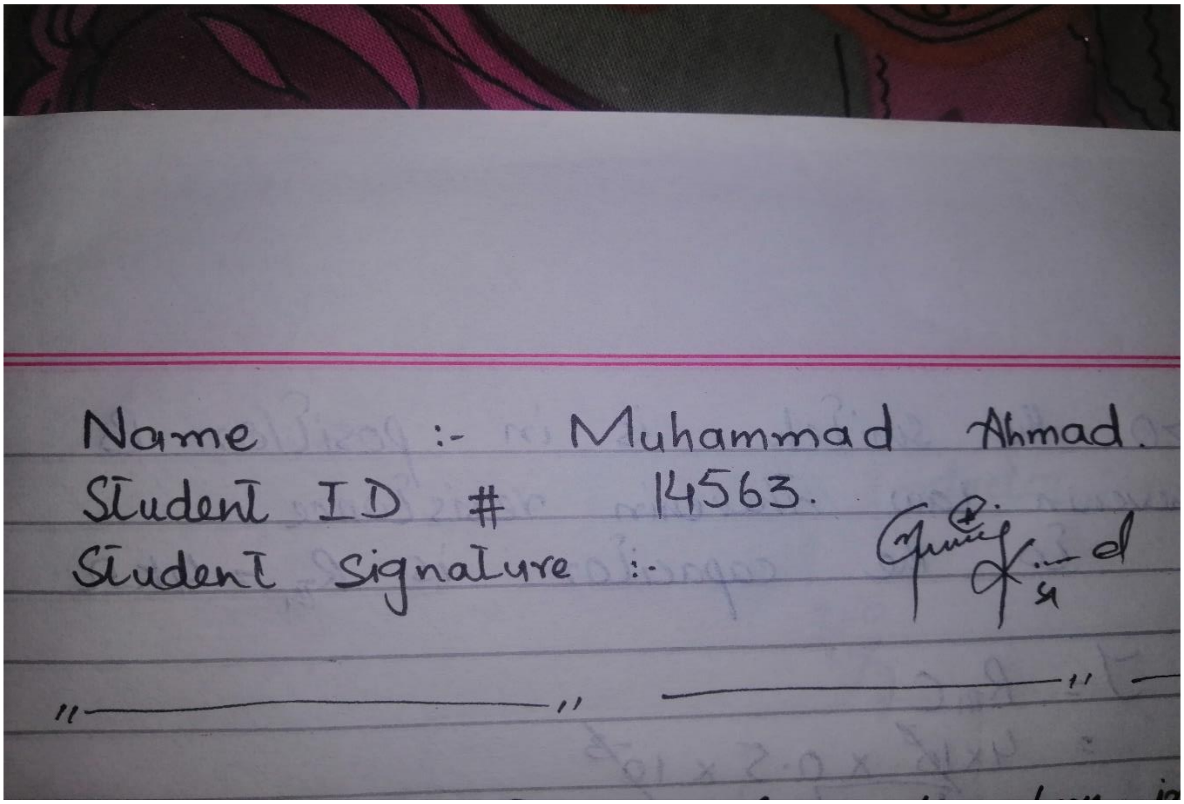
<u>**Department of Electrical Engineering**</u>

Course Title: Electro Magnetic Field Theory

Module: 4th

<u>**Student Detail**</u>



QNo 1(a) :- Transform the vector $B = yi(x+z)j$ located at point $(-2, 6, 3)$ into cylindrical coordinates.

Answer:- Solution:-

$$B = yxij + yzij.$$

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

$$= \sqrt{(-2)^2 + (6)^2}$$

$$= \sqrt{4+36} = \sqrt{40} = \boxed{6.325}$$

$$\Phi = \tan^{-1}\left(\frac{y}{x}\right)$$

$$= \tan^{-1}\left(\frac{6}{-2}\right)$$

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

$$\boxed{\Phi = -71.57}$$

We know $z = Z$

$$\boxed{Z = 3}$$

QNo 1(b) :- Convert the point $(3, 4, 5)$ from Cartesian to spherical coordinates.

Solution:- (r, θ, Φ).

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

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

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

$$r = \sqrt{50}$$

$$r = 7.07$$

$$\theta = \cos^{-1}\frac{z}{r}$$

$$= \cos^{-1}\frac{5}{5\sqrt{2}} = \boxed{45^\circ}$$

$\Phi = \tan^{-1}\left(\frac{y}{x}\right)$

$= \tan^{-1}\left(\frac{4}{3}\right)$

$= 53^\circ$

$A = (7.07, 45^\circ, 53^\circ)$ Ans.

QNo1(c) Find the sperical coordinates of $A(2,3,-1)$.

Ans Solution:-

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

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

$r = \sqrt{4+9+1}$

$r = \sqrt{14}$

$r = \boxed{3.74}$

$\theta = \cos^{-1}\left(\frac{z}{r}\right)$

$= \cos^{-1}\left(\frac{-1}{3.74}\right)$

$\theta = \boxed{105.5^\circ}$

$\Phi = \tan^{-1}\left(\frac{y}{x}\right)$

$= \tan^{-1}\left(\frac{3}{2}\right)$

$\Phi = \boxed{56.31^\circ}$

$= (3.74, 105.5^\circ, 56.31^\circ)$ Ans.

QNo1(d) Find the cartesian coordinates of $B(4, 25, 120)$.

Ans Solution :-

$x = r\sin\theta \cos\phi = 4\sin 25^\circ \cos 120^\circ$
$= 4\sin 25^\circ \cos 120^\circ$
$= -0.845$.

$y = r\sin\theta \sin\phi$.
$= 4\sin 25^\circ \sin 120^\circ$.
$= 1.462$.

$z = r\cos\theta$
$= 4\cos 25^\circ$
$= 3.625$.

QNo1(e) :- Find the force between two charges when they are bought in contact & seperated by 4cm apart, charges are 2nC and -1 nC in μN.

Solution

Befor the charges are brought into contact $F = 11.234\,\mu N$.

After charges are brought into contact & also seperated charge from each other sphere is $\left(\frac{q_1+q_2}{2}\right)$.

$= \frac{2nC + (-1nC)}{2}$

$= \frac{2nC - 1nC}{2} = \frac{1nC}{2}$

$= 0.5nC$

Calculating the force with q_1 and $q_2 = 0.5$

$$\boxed{F = 1.404\mu N}$$

QNo 1 (f):- Find the electric field intensity of two charges +2C and -1C separated by a distance of 1m in air.

Solution:-

$\therefore \varepsilon_0 = (8.854 \times 10^{-12})$

$$F = \frac{q_1 q_2}{4\pi\varepsilon_0 r^2}$$

$$= \frac{+2C \times -1C}{4\pi\varepsilon_0 r^2}$$

$$F = \boxed{+18 \times 10^9 V/m}$$

$$E_f = \frac{F}{q}$$

$$= \frac{18 \times 10^9}{2}$$

$$\boxed{E_f = 9 \times 10^9 V/m} \text{ Ans.}$$

OR

$$E_1 = K\frac{q_1}{d^2}$$

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

$$= 18 \times 10^9 V/m$$

Now

$$E_2 = K\frac{q_2}{d^2}$$

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

$$= 9 \times 10^9 V/m$$

QNo 1 (g):- Determine the charge that produce from electric field strength of 40 V/cm at a distance of 30cm in vacuum (in $10^{-8}C$).

Solution:-

$$E = \frac{Q}{4\pi\varepsilon_0 r^2}$$

$$Q = \frac{4000 \times 0.3^2}{9 \times 10^9}$$

$$Q = \boxed{4 \times 10^{-8} C} \text{ Ans.}$$

$$Q = \frac{Ed^2}{K}$$

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

QNo 1(h) :- A charge of $2\times10^{-7}C$ is acted upon by a force of 0.1N. Determine the distance to the other charge of $4.5\times10^{-7}C$. both the charges are in vaccum. 2P.

Solution:- $q_1 = 2\times10^{-7}C$, $q_2 = 4.5\times10^{-7}C$ $F = 0.01N$

$$F = \frac{q_1 q_2}{4\pi\epsilon_0 r^2} \qquad K = 9\times10^{9}$$

$$r^2 = \frac{q_1 q_2}{4\pi\epsilon_0 F}$$

$$r^2 = \frac{(2\times10^{-7})(4.5\times10^{-7})}{4\pi\epsilon_0 (0.1)N}$$

$$\sqrt{r^2} = \sqrt{\frac{2\times4.5\times10^{-14}}{4\pi\epsilon_0(0.1N)}}$$

$$\boxed{r = 0.09m} \text{ Ans.}$$

OR.

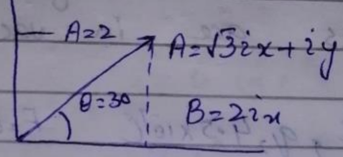
$$F = \frac{K q_1 q_2}{r^2}$$

$$r^2 = \frac{K q_1 q_2}{F} = \frac{9\times10^{9}(2\cdot10^{-7})(4.5\times10^{-7})}{0.1N}$$

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

$$\boxed{r = 0.09m}$$

QNo2(a):- Find the angle between the vectors shown in figure.



A.B $2\sqrt{3}$

$A=(\sqrt{3}, 1)$, $B=(2, 0)$

$A \cdot B = (\sqrt{3}, 1)(2, 0)$

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

$|A| = \sqrt{(\sqrt{3})^2+(1)^2} = \sqrt{3+1} = \sqrt{4} = 2$

$|B| = \sqrt{(2)^2+(0)^2} = \sqrt{4} = 2$

$\cos\theta = \frac{A \cdot B}{|A||B|}$

$\theta = \cos^{-1} \frac{2\sqrt{3}}{2 \cdot 2}$

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

$\theta = 30.0029°$ Ans

QNo2b:- Find the gradient of each of the following functions where a & b are constant.

$f = ax^2 + by^3z$.

formula = $\nabla f = \frac{\partial f}{\partial x} + \frac{\partial f}{\partial y} + \frac{\partial f}{\partial z}$.

$= ax^2 + by^3z$

$= \boxed{2ax + 3y^2z + by^3}$

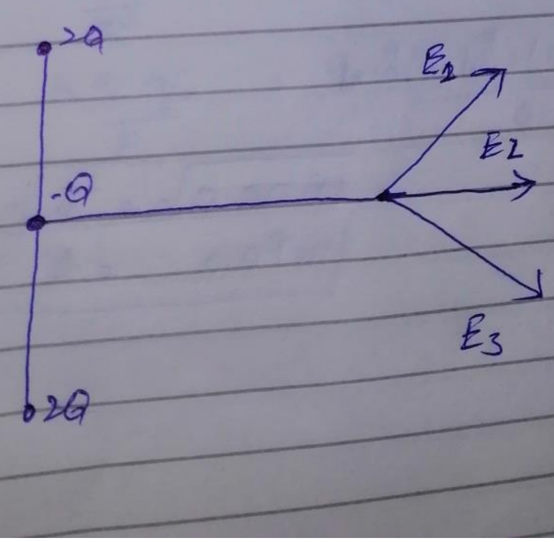
(ii) $f = ar^2 \sin\phi + brz\cos 2\phi$.

$\frac{\partial f}{\partial r} + \frac{1}{r}\frac{\partial f}{\partial \theta} + \frac{1}{r\sin\theta}\frac{\partial f}{\partial \phi}$.

$2ar\sin\phi + ar\cos\theta + \frac{1}{r\sin\theta} brz - \sin 2\phi\, 2$

$\boxed{2ar\sin\theta + ar\cos\theta - 2bz}$ A

QNO3 Three pointer charges are placed on the y-axis as shown. Find the electric field at point P on the x axis.



$$E = \frac{KQ}{R^2}$$

Due to 2Q charge at the top.

$$E_{1x} = \frac{K(2Q)}{a^2+b^2} \cos\theta.$$

Due to -Q charge:-

$$E_{2x} = -\frac{KQ}{a^2}$$

Due to 2Q charge at bottom.

$$E_{3x} = \frac{2KQ}{a^2+b^2} \cos\theta.$$

Add $E_{1x} + E_{2x} + E_{3x}$.

$$E_x = \frac{4KQ\cos\theta}{a^2+b^2} - \frac{KQ}{a^2}.$$

$$\cos\theta = \frac{a}{\sqrt{a^2+b^2}}$$

$$= KQ\left[\frac{4\cos\theta}{a^2+b^2} - \frac{1}{a^2}\right].$$