



SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
An Autonomous Institution



Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A++' Grade
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

19ECT302 – TRANSMISSION LINES AND WAVE GUIDES

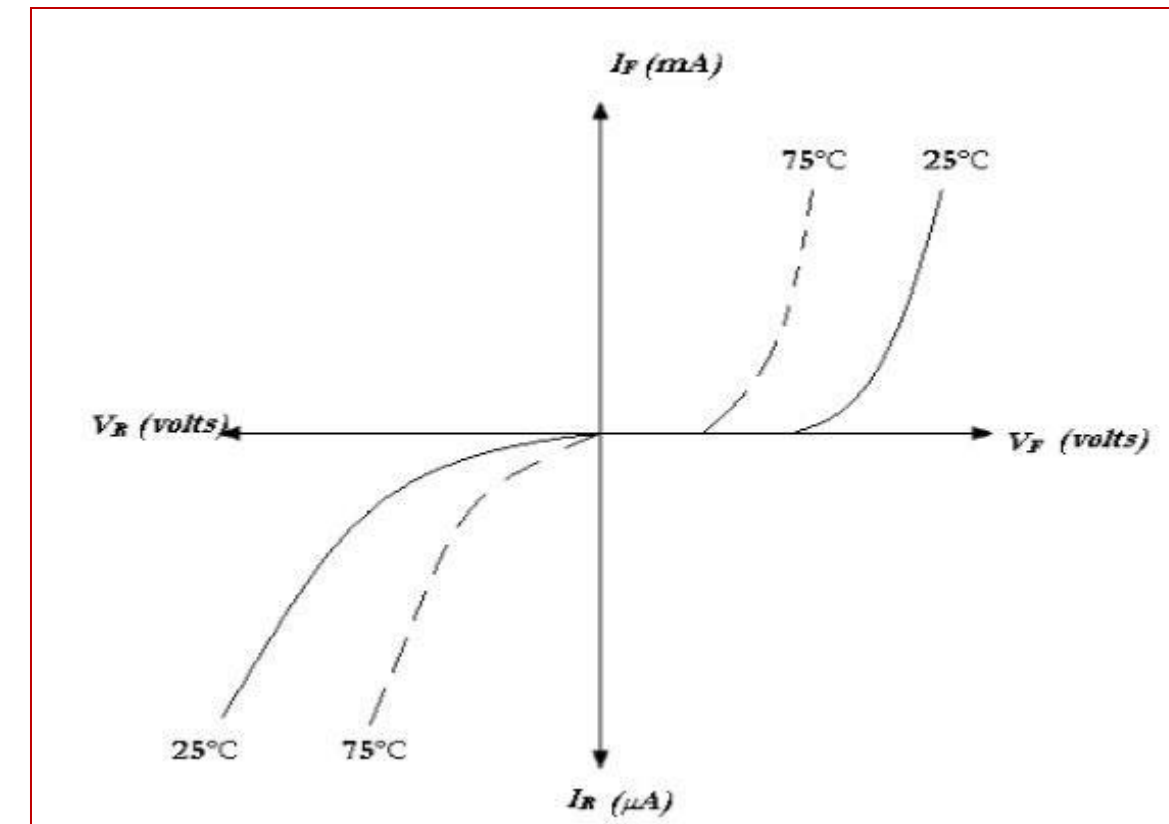
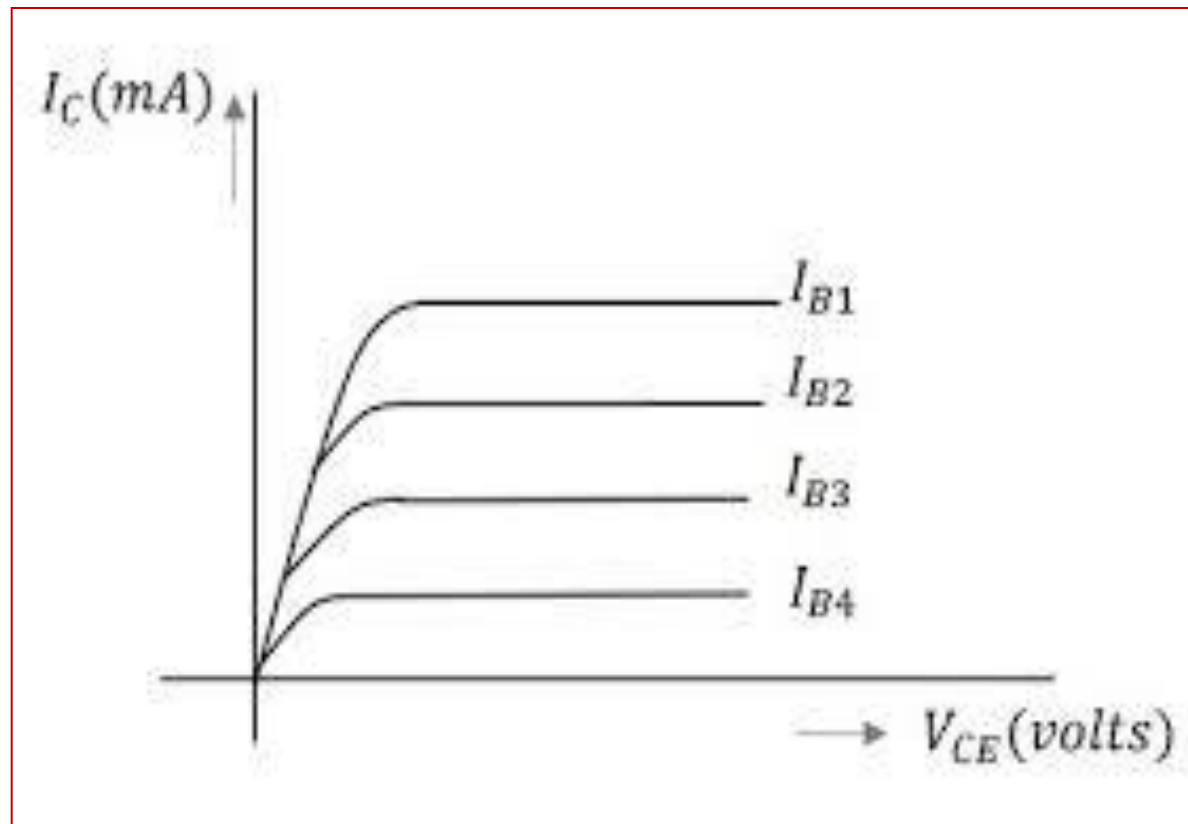
III YEAR/₁ V SEMESTER

UNIT 3 – GUIDED WAVES

TOPIC 3 – CHARACTERISTICS OF TE AND TM WAVES



WHAT DO YOU INFER FROM THESE DIAGRAMS ?





TE & TM WAVE CHARACTERISTICS



→ Examination of field equations of TE and TM waves shows that for each component of E or H there is a sinusoidal or cosinusoidal standing wave distribution across the guide in the x -direction.

→ In y -direction, by assumption there is no variation of either magnitude or phase of any of the field components.

Thus an x - y plane is an equiphase plane for each of the field components.

→ All these equiphase surfaces progress along the guide in z direction with a velocity

$$\bar{v} = \omega / \bar{\beta} \quad , \quad \bar{\beta} \rightarrow \text{phase constant,} \\ \text{imaginary part of the } \gamma.$$



TE & TM WAVE CHARACTERISTICS



The propagation constant

$$\bar{\gamma} = \sqrt{h^2 - \omega^2 \mu \epsilon} \rightarrow \textcircled{1}$$

$$h^2 = \bar{\gamma}^2 + \omega^2 \mu \epsilon$$
$$\bar{\gamma}^2 = h^2 - \omega^2 \mu \epsilon$$

w.k.T $h = \frac{m\pi}{a}$

$$\therefore \bar{\gamma} = \sqrt{\left(\frac{m\pi}{a}\right)^2 - \omega^2 \mu \epsilon} \rightarrow \textcircled{2}$$

$$\bar{\gamma} = \bar{\alpha} + j\bar{\beta}$$

at high frequencies $\omega^2 \mu \epsilon > \left(\frac{m\pi}{a}\right)^2$



TE & TM WAVE CHARACTERISTICS



Therefore eq (2) becomes

$$\bar{\gamma} = \alpha + j\beta = \sqrt{-(\omega^2\mu\epsilon - (\frac{m\pi}{a})^2)}$$

$$\alpha + j\beta = j\sqrt{\omega^2\mu\epsilon - (\frac{m\pi}{a})^2}$$

$$\therefore \alpha = 0$$

at all frequency $\beta = \sqrt{\omega^2\mu\epsilon - (\frac{m\pi}{a})^2} \rightarrow (3)$



TE & TM WAVE CHARACTERISTICS



As the frequency is decreased, a critical frequency is reached at which

$$\omega_c^2 \mu \epsilon = \left(\frac{m\pi}{a} \right)^2$$

$$f_c = \frac{\omega_c}{2\pi}$$

$$\omega_c^2 = \frac{1}{\mu \epsilon} \left(\frac{m\pi}{a} \right)^2$$

$$\omega_c = \frac{1}{\sqrt{\mu \epsilon}} \left(\frac{m\pi}{a} \right)$$

$$2\pi f_c = \frac{1}{\sqrt{\mu \epsilon}} \left(\frac{m\pi}{a} \right)$$

$$\therefore f_c = \frac{1}{2a\sqrt{\mu \epsilon}} \left(\frac{m\pi}{a} \right)$$

$$f_c = \frac{m}{2a\sqrt{\mu \epsilon}} \rightarrow \textcircled{4}$$

For each value of m , there is a corresponding cut off frequency below which wave propagation can not occur.



TE & TM WAVE CHARACTERISTICS



wave length ($\bar{\lambda}$)

The distance required for the phase to shift through 2π radians is a wavelength.

$$\bar{\lambda} = \frac{2\pi}{\beta}$$

$$\bar{\lambda} = \frac{2\pi}{\sqrt{\omega^2 \mu \epsilon - \left(\frac{m\pi}{a}\right)^2}} \rightarrow (5)$$



TE & TM WAVE CHARACTERISTICS



Phase velocity (or) wave velocity

$$\bar{v} = \bar{\lambda} f = \frac{2\pi f}{\beta} = \frac{\omega}{\beta} \rightarrow (6)$$

$$\therefore \bar{v} = \frac{\omega}{\sqrt{\omega^2 \mu \epsilon - \left(\frac{m\pi}{a}\right)^2}} \rightarrow (7)$$



ASSESSMENT



1. What is cut –off frequency?
2. The relationship between phase velocity and group velocity is -----
3. Define guide wavelength
4. What is the relationship between cut-off frequency and cut-off wavelength.



THANK YOU