P-8-31) A doppler radar is used to determine (8) the speed of a moving vehicle by measuring the frequency shift of the wave reflected from the vehicle. determine the speed u in (Km/hr) if $\Delta f = -2.33$ (KHZ) with $f = 10.5$ GHZ.

Ans;

$$\Delta f = \frac{-2u}{c} f$$

$$u = 120 \text{ (Km/hr)}$$

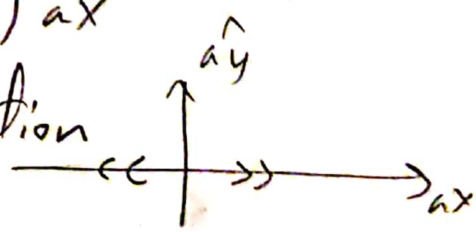
* polarization of plane waves:

polarization: describes the time varying behavior of the electric field intensity vector at a specific point in space.

* Types:

* $E = E_x \hat{a_x} = E_0 \cos(wt) \hat{a_x}$

linearly polarized in x direction



* The same for $\bar{E} = E_y \hat{a_y}$

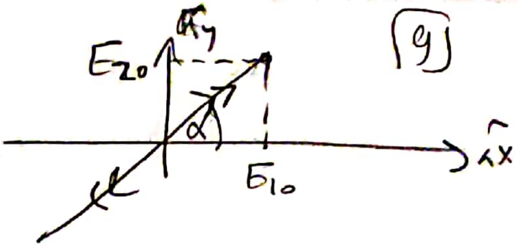
linearly polarized in y direction

* $E = E_x \hat{a_x} + E_y \hat{a_y}$

$= E_{10} \cos(wt) \hat{a_x} + E_{20} \cos(wt) \hat{a_y}$

linearly polarized

$$\alpha = \tan^{-1}\left(\frac{E_{20}}{E_{10}}\right)$$



For $E_2 = E_1 \longrightarrow \alpha = 45^\circ$

* $E(z,t) = \hat{a}_x E_{10} \cos(\omega t - \beta z) + \hat{a}_y E_{20} \sin(\omega t - \beta z)$

$E(0,t) = \hat{a}_x E_{10} \cos(\omega t) + \hat{a}_y E_{20} \sin(\omega t)$

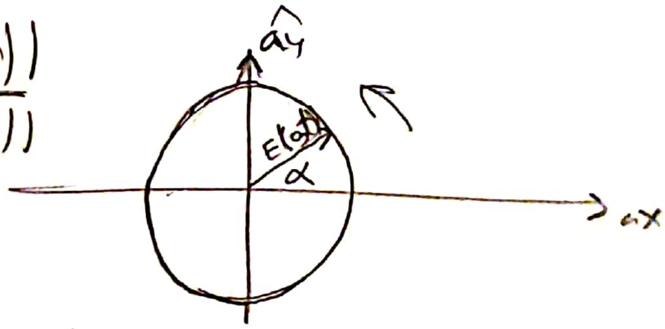
$= \hat{a}_x E_{10} \cos(\omega t) + \hat{a}_y E_{20} \cos(\omega t - \frac{\pi}{2})$

$E_{10} \neq E_{20} \longrightarrow$ elliptical polarizat...

$E_{10} = E_{20} \longrightarrow$ Circular ~

For $E_{10} = E_{20}$

$$\alpha = \tan^{-1} \frac{(E_{20} \sin(\omega t))}{(E_{10} \cos(\omega t))}$$



$\alpha = \boxed{\omega t}$

at $t = 0 \longrightarrow \alpha = 0$

$t = \frac{T}{8} \longrightarrow \alpha = \omega t = 2\pi f t = \frac{2\pi t}{T} = \boxed{\frac{\pi}{4}}$

$t = T/4 \longrightarrow \alpha = \frac{2\pi}{T} \times \frac{T}{4} = \boxed{\frac{\pi}{2}}$

← مع تغير الزمن فإن α تزيد في اتجاه عكس عقارب الساعة (+ve)

(Counterclockwise polarization)

← في هذه الحالة فإن أصابع اليد اليمنى تتبع اتجاه الدوران والإصبع الإبهام يشير إلى اتجاه propagation

(right hand (+ve) polarization)

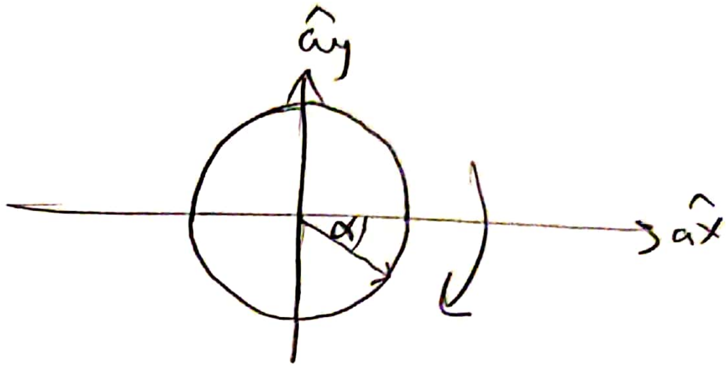
* $E(0,t) = \hat{a}_x E_{10} \cos(\omega t) - \hat{a}_y E_{20} \sin(\omega t)$ (10)

$$= \hat{a}_x E_{10} \cos(\omega t) + \hat{a}_y E_{20} \cos\left(\omega t - \frac{\pi}{2} + \pi\right)$$

بسبب -

$$= \hat{a}_x E_{10} \cos(\omega t) + \hat{a}_y E_{20} \cos\left(\omega t + \frac{\pi}{2}\right)$$

For $E_{10} = E_{20}$



$\alpha = -\omega t$

$t = 0 \longrightarrow \alpha = 0$

$t = \frac{T}{8} \longrightarrow \alpha = -\frac{\pi}{4}$

← مع تغير الزمن فإن α تزيد واتجاه عقارب الساعة (-ve)
(Clockwise Polarization)

← أصابع اليد اليسرى تتبع اتجاه الدوران وإصبع الإبهام يشير إلى اتجاه Propagation
(left hand (-ve) polarization)

Ex: Find the polarization of the field given by

$$\bar{E} = (2\hat{a}_x + J2\hat{a}_y)\, e^{+JKZ}$$

Ans:

$$E_x = 2\, e^{+JKZ}$$

$$E_y = J2\, e^{+JKZ} = 2\, e^{+J\frac{\pi}{2}}\, e^{+JKZ}$$

$$= 2\, e^{+J\left(\frac{\pi}{2} + KZ\right)}$$

$$E_x(Z,t) = \mathrm{Re}\left(2\, e^{+JKZ}\, e^{J\omega t}\right)$$

$$= 2\cos(\omega t + KZ)$$

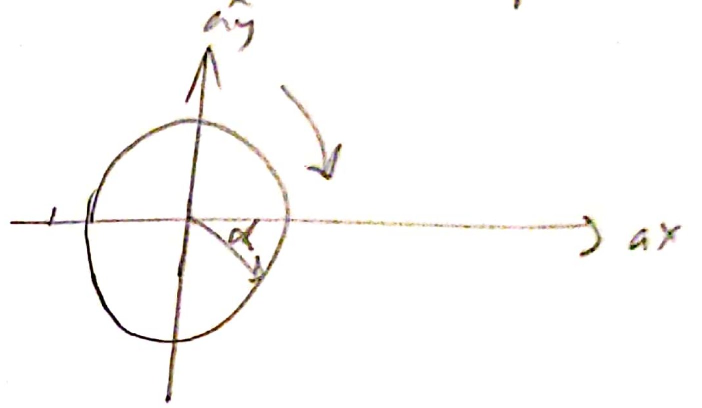
III

$$E_y(z,t) = Re\left(2\, e^{j(kz+\frac{\pi}{2})}\, e^{j\omega t}\right)$$
$$= 2\cos\left(\omega t + kz + \frac{\pi}{2}\right)$$

$$\bar{E}(z,t) = 2\cos(\omega t + kz)\,\hat{a}_x + 2\cos\left(\omega t + kz + \frac{\pi}{2}\right)\hat{a}_y$$
$$E(0,t) = 2\cos(\omega t)\,\hat{a}_x + 2\cos\left(\omega t + \frac{\pi}{2}\right)\hat{a}_y$$

$\therefore E_{10} = E_{20} = 2 \Longrightarrow$ Circular Pola

clockwise circular polarization



P 8-61

The E-field of a uniform wave propagating in a dielectric medium is given by:

$$E(t,z) = \hat{a}_x\, 2\cos\Big(\underbrace{10^8 t}_{\omega t} - \underbrace{\frac{z}{\sqrt{3}}}_{\beta z}\Big) - \hat{a}_y \sin\left(10^8 t - \frac{z}{\sqrt{3}}\right) \text{ V/m}$$

a) Determine the frequency and wavelength of the wave

b) what is the dielectric constant of the medium

c) Describe the polarization of the wave.

d) Find the corresponding H field.

Ans:

$$\omega = 10^8 \Longrightarrow f = \frac{10^8}{2\pi} = \boxed{1.59 \times 10^7 \text{ Hz}}$$

$\beta = \frac{1}{\sqrt{3}} \Longrightarrow \lambda = \frac{2\pi}{\beta} = \boxed{2\sqrt{3}\,\pi \text{ m}}$

b) $u = \frac{c}{\sqrt{\varepsilon_r}} = \frac{\omega}{\beta}$

$\varepsilon_r = \boxed{3}$

c) $\vec{E}(0,t) = \hat{a}_x\, 2\cos(\overset{10^8}{\omega} t) - \hat{a}_y \sin(\omega t)$

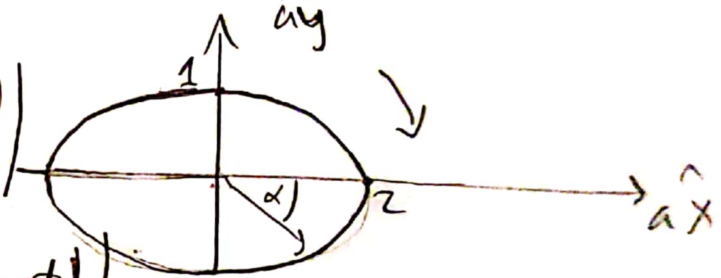
$= \hat{a}_x\, 2\cos(\omega t) + \hat{a}_y \cos(\omega t - \frac{\pi}{2} + \pi)$

$= \hat{a}_x\, 2\cos(\omega t) + \hat{a}_y\, 1\cos(\omega t + \frac{\pi}{2})$

$\because E_{10} \neq E_{20} \Longrightarrow$ elliptical pola.

$\alpha = \tan^{-1}\left(\frac{-\sin(\omega t)}{2\cos(\omega t)}\right)$

$= -\tan^{-1}\left(\frac{1}{2}\tan(\omega t)\right)$



left hand clockwise elliptical polarization

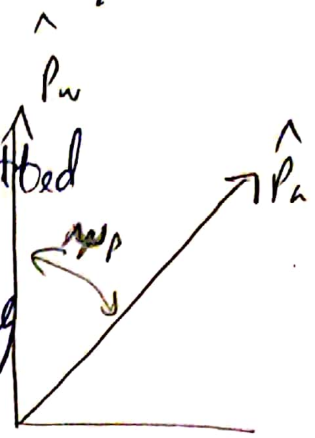
d) $\hat{H} = \frac{1}{\eta}(\hat{a}_z \times \bar{E})$

$\eta = \sqrt{\frac{\mu}{\varepsilon}} = \sqrt{\frac{\mu_0}{\varepsilon_0 \varepsilon_r}} = \frac{\sqrt{\mu_0/\varepsilon_0}}{\sqrt{\varepsilon_r}} = \frac{120\pi}{\sqrt{3}}$

$\hat{H} = \frac{\sqrt{3}}{120\pi}\left[\hat{a}_x \sin\left(10^8 t - \frac{z}{\sqrt{3}}\right) + \hat{a}_y \cos\left(10^8 t - \frac{z}{\sqrt{3}}\right)\right]$ A/m

* Polarization Loss Factor:

For max reception, the recieving antenna should be parallel to $\bar{E}$.



P_w: is a unit vector for the transmitted wave

P_a: is a unit vector for recieving antenna.

Ψ_p: angle between two vectors

$$PLF = |\hat{P}_w \cdot \hat{P}_a|^2 = |\cos \Psi_p|^2$$

$$PLF|_{dB} = 10 \log |\hat{P}_w \cdot \hat{P}_a|^2$$

$$= 20 \log (\cos(\Psi_p))$$

$$P_{recieved} = P_{transmitted} * PLF$$

← اعلى قيمة لـ P_{reci} لما تساوي P_{trans} لما تساوي (PLF = 1)

وذلك لما | اي ($\Psi_p = 0$)

← اقل قيمة (P_{reci} = Zero) لما تساوي (PLF = 0)

وذلك لما ($\Psi_p = 90$)

* TV Broadcasting (linear horizontal Polari)

* AM ~ (linear vertical Polar)

* FM ~ (Circular Polar.)