IQRA NATIONAL UNIVERSITY

Name Farhan Ali

ID 12761

Subject Intro to field wave Antenna

Module 8th semester

Instructor Name Engr Latif Jan

Program BS Telecom

Q1- Answer the following short question.

(1) What is Electromagnetism? Explain in brief along with Gravitional force analogue.

Ans) ⇒ Electromagnetism is the force that causes the interaction between electrically charged particles.

⇒ It is as well one of the four fundamental interactions of nature. The ~~other~~ three are

⇒ Strong interaction
⇒ weak interaction
gravitation

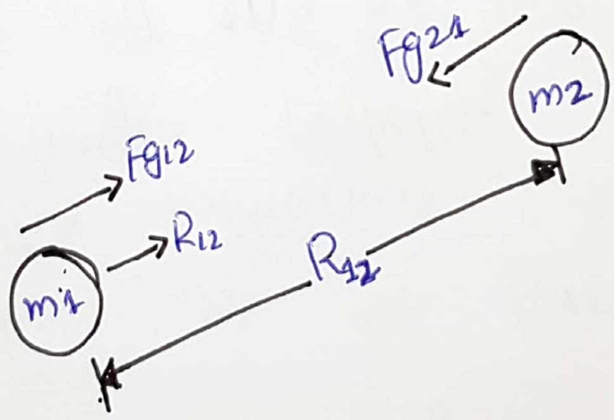
Among the four electromagnetism is the most present in daily life.

★ Gravitional force analogue

Newton's Law of gravity states:

$$F_{g21} = R_{12} \frac{G m_1 \cdot m_2}{R_{12}^2} \ (N)$$

Which expresses the dependence of the gravitional force F acting on mass (m_2) due to a mass (m_1) at distance R_{12}. G is the Universal gravitational constant and R_{12} is a unit vector pointing from m_1 to m_2



Gravitational forces between two masses.

(2) Explain in brief the branches of electromagnetism along with the table.

(Ans) There are three branches of electromagnetism.

(a) <u>Electrostatic</u>:-
(Also known as static electricity)
Is the branch of Physics that deals with apparently stationary electric-charges.

(b) <u>Magnetostatics</u>:-
It the study of magnetic field in systems where the currents are steady (not changing with time).

(c) <u>Dynamics</u>:-
Branche of physics science and sub division of mechanics That is concrened with the motion of material objects in relation of the Physical factor. that effect the terms (force, momentum)

Table : Branches of electromagnetism

Branch	Condition	Field Quantities (Units)
Electrostatics	Stationary Charges ($\partial q/\partial t = 0$)	Elec. field intensity E (V/m) Elec. flux density D (C/m²) $D = \epsilon E$
Magnetostatics	Steady Currents ($\partial I/\partial t = 0$)	Magnetic flux density B (T) Mag field intensity H (A/m) $B = \mu H$
Dynamics	Time varying currents ($\partial I/\partial t \neq 0$)	E, D, B and H (E, B) coupled to (B, H)

3) Explain in detail the Sinusoidal wave in lossless medium with mathematical expressions.

Ans) Sinusoidal wave in lossless medium.

Lossless medium :- It does not alternate the amplitude of the wave travelling within it or on its surface. Take water surface waves. where y denotes the height of water relative to unperturbed state. then

$$y(x,t) = A\cos\left(\frac{2\pi t}{T} - \frac{2\pi x}{\lambda} + \phi_0\right) \text{ cm}$$

A is amplitude of the wave, T is its forced Periode, λ is spatial wave length, and ϕ_0 is reference phase.

Even simpler form is obtained if the argument of the cosine term is called the phase of the wave (not be confused with the reference phase ϕ_0).

$$\phi(x,t) = \left(\frac{2\pi t}{T} - \frac{2\pi x}{\lambda} + \phi_0\right)$$

The quantity $y(x,t)$ can be written $y(x,t) = \cos\phi(x,t)$

4. Proof the Eulers Formula? where does it come from?

(Ans) Eulers Formula:- (with real ϕ)

$$e^{j\phi} = \cos\phi + j\sin\phi$$

Where does it come from

One way to see this is using taylor series Even if you don't prove it. You can convince yourself that these series hold. Take the taylor series representation for sin and cos.

$$\cos\phi = 1 - \frac{\phi^2}{2!} + \frac{\phi^4}{4!} - \frac{\phi^6}{6!} + \frac{\phi^8}{8!} \cdots$$

$$\sin\phi = \phi - \frac{\phi^3}{3!} + \frac{\phi^5}{5!} - \frac{\phi^7}{7!} + \frac{\phi^9}{9!} \cdots$$

What about for exponential function?

$$e^z = 1 + z + \frac{z^2}{2!} + \frac{z^3}{3!} + \frac{z^4}{4!} + \frac{z^5}{5!} + \frac{z^6}{6!} + \frac{z^7}{7!} \cdots$$

we write as z since this can be a complex number.

- What about if we take z to be $j\phi$?

$$e^z = 1 + z + \frac{z^2}{2!} + \frac{z^3}{3!} + \frac{z^4}{4!} + \frac{z^5}{5!} + \frac{z^6}{6!} + \frac{z^7}{7!} \cdots$$

$$e^{j\phi} = 1 + j\phi - \frac{\phi^2}{2!} - \frac{j\phi^3}{3!} + \frac{\phi^4}{4!} + \frac{j\phi^5}{5!} - \frac{\phi^6}{6!} - \frac{j\phi^7}{7!} \cdots$$

$$\cos\phi = 1 \frac{\phi^2}{2!} + \frac{\phi^4}{4!} - \frac{\phi^6}{6!} + \frac{\phi^8}{8!} \cdots$$

$$j\sin\phi = j\phi - j\phi^3 + \frac{j\phi^5}{5!} - \frac{j\phi^7}{7!} + \frac{jz^9}{9!} \cdots$$

So we have

$$e^{j\phi} = \cos\phi + j\sin\phi$$

Euler's Formula (with real ϕ)

Imaginary axis $\quad e^{j\phi} = \cos\phi + j\sin\phi$

Real axis

In general, when magnitude is not 1:

$$|c| = \sqrt{a^2 + b^2}$$

$$c = |c|\, e^{j\phi} = \underbrace{|c|\cos\phi}_{\text{Real}} + j\, \underbrace{|c|\sin\phi}_{\text{Imaginary}}$$

Polar to rectangular
Phase form.

1.2(a) (a)

An airline is a transmission line in which air separates the two conductors are made of a material .... Following quantities are given as:

Solution:- The following quantaties are given

$$Z_0 = 50\,\Omega$$

$$f = 700\,MHz = 7 \times 10^8\,Hz$$

with $R' = G' = 0$, Eqs. (2.25b) and (2.29) reduce to

$$\beta = Im\left[\sqrt{(j\omega L')\,(j\omega C)}\right]$$

$$= Im\left(j\omega\sqrt{L'C'}\right) = \omega\sqrt{L' \cdot C'},$$

$$Z_0 = \sqrt{\frac{j\omega L'}{j\omega C'}} = \sqrt{\frac{L'}{C'}}$$

The ratio of β to Z_0 is

$$\frac{\beta}{Z_0} = \omega C',$$

or

$$C' = \frac{\beta}{\omega Z_0}$$

$$= \frac{20}{2\pi \times 7 \times 10^8 \times 50}$$

$$= 9.09 \times 10^{-11} \text{ (F/m)} = 90.9 \text{ (pF/m)}$$

From $Z_0 = \sqrt{L'/C'}$, it follow that

$$L' = Z_0^2 C'$$

$$= (50)^2 \times 90.9 \times 10^{-12}$$

$$= 2.27 \times 10^{-7} \text{ (H/m)}$$

$$= \boxed{2.27 \text{ (nH/m)}}$$

Q2 (b)

A 50 microstrip line uses a 0.5mm-thick sapphire substrate with what is the width of its copper strip?

(Ans) Solution:-

Since $Z_0 = 50 > 44 - 18 = 32$. we should use

Eq

$$P = \sqrt{\frac{\epsilon_r + 1}{2}} \times \frac{Z_n}{60} + \left(\frac{\epsilon_r - 1}{\epsilon_r + 1}\right)\left(0.23 + \frac{0.12}{\epsilon_r}\right)$$

$$= \sqrt{\frac{9+1}{2}} \times \frac{50}{60} + \left(\frac{9-1}{9+1}\right)\left(0.23 + \frac{0.12}{9}\right)$$

$$= 2.06.$$

$$\delta = \frac{w}{h}$$

$$= \frac{8e^P}{e^{2P} - 2}$$

$$= \frac{8e^{2.06}}{e^{4.12} - 2}$$

$$\boxed{= 1.056}$$

Hence,

$$\omega = Sh$$
$$= 1.056 \times 0.5mm$$
$$= 0.53mm$$

To check our calculations, we will use $S = 1.056$ to calculate Z_0 to verify that the value we obtained is indeed equal or close to $50\,\Omega$ with $\varepsilon_r = 9$.

$x = 0.55,$

$y = 0.99,$

$t = 12.51$

$\varepsilon_{eff} = 6.11,$

$$\boxed{Z_0 = 49.93\,\Omega}$$

The calculated value of Z_0 is for all practical purposes, equal to the value specific in the problem statement.

Q3 (a) Transform the vector $(x+z)\,a_y$ to cylindrical

$$\begin{bmatrix} A_\rho \\ A_\phi \\ A_z \end{bmatrix} = \begin{bmatrix} \cos\phi & \sin\phi & 0 \\ -\sin\phi & \cos\phi & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 \\ x+z \\ 0 \end{bmatrix}$$

$x = \rho\cos\phi$

$y = \rho\sin\phi$

$z = r\cos\theta$

$\rho = r\sin\theta$

$\rho = \sqrt{x^2+y^2}$

$r = \sqrt{x^2+y^2+z^2}$

Solution:-

$A_\rho = 0 * \cos\phi + (x+z)\sin\phi + 0$

$A_\rho = (x+z)\sin\phi$

$A_\rho = (\rho\cos\phi + z)\sin\phi$

$A_\phi = 0 * (-\sin\phi) + (x+z)\cos\phi + 0$

$A_\phi = (x+z)\cos\phi$

$A_\phi = (\rho\cos\phi + z)\cos\phi$

$A_z = 0$

Cont....

Convert the vector F to cylindrical.

$$F = \frac{x a_x + y a_y + 4 a_z}{\sqrt{x^2 + y^2 + z^2}}$$

$$\begin{bmatrix} A_\rho \\ A_\phi \\ A_z \end{bmatrix} = \begin{bmatrix} \cos\phi & \sin\phi & 0 \\ -\sin\phi & \cos\phi & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} A_x \\ A_y \\ A_z \end{bmatrix}$$

$$AP = \frac{x^* \cos\phi + y^* \sin\phi + 0}{\sqrt{x^2 + y^2 + z^2}}$$

$$= \frac{P\cos\phi^* \cos\phi + P\sin\phi^* \sin\phi}{\sqrt{P^2 + z^2}} = \frac{P}{\sqrt{P^2 + z^2}}$$

$$A\phi = \frac{x^*(-\sin\phi) + y^2 \cos\phi + 0}{\sqrt{x^2 + y^2 + z^2}} = \frac{P\cos\phi^* - \sin\phi + P\sin\phi\cos\phi}{\sqrt{P^2 + z^2}} = 0$$

$$Az = \frac{4}{\sqrt{x^2 + y^2 + z^2}} = \frac{4}{\sqrt{P^2 + z^2}}$$

$$A_{cyl} = \frac{P}{\sqrt{P^2 + z^2}} a_p + \frac{4}{\sqrt{P^2 + z^2}} a_z$$

Scanned by CamScanner

Q3 (B)

Explain the difference between the two points help of figure..... A at points (3, -4, 0) given below.

(Ans) The distance between two points

$$d = |r_2 - r_1|$$

Cartesion $\Rightarrow d^2 = (x_2 - x_1)^2 + (y_2 - y_1)^2 + (Z_2 - Z_1)^2$

cylindrical $\Rightarrow d^2 = P_2^2 + P_1^2 = 2P_2 P_1 \cos(\phi_2 - \phi_1) + (Z_2 - Z_1)^2$

spherical $\Rightarrow d^2 = r_2^2 + r_1^2 - 2r_2 r_1 \cos\phi_2 \cos\phi_1 - Z r_2 r_3 \sin\phi_2 \sin\phi_1 \cos(\phi_2 - \phi_1)$

(a) $P_1 = (2, 1, 5)$ and $P_2 = (6, -1, 2)$

$P_1 P_2 = P_2 - P_1 = 4a_x - 2a_y - 3a_z$

$|P_1 P_2| = \sqrt{16 + 4 + 9} = 5.38$

(b) $P_1 = (3. \, Pi/2, -1)$ and $P_2 = (5, 3Pi/2, 5)$

$d^2 = P_2^2 + P_1^2 - 2P_1 - 2P_2 P_1 \cos(\phi_2 - \phi_1) + (Z_2 - Z_1)^2$

$d_t^2 = 5^2 + 3^2 - 2(5)(3)\cos(\pi) + (6)^2 = 100$

$d = 10.$

Or convert all points to cartesion coordinates:

$(3, pi/2, -1) \Rightarrow (0, 3, -1)$

$(5, 3i/2, 5) = (0, -5, 5)$

$d = \sqrt{0+64+36} = 10$

$= H = P_z \cos\phi \, a_p + \sin\frac{\phi}{2} a_\phi + P^2 a_z$

At point $(1, \pi/3, 0)$ find

a) H, a_x : first we must convert [H to cartesian] or [A to cylinchical]

$$\begin{bmatrix} H_x \\ H_y \\ H_z \end{bmatrix} = \begin{bmatrix} \cos\phi & -\sin\phi & 0 \\ \sin\phi & \cos\phi & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} P_z \cos\phi \\ \sin\frac{\phi}{2} \\ P^2 \end{bmatrix}$$

$H = P_z \cos\phi \, a_p + \sin\frac{\phi}{2} a_\phi + P^2 a_z$

At point $(1, \pi/3, 0)$ find

a) $H \times a_\theta$

first we must convert [H to sph] or [A to cyl]

$A_\rho = \cos\phi$

$A_\phi = 0$

$A_z = -\sin\phi$

$\theta = \tan^{-1}\left(\frac{\rho}{z}\right) = \tan^{-1}\left(\frac{1}{0}\right) = \pi/2$

$A_\rho = \cos 90 = 0$

$A_\phi = 0$

$A_z = \sin 90 - 1$

$H \downarrow \ (1, \pi/3, 0) = 0.5 a_\phi + a_z$

$H \times A = H \times a_z = (0.5 a_\phi + a_z) \times (a_z)$

$$= \begin{vmatrix} a_\rho & a_\phi & a_z \\ 0 & 0.5 & 1 \\ 0 & 0 & -1 \end{vmatrix} = -0.5 a_\rho$$

Transform A to spherical and Find the value of A at point (3, -4, 0)

$$A = \rho \cos\phi \, a_\rho + \rho z^2 \sin\phi \, a_z$$

$$\begin{bmatrix} A_r \\ A_\theta \\ A_\phi \end{bmatrix} = \begin{bmatrix} \sin\theta & 0 & \cos\theta \\ \cos\theta & 0 & -\sin\theta \\ 0 & 1 & 0 \end{bmatrix} \begin{matrix} \rho\cos\phi \\ 0 \\ \rho z \sin\phi \end{matrix}$$

$$A_r = \rho\cos\phi \sin\theta + \rho z^2 \sin\phi \cos\theta$$

$$= (r\sin\theta)\cos\phi \sin\theta + (r\sin\theta)(r\cos\theta)^2 \sin\phi \cos\theta$$

$$= r\sin^2\theta \cos\phi + r^3 \sin\theta \cos^3\theta \sin\theta$$

$$A_\theta = r\sin\theta\cos\theta\cos\theta - r^3\sin^2\cos^2\theta \sin\theta$$

$$A_\theta = a$$

$$\Rightarrow A = A_r . a_r + A_\theta a_\theta + A_\theta a_\theta$$

$$(x, y, z) = (3, -4, 0) \Rightarrow (x, \theta \phi)$$

$$= (5, \pi/2 - 53.13^\circ)$$

$$A \downarrow (5, \pi/2, -53.13^\circ) = 3a_r$$

$|A| = 3$ as in part (a).