Course title	Electro magnetic Theory
Instructor	Sir Rafiq mansoor
Module	4th
Name	Farhan Ali
ID	14873
Signature	

Q1:- Transform the vector $B = yi\ (x+z)$ located at point $(-2, 6, 3)$ into cylindrical Coordinate

Ans:- Part (a)

Solution:-

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

Point $(-2, 6, 3)$

Then

$B = yi\ (xj + zj)$

$B = yxij + yzij$

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

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

$z = z$

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

$$\boxed{5.83}$$

$$\phi = -71.565$$

$$\boxed{z = 3}$$

$$B = (5.83, -71.56, 3),$$

Q1
Part (B)

Convert the point (3,4,5) from Cartesian coordinates.

Sol:

For spherical we have to find

$r, \phi\, \theta$

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

$$r = \sqrt{3^2+4^2+5^2} = 7.07$$

$$r = 7.07$$

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

$$-\tan^{-1} 4/3$$

$$\phi = 53.13$$

$\theta = \cos^{-1} z/r$
$= \cos^{-1} 5/7.07$

$\theta = 45^{\circ}$

$(r, \theta, \phi) = (7.07, 45, 53.13)$

Q1
Part(C):-

Find the spherical coordinates of. A(2, 3, -1)

Q1:
part c:
Solution:-

A (2, 3, -1)

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

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

$\sqrt{}$

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

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

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

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

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

Q1:
Part (D):-

Find the "Spherical" cartesian

Coordinates of $B(4.25, 120)$

Answer:-
point B is actually given is spherical

(r, θ, ϕ)

we have to find (x, y, z)

$x = r \sin\theta \cos\phi$
$= 4 \sin 25 \cos 120$
$= 0.84$
$y = r \sin\theta \sin\phi$
$= y \sin 25 \sin 120$
$= y = 1.40$

$z = r\cos\theta = 4\cos 25$

$z = 3.62$

$(x, y, z) = (-0.848, 1.46, 3.6)$

Q1:

part(e):-

Find the force between to charges when they brought in contact and separated by 4cm apart, charges are 2nc and -1nc in μN.

Solution:

$$F = \frac{k\, q_1 q_2}{r_2}$$

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

$$F = \frac{2\times10^{-9} \times 1\times10^{-9}}{4\pi\times8.85\times10^{-12}\times(4\times10^{-2})^2}$$

$F = -1123\times10^{-5}$

Then configuration

$$\boxed{F = -11.23 \ Gw}$$

Q1
part (F):

Find the electric field intensity of two charges $-2C$ and $1C$ separated by distance $1m$ in air

Solution

$q_1 = -2C$ and $q_2 = -1C$
So for E_1

$$E_1 = \frac{q_1}{4\pi \varepsilon_0 r} = \frac{-2}{4\pi \times 8.85 \times 10^{-12} \times 1^2}$$

$$E_1 = -1.798 \times 10^{10} \ N/C$$

$$E_2 = \frac{-1}{4\pi \varepsilon_0 \times 10^2} = -8.9 \times 10^9 \ N/C$$

$$\boxed{E_2 = -8.9 \times 10^9 \ N/C}$$

Q1
Part (G)

Determine the charges that produce an electric field strength of 40 v/cm at a distance of 30cm in vacuum (in $10^{-8}C$)

Solution :-

$E = 40 \ V/m = 40 \ V/10^{-2} m$

$E = 4000 \ V/m$

$r = 30 \times 10^{-2} m$

find $q = ?$

Now

$E = \frac{q}{4\pi \epsilon_0 r^2}$

$q = E \times 4\pi \epsilon_0 r^2$

$= 4000 \times 4 \times 3.14 \times 8.85 \times 10^{-12} (30 \times 10^{-2})^2$

$\boxed{q = 4 \times 10^{-8} C}$

Q1
part (h)

A charges of 2 * *10^{-7} C is acted upon by a force of 0.1N. determine the distance to the other charges of 45* 10^{-7}C, both the charges are in vacuum.

Solution:

$r = ?$
To find r we
$q_1 = 2 \times 10^{-7}$ and
$q_2 = 45 \times 10^{-2}$

where,
$$F = \frac{q_1 q_2}{4\pi\varepsilon_0 0}$$

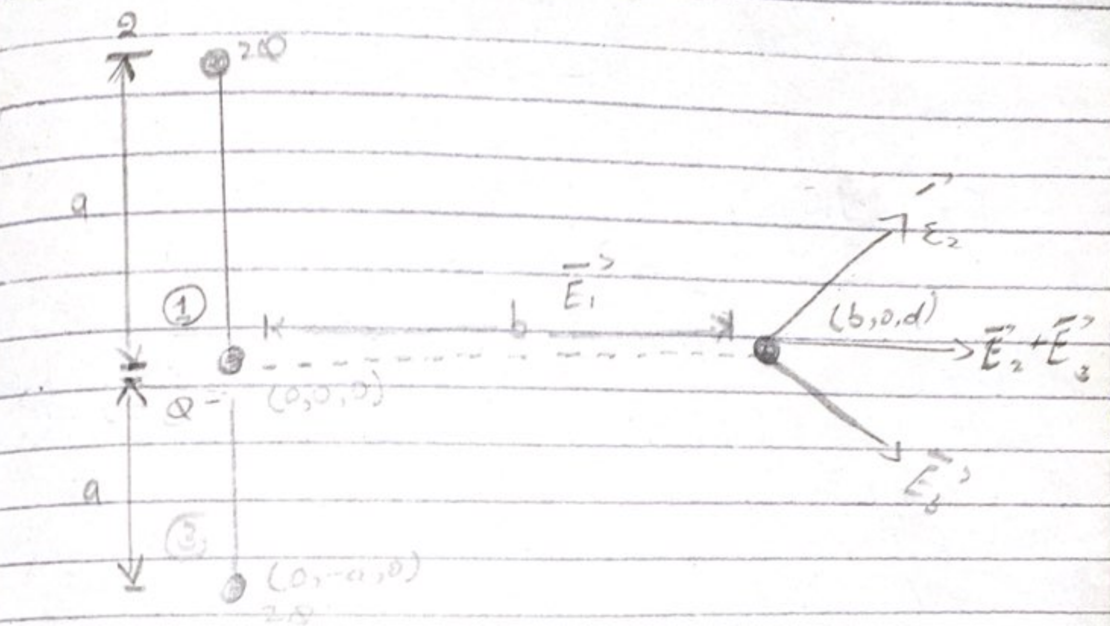
$$r^2 = \sqrt{\frac{q_1 q_2}{4\pi\varepsilon_0 F}}$$

Now putting values.

$$r^2 = \sqrt{2 \times 10^{-7} \times 4.5 \times 10^{-7}}$$

$\boxed{r^2 = 0.09 m}$ $R = 0.0899 m$

Find E at P. (0, a, 0)



$r = b a_x + 0 a_y + 0 a_z$

$r_1 = 0 a_x + 0 a_y + 0 a_z$

$r_2 = 0 a_x + \quad + 0 \cdot a_z$

$r_3 = 0 a_x + - a \cdot a_y + 0 \cdot a_z$

$r - r_1 = b a_x + 0 \cdot a_y + 0 \cdot a_z$

$r - r_2 = b a_x - a \cdot a_y + 0 \cdot a_z$

$r - r_3 = b \cdot a_x + a \cdot a_y + 0 \cdot a_z$

$|r - r_1| = b$

$|r - r_2| = \sqrt{b^2 + a^2}$

$|r - r_3| = \sqrt{b^2 + a^2}$

Now

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

For charge 1

$$E_1 = \frac{-Q}{4\pi\varepsilon_0 \frac{\vec{r}-r_1}{r^2-r_1}} = \frac{-Q}{4\pi\varepsilon_0 \left[\frac{ba_x}{b}\right]\left\{\frac{1}{(b)^2}\right]}$$

For charg 2

$$E_2 = \frac{2Q}{4\pi\varepsilon_0 \left\{\frac{ba_x - aa_y}{\sqrt{b^2+a^2}}\right]\left[\frac{1}{\sqrt{b^2+a^2}}\right)^2\right]}$$

For charg 3

$$E_3 = \frac{2Q}{4\pi\varepsilon_0 \left[\frac{ba_x + a \cdot a_y}{\sqrt{b^2+a_2}}\right]\left[\frac{1}{\sqrt{b^2+a_2}}\right)^2\right]}$$

$$E = E_1 + E_2 + E_3$$

$$E = \frac{-Q}{4\pi\varepsilon_0 \left[\frac{ba_x}{b}\right]\left[\frac{1}{b^2}\right]} + \frac{2Q}{4\pi\varepsilon_0 \left[\frac{ba_x - a \cdot a_y}{\sqrt{b^2+a^2}}\right]\left[\frac{1}{b^2+a^2}\right]}$$

$$+ \frac{2Q}{4\pi\varepsilon_0 \left[\frac{ba_x + a \cdot a_y}{\sqrt{b^2+a^2}}\right]\left[\frac{1}{b^2+a^2}\right]}$$

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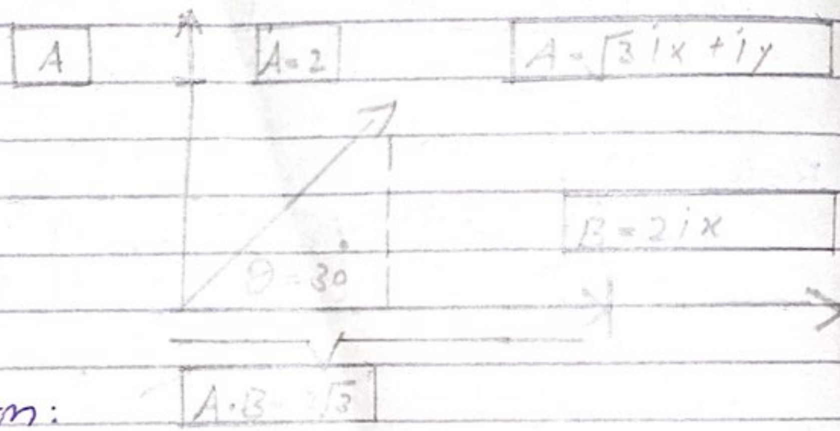
$$E = \frac{Q}{4\pi\varepsilon_0}\left[\frac{1}{\left[\frac{ba_x}{b}\right]\left[\frac{1}{b^2}\right]} + \frac{2}{\left[\frac{ba_x - a \cdot a_y}{\sqrt{b^2+a^2}}\right]\left[\frac{1}{b^2+a^2}\right]} + \frac{2}{\left[\frac{ba_x + a \cdot a_y}{\sqrt{b^2+a^2}}\right]\left[\frac{1}{b^2+a^2}\right]}\right]$$

$$E = \frac{Q}{4\pi\varepsilon_0}\left[\frac{1}{\left[\frac{ba_x}{b}\right]\left[\frac{1}{b^2}\right]} + \frac{2}{\left[\frac{ba_x - a \cdot a_y}{\sqrt{b^2+a^2}}\right]\left[\frac{1}{b^2+a^2}\right]} + \frac{2}{\left[\frac{ba_x + a \cdot a_y}{\sqrt{b^2+a^2}}\right]\left[\frac{1}{b^2+a^2}\right]}\right]$$

Q2

(a)

Find the angle between the vector Shown in figure.



Solution:

Part (a)

$A = \sqrt{3}\, 1x + 1y$

$|A| = 2$

$B = 2 1x$

$|B| = 2$

So

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

Now

$A \cdot B = |A||B| \cos \theta_{AB}$

$\cos \theta_{AB} = \frac{A \cdot B}{|A||B|}$

$\theta_{AB} = \cos^{-1}\left(\frac{\sqrt{3}}{1 \times 2}\right.$

$\boxed{\theta_{AB} = 30}$

Q2

Part (B)

Find the gradient of each of the following function where a and b are constant.

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

Solution:

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

$$\nabla f = \left(\frac{\partial}{\partial x} i + \frac{\partial}{\partial y} j + \frac{\partial}{\partial z} k\right)(ax^2 + by^3 z)$$

$$\nabla f = \frac{\partial}{\partial x} ax^2 i + \frac{\partial}{\partial y} by^3 z j + \frac{\partial}{\partial z} by^3 z k$$

Then Now

$$\nabla f = 2axi + 3bzy^2 j + by^3 k$$

Then we find

$$\boxed{\nabla f = 2axi + 3bzy^2 j + by^3 k}$$

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

Solation :

gradient in cos of spherical

$$\nabla f = \frac{\partial f}{\partial r}\hat{r} + \frac{1}{r}\frac{\partial f}{\partial \theta}\hat{\theta} + \frac{1}{r\sin\theta}\frac{\partial f}{\partial \phi}\hat{\phi}$$

so

$$\nabla f = \frac{\partial}{\partial r}(ar^2 \sin\phi + brz \cos 2\phi)\hat{r} + 1/r$$

$$\frac{\partial}{\partial \theta}(ar^2 \sin\phi + brz \cos 2\phi)\hat{\theta}$$

$$+ \frac{1}{r\sin\theta}\frac{\partial}{\partial \phi}(ar^2 \sin\phi + brz \cos 2\phi)\hat{\phi}$$

Then

$$\nabla f = (2ar \sin\phi + bz \cos 2\phi)\hat{r} + 1/r (2)$$

$$+ \frac{1}{r\sin\theta}(ar^2 \cos\phi - 2brz \sin\phi)\hat{\phi}$$

so

$$\nabla f = (2ar \sin\theta + bz \cos 2\theta)$$

$$(ar^2 \cos\phi - 2brz \sin\phi)\hat{r} + \frac{1}{r\sin\theta}$$

$$e(ar^2 \cos\theta - +2brz \sin\theta$$

In the case of cylindrical.

$$\nabla f = \frac{\partial f}{\partial \rho} \hat{\rho} + \frac{1}{\rho} \frac{\partial f}{\partial \phi} \hat{\phi} + \frac{\partial A_z}{\partial z}$$

$$\nabla f = 0 \hat{\rho} + \frac{1}{\rho} (a r^2 \cos \phi - 2 b r z \sin 2\phi) \hat{\phi}$$

$$+ (r \cos 2 \phi) . \hat{z}$$

Then the first term is zero (0)

$$Af = \frac{1}{\rho} (a r^2 \cos \phi) - 2 b r z \sin 2 \phi) \hat{\phi} .$$

$$+ (b r \cos 2 \phi) \hat{z} .$$