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Electromagnetic Field Theory (NEC-404)

Title of the Activity:

Penetration of **Electromagnetic Waves** through different mediums.

Methodology:

Different mediums like metal, free space and woods are used for the analysis of penetration of EM wave.

Procedure of conducting the activity

This activity is performed by group of EC 2nd year student in Microwave lab. Our aim is to calculate the penetration of EM wave through different medium. We consider Wood, Free space, Sheet, Metal as different-different medium. For this activity, we need different components such as Klystron Oscillators, Horn Antennas etc.

Procedures:

1. Set components and equipments properly.
2. Same type of transmitting and receiving horn antenna are used in same axis line.
3. All the parameters set properly and antenna aligned at 0^{o} direction.
4. In free space (when no obstacles are placed in between two antennas) the strength of received wave is noted with the help of CRO.
5. Wooden plates of 2cm, 4cm, and 10cm width are placed in between two antennas and strength of received wave is noted with the help of CRO.
6. A4 sheet is placed in between two antennas and strength of received wave is noted with the help of CRO.
7. Tin Plate is placed in between two antennas and strength of received wave is noted with the help of CRO.
8. Calculate Skin depth in case of different materials.

The Result and Analysis:

Used Formula:

Attenuation constant, $\alpha = \omega \sqrt{\frac{\mu\varepsilon}{2}\left(\sqrt{1+\left(\frac{\sigma}{w\varepsilon}\right)^2}-1\right)}$

Phase constant, $\beta = \omega \sqrt{\frac{\mu\varepsilon}{2}\left(\sqrt{1+\left(\frac{\sigma}{w\varepsilon}\right)^2}+1\right)}$

Loss tangent, $tan\theta = \left(\frac{\sigma}{\omega\epsilon}\right)$

Skin Depth, $\delta = \frac{1}{\alpha} = 1\backslash\sqrt{\pi\mu f\sigma}$

Electric Field Intensity, $\mathbf{E}=E_0e^{-\alpha z}$

FOR METAL: - $\sigma\approx\infty$

$\delta = 1\backslash\sqrt{\pi\mu f\sigma}$

$\delta = 0$

So $\propto = \frac{1}{\delta} = \infty$

From equation $\mathbf{E}=E_0e^{-\alpha z}$

$\mathbf{E}=E_oe^{-\infty z}$

$\mathbf{E}=0$

FOR WOOD: - $\sigma\approx10^{-3}$ S/m

$\mu = 1.256 * 10^{-6}$ H/m

$\delta = 1\backslash\sqrt{\pi\mu f\sigma}$

$=1\backslash\sqrt{3.14 * 10\hat{}10 * 1.25 * 10\hat{} - 6 * 10\hat{} - 3}$

=0.16 m

Therefore, $\propto = \frac{1}{\delta} = 1\backslash0.16$

For z= 0.02 m $\mathbf{E}= E_oe^{-0.02\backslash0.16}$

$= 0.882E_o$

For z= 0.04 m $\mathbf{E}= E_oe^{-0.04\backslash0.16}$

$= 0.778E_o$

For z= 0.10 m $\mathbf{E}=E_oe^{-\alpha z}$

$= E_oe^{-0.10\backslash0.16}$

$= 0.53E_o$

IN FREE SPACE: - $\propto\approx0$

$\delta = 1\backslash\sqrt{\pi\mu f\sigma}$

$\delta = \infty$

$\propto = 0$

So, $\mathbf{E}=E_oe^{-0z}$

$\mathbf{E}=E_o$

Strength of the received wave is observed with the help of CRO and VSWR meter, indexed as shown in table given below:

Sl. No.	**Medium**	**Strength of Received Wave Measured**	**Strength of Received Wave Calculated**
01	Free Space	E_o	E_o
02	Wooden Plate (width=2cm)	0.84 E_o	0.88 E_o
03	Wooden Plate (width=4cm)	0.76 E_o	0.78 E_o
04	Wooden Plate (width=10cm)	0.45 E_o	0.53 E_o
05	A4 Sheets	E_o	E_o
06	Tin Plate (width=1.2mm)	0 E_o	0 E_o