Course Title :- Electromagnetic Field Theory

Module :- 4th.

Instructor :- Rafiq, Mansoor

Name :- Syed Muhammad Raza

Student ID :- 14620

Student Signature :- S.Raza

Date :- 16 April, 2020.

Q No :- 1

Short questions

(a) Transfer the vector $B = yi\,(x+2)\,j$ located at point $(-2, 6, 3)$ into cylindrical coordination.

Solution :-

$B = yi\,(x+z)\,j$

Given points are $(-2, 6, 3)$

$$B = yi\,(x+2)\,j$$

$$B = yi\,(xj + zj)$$

$$B = yxij + yzij$$

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

$$\rho = \sqrt{40}$$

$$\boxed{\rho = 6.32}$$

As we know that.

$z = Z$

So $\boxed{Z = 3}$

As we know that

$\phi = \tan^{-1}(y/x)$

$\phi = \tan^{-1}(6/-2)$

$\phi = \tan^{-1}(-3)$

$\boxed{\phi = -71.56}$

So

$\boxed{B = 6.32, -7.56, 3}$

(b) Convert the point (3, 4, 5) from Cartesian to spherical coordination.

Solution :-

P (3, 4, 5)

$x = 3, \; y = 4, \; z = 5$

In spirical coordinates system

r, θ, ϕ.

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

$r = \sqrt{3^2 + 4^2 + 5^2}$

$r = \sqrt{9 + 16 + 25}$

$r = \sqrt{50}$

$r = 7.07$.

Now :-

$\theta = \tan^{-1}(y/x)$

$\theta = 4/3 = \tan^{-1}(1.33)$

$\boxed{\theta = 53.1^\circ}$

$\theta = \tan^{-1}\left(\frac{\sqrt{x^2 + y^2}}{z}\right)$

$\theta = \tan^{-1}\left(\frac{\sqrt{3^2 + 4^2}}{5}\right)$.

$\theta = \tan^{-1}\left(\frac{\sqrt{9+16}}{5}\right)$

$= \tan^{-1}\left(\sqrt{25}/5\right)$

$\theta = \tan^{-1}\left(\frac{5}{5}\right) \Rightarrow \tan^{-1}(1)$

$\boxed{\theta = 45}$

$r = 7.07, \quad \theta = 53.1^\circ, \quad \phi = 45.$

(c) Spherical coordinates of A (2, 3, -1)

Solution :-

r, θ, ϕ

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

$r = \sqrt{2^2 + 3^2 + (-1)^2}$

$r = \sqrt{14} \Rightarrow \boxed{r = 3.74}$

$\theta = \tan^{-1}(y/x)$

$\theta = \tan^{-1}(3/2)$

$\theta = \tan^{-1}(1.5)$

$$\boxed{\theta = 56.3^\circ}$$

$$\phi \tan^{-1}\left(\frac{\sqrt{x^2+y^2}}{z}\right)$$

$$\phi \tan^{-1}\left(\frac{\sqrt{2^2+3^2}}{-1}\right)$$

$$\phi \tan^{-1}\left(\frac{\sqrt{4+9}}{-1}\right) \Rightarrow \left(\frac{\sqrt{13}}{-1}\right)$$

$$\phi = \tan^{-1}(-3.60)$$

$$\boxed{\phi = 74.4}$$

$$r = 3.74, \quad \theta = 56.3^\circ, \quad \phi = 74.4$$

(d) Cartesian Coordinates of B (4, 25, 120)

Solution :-

B (4, 25, 120) is in spherical coordinates (r, θ, ϕ) we will find (x, y, z) :-

$$x = r\sin\theta \cdot \cos\phi$$

$x = 4 \sin(25) \cdot \cos(120)$

$x = 4(0.42) \cdot (-0.5)$

$\boxed{x = -0.84}$

As $y = r \sin\theta \sin\phi$

$y = 4 \sin(25) \cdot \sin(120)$

$y = 4(0.42)(0.86)$

$\boxed{y = 1.45}$

:-

$z = r\cos\theta$

$z = 4\cos(25)$

$z = 4(0.90)$

$\boxed{z = 3.62}$

$(x, y, z) = (-0.84, 1.45, 3.62)$

(e) Find the force b/w the charge?

Solution :-

$q_1 = 2nC, \quad q_2 = -1nC$

$d = 4cm$

To find $F = ?$

where, $F = k \frac{q_1 q_2}{r^2}$

$k = \frac{1}{4\pi\varepsilon_0}$

$$F = \frac{2 \times 10^{-9} \times 1 - 1 \times 10^{-9}}{4(3.14) \times 8.8 \times 10^{-12} \times (4 \times 10^{-2})^2}$$

$F = -1.124 \times 10^{-5}$

$F = -11.24 - 4 \text{ N}$

7) Find the electric feild intensity of two charges.

SOLUTION:-

$q_1 = -2c \quad q_2 = -1c$

$d = 1m$

To find $E = ?$

we have

$$E_1 = \frac{kq_1}{d^2} \qquad k = 9 \times 10^9$$

$$E_1 = \frac{9 \times 10^9 \, -2}{(1)^2}$$

$$E_1 = -18 \times 10^9 \, \frac{v}{m}$$

$$E_2 = \frac{9 \times 10^9 \times -(-1)}{(1)^2}$$

$$E_2 = -9 \times 10^9 \, v/m$$

AS :-

$$E_T = E_1 + E_2$$

$$E_T = -18 \times 10^9 + (-9 \times 10^9)$$

$$ET = -18 \times 10^9 + (-9 \times 10^9)$$

$$ET = -18 \times 10^9 - 9 \times 10^9$$

$$ET = -27 \times 10^9 \ N/m$$

(9) Determine the strength produce by electric feild.

$E = 40 \frac{V}{m}$ $\quad d = 30 \text{ cm}$

where

$$E = \frac{kQ}{d^2}$$

$$Ed^2 = kQ$$

$$\frac{Ed^2}{k} = Q \rightarrow (1)$$

$$Q = \frac{Ed^2}{k} \Rightarrow Q = \frac{40 \times (30)^2}{9 \times 10^9}$$

$$Q = \frac{40 \times 900}{9 \times 10^9}$$

$$Q = 4 \times 10^{-6} C$$

$$\boxed{Q = 4 \mu C}$$

(h) A Charge of 2×10^{-7} is acted upon by the of 0.1N. Detlermine the distance to the other Charge of $4.5 \times 10^{-7} C$ both charges are in varcum.

SOLUTION:-

$q_1 = 2 \times 10^{-7} C$ $F = 0.1N$

$q_2 = 4.5 \times 10^{-7}$ $K = 9 \times 10^9$

Find $d = ?$

$$F = \frac{K q_1 q_2}{d^2}$$

$$d^2 = \frac{k q_1 q_2}{F}$$

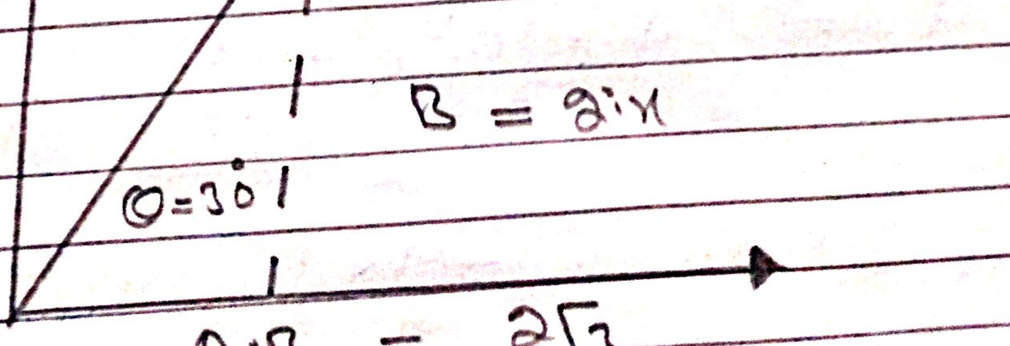
$$= \frac{9\times10^9(2\times10^{-7})(4.5\times10^{-7})}{(0.1)}$$

$$d^2 = 8.1\times10^{-3}$$

$$\sqrt{d^2} = \sqrt{0.0081}$$

$$\boxed{d = 9cm}$$

Q.02 :- Find angle between the vector show in figure



$A\cdot B = 2\sqrt{3}$

A8 :-

$$AB = |A||B| \cos\theta \rightarrow 1$$
$$A \cdot B = 2\sqrt{3}$$

$|A| = \sqrt{2^2}$ $\quad |B| = \sqrt{2^2}$

$|A| = 2$ $\quad |B| = 2$

So Eq Becomes

$$2\sqrt{3} = 2 \times 2 \cos\theta$$
$$2\sqrt{3} = 4 \cos\theta$$
$$\frac{2\sqrt{3}}{4} = \cos\theta$$

$$\frac{\sqrt{3}}{2} = \cos\theta$$

$$\theta = \cos^{-1}(\sqrt{3}/2)$$

$$\boxed{\theta = 30^\circ}$$

(b) Find the gradient of each of the following functions where a and b are constant.

(i) $F = ax^2 + by^3 z$

SOLUTION :-

$$F = ax^2 + by^3 z$$

$$\frac{dF}{dy} = 2ax$$

$$\frac{dF}{dy} = \frac{d}{dz}(ax^2 + by^3 z)$$

$$\frac{dF}{dy} = 3by^2 z$$

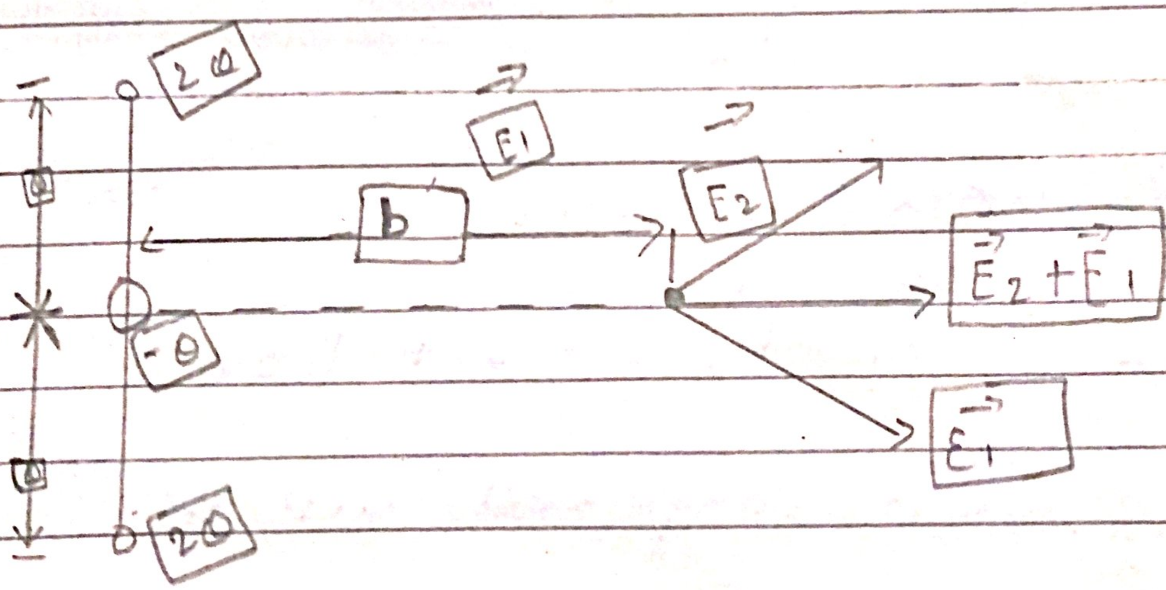
$$\frac{dF}{dz} = \frac{d}{dz}(ax^2 + by^3 z)$$

$$\frac{dF}{dz} = by^3$$

$$\nabla F(x, y, z) = (2ax + 3byz, by^3)$$

Q = 03 :-

Three pointer charges are placed on the y-axis as shown. Find the electric feild at Point P On the x- axis -



SOLUTION :-

The distance between the Charge 2Q and Point (P) is

$$r^2 = b^2 + a^2$$

$$r = \sqrt{b^2 + a^2}$$

Let Suppose that the angel 2θ make (α) and $(-\alpha)$ with x-axis.

Magnitude of $|\vec{E_1}| = |\vec{E_2}| = \frac{kq}{r^2}$

$$= \frac{k(2\theta)}{r^2}$$

$$= \frac{k(2\theta)}{b^2 + a^2}$$

Resultant :-

$$\vec{E}_{1+2} = \vec{E_1} + \vec{E_2} + \vec{E}_{1x} + \vec{E}_{2x}$$

(Y- component will be Cancel)

$$= k = \frac{(2\theta)(2\cos(\alpha))}{b^2 + a^2}$$

$$\vec{E}_{1+2} = \frac{4k\theta\cos(\alpha)}{b^2+a^2}$$

Now Electric feild at point (P) due to Charge "$-\theta$"

$$\vec{E}_A = \frac{-k(Q)}{b^2}$$

Net electric feild at point (P) will be $E_{net} = E_A + (E_1 + E_2)$

$$= \frac{-k(Q)}{b^2} + \frac{4kQ\cos\alpha}{b^2 + a^2}$$

$$= \frac{kQ}{b^2(a^2+b^2)}\left[4b^2\cos\alpha - (a^2+b^2)\right]$$

$$= E_{net} = \frac{9\times10^9 Q}{b^2(a^2+b^2)}\left[4b^2\cos\alpha - (a^2+b^2)\right]$$

Now $\alpha = \tan^{-1}(a/b)$

$$E_{net} = \frac{9\times10^9 Q}{b^2(a^2+b^2)}\left[4b^2\cos\left[\tan^{-1}(a/b)\right] - (a^2+b^2)\right]$$