(\frac{m\pi}{a}x)\sin(\frac{n\pi}{b}y)\cos(\frac{p\pi}{d}z)
\end{cases}
$$

1. Transverse Electric has a sin component associated with the value of p. So If p=0, no mode will exist. TE_{001} mode also does not exist in waveguide as all the field components of Electric Field become zero for m=n=0.

2. Transverse Mode does not depend on p. So TM_{00p}, TM_{01p} and TM_{10p} mode 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

$$f_{mnp} = \frac{1}{2\sqrt{\mu\varepsilon}} \cdot \sqrt{(\frac{m}{a})^2 + (\frac{n}{b})^2 + (\frac{p}{d})^2}$$

where a > b < d, The **TE_{101} mode** has the lowest cutoff frequency and hence is the dominant mode of the rectangular cavity. Only the dominant mode has a sinusoidal dependence upon y and thus possesses fields that are periodic in y and "dominate" the field pattern.