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

Course Details

Course Title: Electro Magnetic Field Theory **Module:** 4th semester

Instructor: Dr Rafiq Mansoor **Total Marks:** 30 .

Student Details

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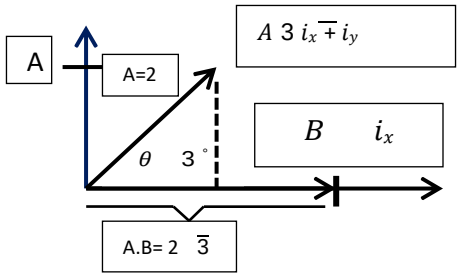
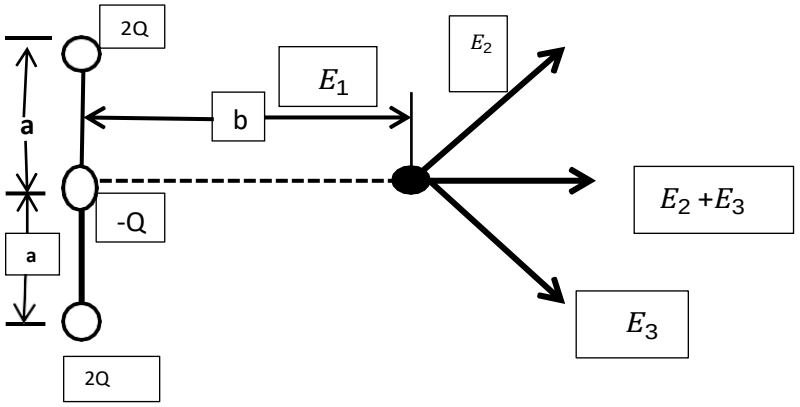
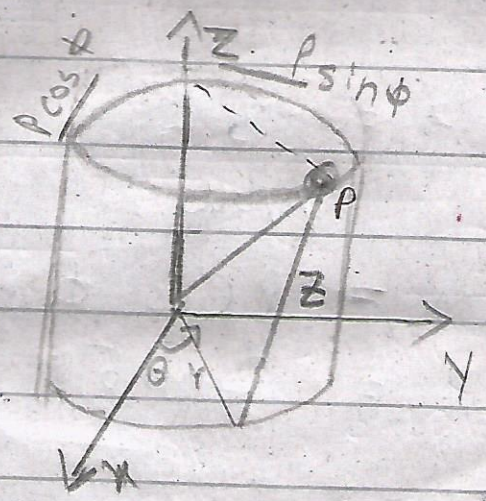
Q1: Solve the following short Question	(a)	Transform the vector ( ) located at point (-2,6,3) into cylindrical coordinates	Marks 2 CLO 1
	(b)	Convert the point (3,4,5) from Cartesian to spherical coordinates	Marks 2 CLO 1
	(c)	Find the spherical coordinates of A(2,3,-1)	Marks 2 CLO 1
	(d)	Find the Cartesian 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 c)	Marks 2 CLO 2
	(h)	A charge of C is acted upon by a force of 0.1N. determine the distance to the other charge of 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)** **(ii)**	**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**

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

(a) $B = y\,i\,(x+z)\,j$ located at Point $(-2, 6, 3)$ into Cylindrical coordinate



$x = \rho\cos\phi$

$y = \rho\sin\phi$

$z = z$

Sol:- $x = -2$

$y = 6$

$z = 3$

So Now find ρ

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

$$= \sqrt{4+36} = 6.324$$

$$\phi = \tan^{-1}\frac{6}{-2}$$

$$\phi = -1.24904$$

$$z = 3$$

Now

$$x = P\cos\phi$$

$$= 2.054$$

$$Y = P\sin\phi$$

$$= -5.98$$

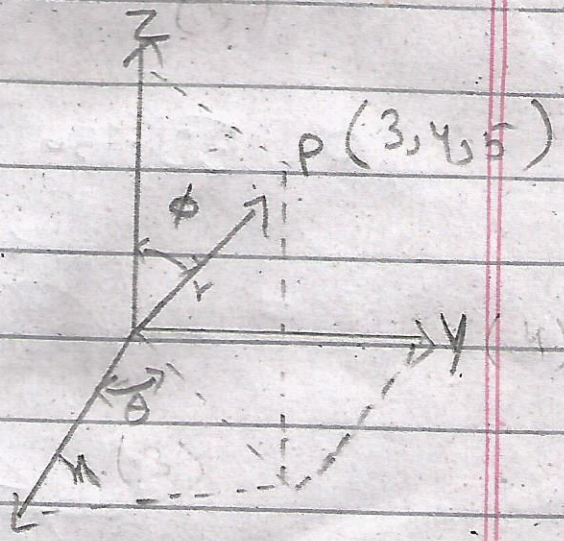
$$z = 3$$

So the answer is

$$B = -5.98i\ (2.054 + 3)j$$

(b)	Convert the point (3,4,5) from Cartesian to spherical coordinates	Marks 2
		CLO 1

b) Convert Point (3,4,5) from cartesian to spherical



Sol:-

first we find r

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

$$= \sqrt{9+16+25} = 7.07$$

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

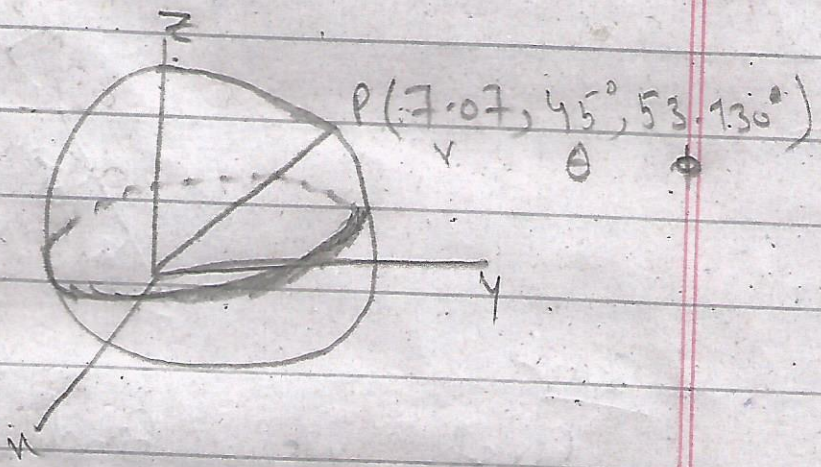
$$= \tan^{-1}\left(\frac{\sqrt{(3)^2+(4)^2}}{5}\right)$$

$$\theta = 45$$

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

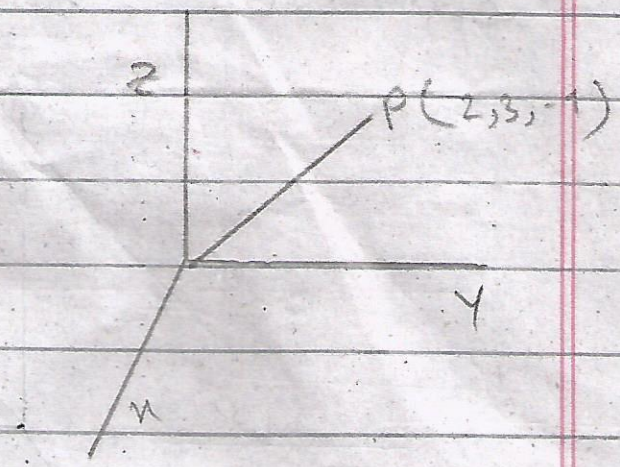
$$= \tan^{-1}\left(\frac{4}{3}\right)$$

ϕ 53.130°



(c)	Find the spherical coordinates of A(2,3,-1)	Marks 2 CLO 1

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



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

$$= \sqrt{4+9+1} = \sqrt{14}$$

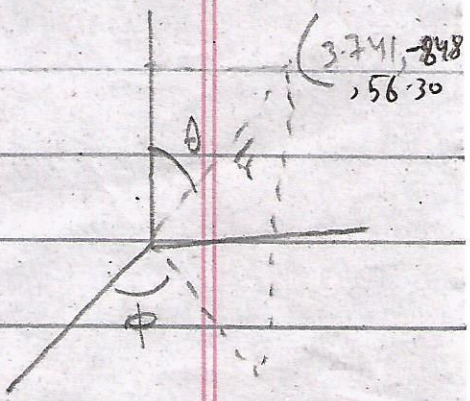
$$= 3.741$$

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

$$= -84.80^\circ$$

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

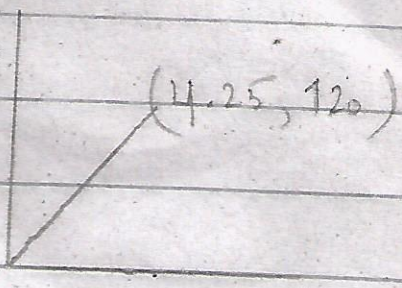
$$= 56.3093^\circ$$



(d)	Find the Cartesian coordinates of B(4.25,120)	Marks 2 CLO 1

d) Find cartesian coordinate

B(4.25, 120)



$B = 4.25a_x + 120a_y$

$|B| = \sqrt{(4.25)^2 + (120)^2}$

$= \sqrt{18.0625 + 14400} = 120.075$

$a_B = \frac{B}{|B|} = \frac{4.25a_x}{120.075} + \frac{120a_y}{120.075}$

$= 0.0353a_x + 0.993a_y$

(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

Ans (e) :-

Solr Given data

$r = 4cm$

$q_1 = 2nC$

$q_2 = -1nC$

$f = ?$

By using

$$F = \frac{Q_1 Q_2}{4\pi \varepsilon_0 R^2} = \frac{2 \times 10^{-9} \times -1 \times 10^{-9}}{4 \times 3.141 \times 8.84 \times 10^{-12} \times (4 \times 10^{-2})^2}$$

$$= \frac{-2 \times 10^{-18}}{111.065 \times 10^{-12} \times 16 \times 10^{-4}}$$

$$\Rightarrow \frac{-2 \times 10^{-18}}{1777.04 \times 10^{-16}} =$$

$$\Rightarrow -0.001125 \times 10^{-2}$$

$$= -1.125 \times 10^{-5}$$

$$= -1.125 \times 10^{-6} N$$

$$= -1.125 \mu N$$

(f)	Find the electric field intensity of two Charges -2C and -1C separated by a distance 1m in air	Marks 2
		CLO 2

f)

Given data

$q_1 = -2C$

$q_2 = -1C$

$r = 1m$

Find => electric field = ?

Sol:-

$$f = \frac{q_1 q_2}{4\pi\varepsilon_0 R^2}$$

$$= \frac{-2C \times -1C}{4 \times 3.141 \times 8.84 \times 10^{-12} \times (1)^2} =$$

$$\frac{1.800734994 \times 10^{10} N}{10}$$

$$= 1.800734994 \times 10^9 N$$

$$1.800734994\ gN$$

(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

Ans g)

Sol:-

Given data:-

$r = 30\ cm$

$E = 40\ V/cm$

find:- $q = ?\ in\ 10^{-8}$

$$F = \frac{k q}{r^2}$$

Now we find charge

$$r^2 \times F = \frac{k q}{r^2} \times r^2$$

$$q = \frac{r^2 F}{k}$$

$\because k = 9 \times 10^9$

$$q = \frac{(30 \times 10^{-2})^2 \times (40\ C)}{9 \times 10^9}$$

$$q = 4 \times 10^{-10}$$

$$q = 0.4\ C$$

(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

h) Given data :-

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

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

$f = 0.1 N$

$r = ?$

Soli- $f = \frac{k q_1 q_2}{r^2}$

$r^2 = \frac{k q_1 q_2}{f}$

$r^2 = \frac{9 \times 10^9 Nm^2 C^{-2} \times 2 \times 10^{-7} C \times 4.5 \times 10^{-7} C}{0.1 N}$

$r^2 = 0.0081 Nm^2$

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

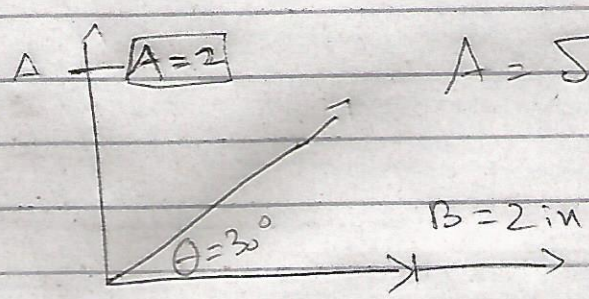
$r = 0.09 m$

Q2:	(a)	Find the angle between the vectors shown in figure.

Marks 4

CLO 1

Q2:- Angle b/w two vectors



$A = \sqrt{3}\,i + j$

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

Solution:-

Angle b/w this two vectors

$$\cos\theta = \frac{\vec{A}\cdot\vec{B}}{|a||b|} = \frac{2\sqrt{3}}{\sqrt{(2)^2+(\sqrt{3})^2}}$$

$$= \frac{2\sqrt{3}}{\sqrt{4+3}} = \frac{2\sqrt{3}}{2.645}$$

$$\cos\theta = \frac{2\sqrt{3}}{2.645}$$

$$\theta = \cos^{-1}\frac{2\sqrt{3}}{2.645}$$

$$\theta = \cos^{-1}\frac{3.464}{2.645}$$

$$= 54.73^\circ$$

(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

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

$\text{Grad}(f) = \vec{\nabla} f = \frac{df}{dx}\hat{i} + \frac{df}{dy}\hat{j} + \frac{df}{dz}\hat{k}$

$\vec{\nabla} f = \frac{d(ax^2+by^3z)}{dx}\hat{i} + \frac{d(ax^2+by^3z)}{dy}\hat{j} + \frac{d(ax^2+by^3z)}{dz}\hat{k}$

$= 2ax + 0\,\hat{i} + 0 + 3by^2z\,\hat{j} + 0 + by^3(1)\hat{k}$

$\vec{\nabla} f = 2ax\,\hat{i} + 3by^2z\,\hat{j} + by^3\,\hat{k}$

a & b are constant
so we take (1)

$\vec{\nabla} f = 2(1)x\,\hat{i} + 3(1)y^2z + (1)y^3\hat{k}$

$= 2x\,\hat{i} + 3y^2z + y^3\hat{k}$

$$f = ar^2 \sin\theta + brz\cos^2\theta$$

$$\text{Grad}(f) = \vec{\nabla} f = \frac{d(f)}{dr} + \frac{d(f)}{dz}$$

$$\vec{\nabla} f = \frac{d(ar^2\sin\theta + brz(\cos^2\theta)}{dr} + \frac{d(ar^2\sin\theta + brz(\cos^2\theta)}{dz}$$

$$\vec{\nabla} f = (2ar\sin\theta + b(1)z(\cos^2\theta)) + (0 + br(1)(\cos^2\theta)$$

$$= 2ar\sin\theta + bz\cos^2\theta + br\cos^2\theta$$

a & b are const so (1)

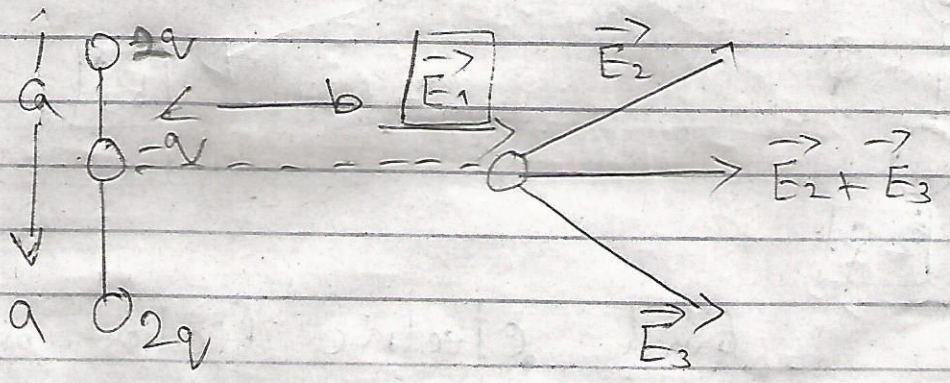
$$= 2(1)r\sin\theta + (1)z\cos^2\theta + (1)r\cos^2\theta$$

$$= 2r\sin\theta + z\cos^2\theta + r\cos^2\theta$$

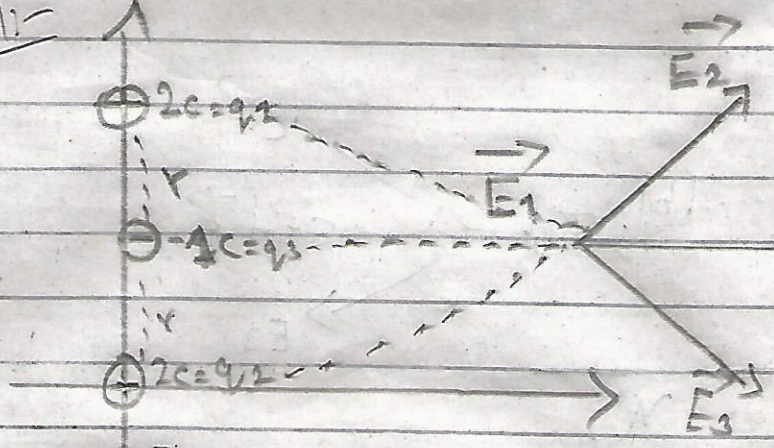
Q3:- Three Pointer charges are Placed on Y-axis find electric field on Point P on x-axis

Marks 6

CLO 2



Soli:-



$$\vec{E_1} = \frac{Kq_3}{r^2} = \frac{(9\times10^9 Nm^2C^{-2})\times(-1C)}{1} = -9\times10^9$$

$$\vec{E_2} = \frac{Kq_1}{r^2} = \frac{(9\times10^9 Nm^2C^{-2})(1C)}{(1m)} = 1.8\times10^{10}$$

$$\vec{E_3} = \frac{Kq_2}{r^2} = \frac{(9\times10^9 Nm^2C^{-2})(2)}{1} = 1.8\times10^{10}$$

$$\vec{E_1} = \vec{E_2} + \vec{E_3} = \left(1.8\times10^{10} + 1.8\times10^{10}\right)$$
$$= 3.6\times10^{10}$$

~~$E_{1x} = (\quad)\cos 45^\circ$~~

$$E_{1x} = (-9\times10^9)\cos 45 = -6.363\times10^9$$

$$E_{Tn} = \varepsilon_x + (\varepsilon_2 + \varepsilon_3)$$

$$= -6.383 \times 10^{9} + 3.6 \times 10^{10}$$

$$= 2.9637 \times 10^{10}$$

[So this is the electric field on Point P on X-axis]