Department of Electrical Engineering
Assignment
Date: 14-04-2020

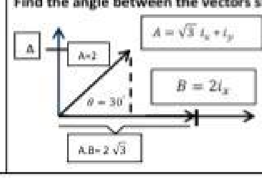
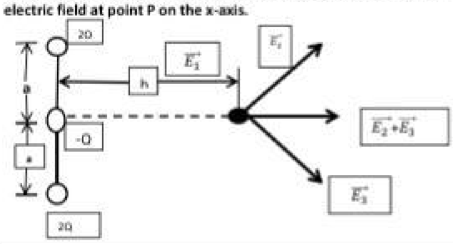
Course Details

Course Title: Electro Magnetic Field Theory **Module:** ____________

Instructor: ____________ **Total Marks:** 30

Student Details

Name: Syed M Zahoor **Student ID:** 12595

Q1: Solve the following short Question	(a)	Transform the vector $B = yi\ (x + z)j$ located at point (-2,6,3) into cylindrical coordinates	Marks 2 CLO 1
	(b)	Convert the point (3,4,5) from Cartesian to spherical coordinates	Marks 2 CLO 1
	(c)	Find the spherical coordinates of A(2,3,-1)	Marks 2 CLO 1
	(d)	Find the Cartesian coordinates of B(4.25,120)	Marks 2 CLO 1
	(e)	Find the force between two charges when they are brought in contact and separated by 4cm apart, charges are 2nC and -1nC, in μN.	Marks 2 CLO 2
	(f)	Find the electric field intensity of two Charges -2C and -1C separated by a distance 1m in air	Marks 2 CLO 2
	(g)	Determine the charge that produce an electric field strength of 40 v/cm at a distance of 30cm in vacuum (in 10^{-8}c)	Marks 2 CLO 2
	(h)	A charge of $2 * 10^{-7}$ C is acted upon by a force of 0.1N. determine the distance to the other charge of $4.5 * 10^{-7}$C, both the charges are in vacuum	Marks 2 CLO 2
Q2:	**(a)**	**Find the angle between the vectors shown in figure.** 	**Marks 4** **CLO 1**
	(b)	**Find the gradient of each of the following functions where a and b are constant** (i) $f = ax^2 + by^3z$ (ii) $f = ar^2 \sin \emptyset + brz \cos 2\emptyset$	**Marks 4** **CLO 1**
Q3:		**Three pointer charges are placed on the y-axis as shown. Find the electric field at point P on the x-axis.** 	**Marks 6** **CLO 2**

"Electro Magnetic field Theory"

Name : Syed. M. Zahoor

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Q②

(a) Transform The Vector $B = yi(x+Z)j$ located at point $(-2, 6, 3)$ into cylindrical Coordinates.

Solution :

Given Data

$B = yi(x+Z]j$

Point $(-2, 6, 3)$

Then

$B = yi(xj + Zj)$

$B = yxij + yZij$

As we know that

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

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

$= 5.83$

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

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

$= -71.565$

$z = z$

$z = 3$

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

Ans.

Q No. 1

(B) Convert The Point (3,4,5) from cartesian to spherical coordinate

Solution

Given Data:

Point (3,4,5)

$x = 3$
$y = 4$
$z = 5$

Find: Cartsain spherical = ?

As we know that

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

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

$r = 7.07$

$\phi = \tan^{-1} y/x = \tan^{-1}(4/3)$

$\phi = 55.13$

As

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

$= \cos^{-1}(5/7.07)$

$\theta = 45°$

as

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

QN.1

© Find The spherical coordinates of A(2, 3, -1)

Solution

$x = 2$

$y = 3$

$z = -1$

$A = (2, 3, -1)$

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

$= \sqrt{(2)^2 + 3^2 (-1)^2} = 3.74$

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

$= \cos^{-1}(-1/3.74)$

$= 105.5°$

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

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

$\boxed{= 56.3°}$

QN.1

D Find The Cartesian coordinates of

$B = (4, 25, 120)$

Solution:-

As we know That

The find (x, y, z)

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

$= 4 \sin 25 \cos 120$

$\boxed{= -0.84}$

$y = r \sin\theta \sin\theta$

$= 4 \sin 25 \sin 120$

$\boxed{y = 1.46}$

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

$\boxed{z = 3.62}$

Q No 1 (4)

(E) Find The force b/w two charges when they are brought in Contact and Separated by 4cm apart, charges are 2nc and -1nc, in μN.

Solution

We know that

The Coulomb's Law

$$f = \frac{K q_1 q_2}{d^2} \quad , \quad f = \frac{k q_1 q_2}{r^2}$$

wher constant

$$K = \frac{1}{4\pi\varepsilon_0} = \frac{2\times10^{-9}\times -1\times10^{-9}}{4\pi\times8.85\times10^{-12}\times(4\times10^{-2})^2}$$

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

$$\boxed{f = -11.23\,\mu N}$$

Q No 1

(F) Find The Electric field Intensity of two charges -2c and -1c Separated by a distance 1m in air:-

Solution:-

Given Data:

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

Find:- E_1, E_2

$$E = \frac{F}{Q}$$

As we know That

$$E = \frac{1}{4\pi\varepsilon}\frac{Q}{r^2}$$

$$E_1 = \frac{q_1}{4\pi\varepsilon_0 r}$$

$$= \frac{-2}{4\pi\times8.85\times10^{-12}\times1} = \boxed{-1.798\times10^{10}\,N/C}$$

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

Q No 1

(G) Determine The charge That produce an electric Field Strength of 40 v/cm at a distance of 30cm in vacuum (in $10^{-8}c$)

Solution:

Given Data

$E = 40 v/cm$ "change "cm" to "m"

$E = 4000 v/m$

$\pi = 3.14$

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

$\varepsilon_0 = 8.85 \times 10^{-12}$

Find: $q = ?$

The Coulomb's Law

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

$$q = E \times 4\pi \varepsilon_0 r^2$$

putting the value

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

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

Q.No 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 charge are in Vacuum:

Solution:

Given Data:

$q_1 = -2\times10^{-7}C$

$q_2 = 4.5\times10^{-7}C$

$F = 0.1N$

Find: $r = ?$

As we know That.

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

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

$$r^2 = \sqrt{\frac{2\times10^{-7}\times4.5\times10^{-7}}{4\pi\varepsilon_0(0.1)}}$$

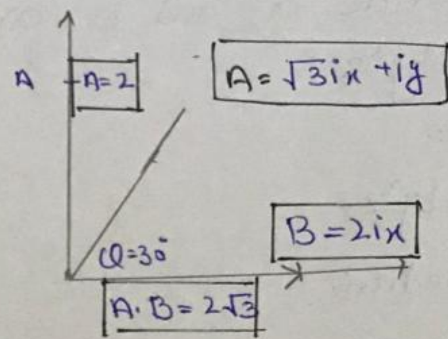
$$r^2 = \sqrt{0.09m}$$

Taking Square root

$$\boxed{r = 0.0899m}$$ Ans

①② ⑦

Ⓐ Find The angle b/w The Vector show figure



Solution:

Given Data:

$A = \sqrt{3}\hat{i}x + \hat{i}y$

$|A| = 2$

$|B| = 2\hat{i}x$

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

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

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

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

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

$$\theta_{AB} = 30^\circ$$

Q ② ⑧

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

① $f = ax^2 + by^3z$

Solution:

$f = ax + by^3z$

find gradient

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

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

the drivate to (x, y, z)

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

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

Solution

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

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

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

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

$\nabla f = (2ar\sin\phi + bz\cos 2\phi)\hat{r} + \frac{1}{r}(0) + \frac{1}{r\sin\phi}(-ar^2\cos\phi - 2brz\sin\phi)\hat{\phi}$

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

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

$\nabla f = 0\hat{\rho} + \frac{1}{f}(ar^2\cos\phi - 2brz\sin 2\phi)\hat{\phi} + (br\cos 2\phi)\hat{z}$

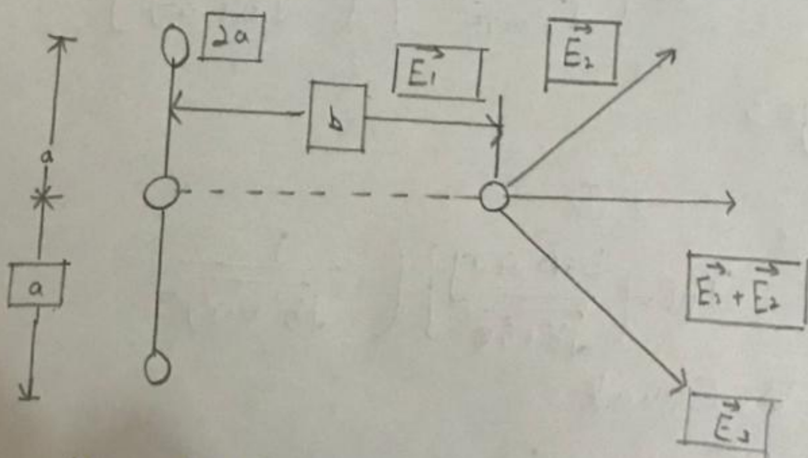
the first term is Zero (0)

$\nabla f = \frac{1}{f}(ar^2\cos\phi) - 2brz\sin 2\phi)\hat{\phi} + (br\cos 2\phi)\hat{z}$

Q No 03

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

Ans:



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

$r_2 = 0a_x + a \cdot a_y + 0 \cdot a_z$

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

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

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

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

$|r - r_1| = b$

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

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

Now

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

for Charge 1

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

Charge(2)

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

Charge 3

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

So is Equal

$$E = E_1 + E_2 + E_3$$

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

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

Take common $(4\pi\varepsilon_0)$

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

$$\frac{2}{\left(\frac{ba_x + a.a_y}{\sqrt{b^2+a^2}}\right]}\left(\frac{1}{b^2+a^2}\right]$$

So

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

$$\left. + \frac{2}{\left[\frac{ba_x + a.a_y}{\sqrt{b^2+a^2}}\right]}\left[\frac{1}{b^2+a^2}\right]\right]$$

* End *