S J P N Trust's

HirasugarInstitute ofTechnology, Nidasoshi.

Inculcating Values, Promoting Prosperity

Approved by AICTE, Recognized by Govt. of Karnataka and Affiliated to VTU Belagavi.

E&E Engg. Dept.
Exam.
Internal Assessment
Odd Sem(2017-18)

FIRST INTERNAL ASSESSMENT

Sem: III
Date: 16-09-2017

Sub: EMT
Time: 3.00PM – 4.00PM

Sub. Code: 15EC36
Max. Marks: 25

Note: Answer two full questions, draw sketches wherever necessary.

Q. No		Discription of Question	Marks	CO	PO.
1	a	Explain electic field intensity and derive E due number of charges.	7		
	b	Ten identical point charges of 500uC each are spaced equally around a circle of radius 2m. Find the force on a charge of -20uC located on the axis 2m from the plane of the circle.	6	CO206.1	PO1 - PO4
		OR			
2	a	Point charge of 50uC each are located at A(1,0,0), B(-1,0,0), C(0,1,0) & D(0,-1, 0) m. Find the force on a charge at A and also E at A.	7	CO206.1	PO6 - PO8
	b	Find the force between a charged circular loop of radius b, uniform charge density ρ_L and point charge Q located on the loop axis at a distance h from the plane of the loop. What is the force when i) $h >> b$ ii) h =0 iii) For what value of h interms of b maximum force acts.	6		PO12
3	a	Derive an expression for E due to an infinitesimal line charge.	6		
	b	A line charge of density 24nC/m is located in free space on the line y = 1 and z = 2m. a) Find E at point P(6, -1, 3). b) What point charge QA should be located at A(-3, 4,1) to make y component of total E zero at point P.	6	CO206.1	
		OR			
4	a	Two uniform line charges of density 4nC/m and 6nC/m are lie in x =0 plane at y = 5 and -6 m respectively. Find E at (4,0,5)m.	6	CO206.1	
	b	A point charge of 6uC is located at the origin, a uniform line charge density of 180nC/m lies along x- axis and uniform sheet of charge equal to 25nC/m^2 lies in the z =0 plane. Find i) D at A (1.2,4) and ii) Total electric flux leaving the sphere of 4m radius centered at origin.	6		

Course Coordinator **Module Coordinator** **HOD**

S J P N Trust's **Hirasugar Institute of Technology,Nidasoshi.** Inculcating Values, Promoting Prosperity Approved by AICTE and Affiliated to VTU Belgaum.	ECE Academic IA Scheme AY: 2017-18 (Odd)

I - IA SCHEME OF EVALUATION

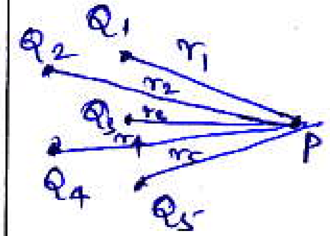
Sem : III	Subject : EMT	Sub Code : 15EC36	Date : 16-09-17

Q. No.	Bit	Description	Marks	Mapped CO's

1\. a. Definition of $\bar{E}$, $\bar{E} = \frac{Q}{4\pi\varepsilon r^2}\bar{a}_r$. — 2

When n number of charges are there

theory — 2

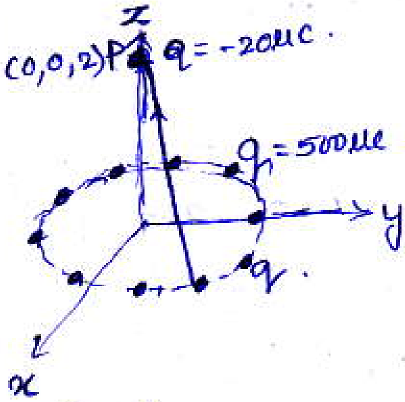


$$\bar{E} = \sum_{i=1}^{N} \frac{Q_i}{4\pi\varepsilon r_i}\bar{a}_{r_i}$$ — 3

7

CO206.1

b.



$q = 500\mu C$, $Q = -20\mu C$

$\bar{E}$ due to one charge is,

$$E_1 = \frac{Q}{4\pi\varepsilon r_{QP}}\bar{a}_{QP}$$

$$\bar{r}_{qp} = P - Q = -2\bar{a}_x + 2\bar{a}_z$$

$$|\bar{r}_{qp}| = \sqrt{4+4} = \sqrt{8}$$

$$\bar{a}_{qp} = \frac{-2\bar{a}_x + 2\bar{a}_z}{\sqrt{8}}$$ — 2

As there are ~~ten~~ charges. So for each charge there is a diametrically opposite charge to cancel r-component.

CO206.1

$$\therefore \text{total } \bar{E} = \frac{10 \times Q}{4\pi\varepsilon_0 |r_{qp}|^2}\bar{a}_{qp} \text{ V/m}$$ — 3

$$F = Q\bar{E} = -20\mu C \times 3.968 \times 10^6 \bar{a}_z$$

$$= -79.372\bar{a}_z N.$$ — 1

- IA SCHEME OF EVALUATION

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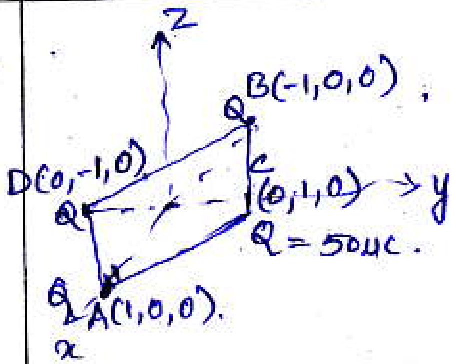
2.	a.			CO206.1



$\bar{F}_A = \bar{F}_{BA} + \bar{F}_{CA} + \bar{F}_{DA}$

$\bar{F}_{BA} = \frac{QQ}{4\pi\varepsilon_0 |\bar{r}_{BA}|^2} \bar{a}_{BA}$

$\bar{r}_{BA} = \bar{A} - \bar{B} = 2\bar{a}_x$

$|\bar{r}_{BA}| = \sqrt{4} = 2$

$\bar{a}_{BA} = \bar{a}_x$ — 1

$\bar{F}_{CA} = \frac{Q^2}{4\pi\varepsilon_0 |\bar{r}_{CA}|^2} \bar{a}_{CA}$; $\bar{r}_{CA} = \bar{A} - \bar{C} = \bar{a}_x - \bar{a}_y$

$|\bar{r}_{CA}| = \sqrt{1^2+1^2} = \sqrt{2}$

$\bar{a}_{CA} = \frac{\bar{a}_x - \bar{a}_y}{\sqrt{2}}$ — 1

$\bar{F}_{DA} = \frac{Q^2 \quad \bar{a}_{DA}}{4\pi\varepsilon_0 |\bar{r}_{DA}|^2}$; $\bar{r}_{DA} = \bar{A} - \bar{D} = a_x + \bar{a}_y$

$|\bar{r}_{DA}| = \sqrt{2}$

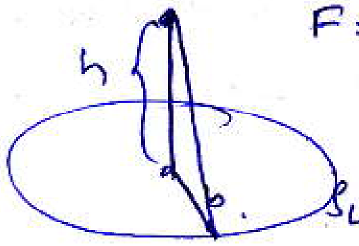
$\bar{a}_{DA} = \frac{\bar{a}_x + \bar{a}_y}{\sqrt{2}}$ — 1

$$\bar{F}_A = \frac{Q^2}{4\pi\varepsilon_0}\left\{\frac{\bar{a}_x}{4} + \frac{\bar{a}_x - \cancel{\bar{a}_y}}{2\sqrt{2}} + \frac{\bar{a}_x + \cancel{\bar{a}_y}}{2\sqrt{2}}\right\}$$ 4

$$= 50\times50\times10^{-12}\times8.98\times10^{9}\left\{\frac{\bar{a}_x}{4} + \frac{2\bar{a}_x}{2\sqrt{2}}\right\}$$

$= \underline{21\cdot47.361\,\bar{a}_x\,N}$. , $\bar{E} = 426 \times 10^3$ V/m

	b.			



$F = Q\bar{E} = \frac{\rho_L b h Q}{2\varepsilon_0 (b^2+h^2)^{3/2}} \bar{a}_n$ — 2

i) h >> b ; ~~F=~~

$F = \frac{Q\rho_L b}{2\varepsilon_0 h^2}$ — 1

- IA SCHEME OF EVALUATION

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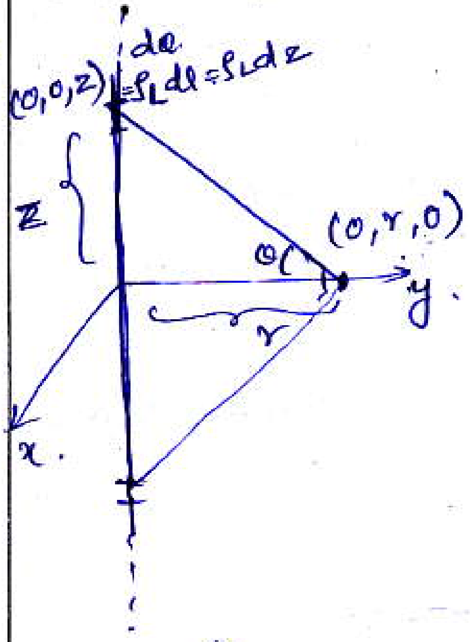
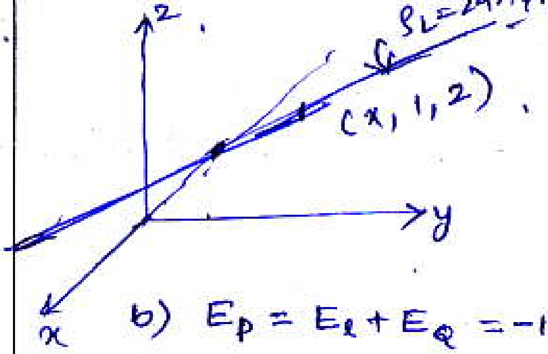
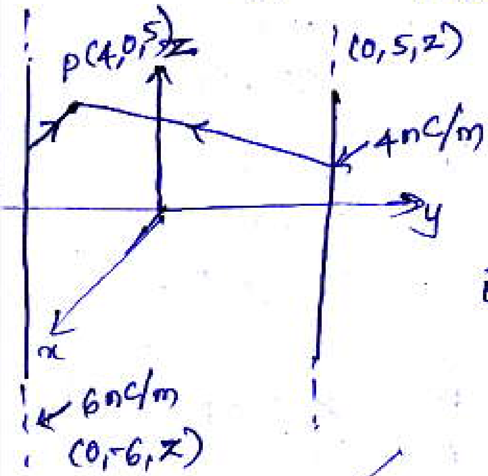
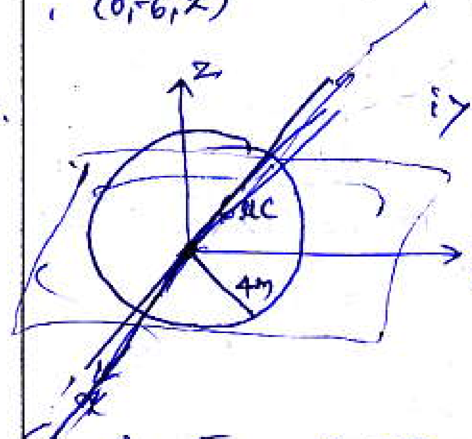
2.	b.	ii) $h = 0$; $F = 0$. as force is due to radial components and the radial force has equal amount of negative value also. iii) $\left\| \frac{dF_{max}}{dh} \right\| = 0 \longrightarrow h = b/\sqrt{2}$	1 2	CO206.1
3.	a.	 $d\bar{E} = \frac{\rho_L dz \, (r\bar{a}_y - z\bar{a}_z)}{4\pi\varepsilon_0 (r^2+z^2)^{3/2}}$ As for every charge on (+)ve z-axis there is equal charge present on the negative z-axis Hence z-component of E due to entire line charge will not have z-component. $\therefore \bar{E} = \int_{-\infty}^{\infty} d\bar{E}$ $\therefore \bar{E} = \int_{-\infty}^{\infty} \frac{\rho_L dz}{4\pi\varepsilon_0 (r^2+z^2)^{3/2}} r\bar{a}_y$ let $z = r\tan\theta \Rightarrow dz = r\sec^2\theta d\theta$ $z = -\infty, \theta = -\pi/2$; $z = \infty, \theta = \pi/2$ $\therefore \bar{E} = \int_{-\pi/2}^{\pi/2} \frac{\rho_L r \sec^2\theta d\theta}{4\pi\varepsilon_0 (r^2 + r^2\tan^2\theta)} \bar{a}_y$ $= \int_{-\pi/2}^{\pi/2} \frac{\rho_L}{4\pi\varepsilon_0 r} \cos\theta d\theta \, \bar{a}_y$ $\bar{E} = \frac{\rho_L}{2\pi\varepsilon_0 r} \bar{a}_y$ V/m .	2 1 1 2	CO206.1

- IA SCHEME OF EVALUATION

Sem : III | **Subject :** 15EC36 | **Sub Code :** 15EC36 | **Date :** 16-09-17

Q. No.	Bit	Description	Marks	Mapped CO's
	b.	 $\rho_L = 24 nC/m$. $(x,1,2)$ a) $\bar{E} = \frac{\rho_L}{2\pi\epsilon_0 r}\bar{a}_r$ $= -172.56\bar{a}_y + 86.28\bar{a}_z V/m$. b) $E_p = E_l + E_Q = -172.56\bar{a}_y + 86.2\bar{a}_z + \frac{Q_A \times 8.98}{(110)^{3/2}}\{9\bar{a}_x - 5\bar{a}_y + 2\bar{a}_z\}$ $Q_A = -4.431 \mu C$.	2 2 2 2	CO206.1
4.	a.	 $P(4,0,5)$ $(0,5,z)$ $4nC/m$ $6nC/m$ $(0,-6,z)$ $\bar{E} = \bar{E}_1 + \bar{E}_2$ $\bar{r}_{1P} = 4\bar{a}_x - 5\bar{a}_y$ $\bar{r}_{2P} = 4\bar{a}_x + 6\bar{a}_y$ $\bar{E} = 15.311\bar{a}_x + 3.67\bar{a}_y V/m$.		CO206.1
	b.	 i) $D_1 = \frac{Q}{4\pi r^2}\bar{a}_r$ $4.96\bar{a}_x + 9.923\bar{a}_y + 0.98\bar{a}_y nC/m^2$ $D_2 = \frac{\rho_L}{2\pi r}\bar{a}_r$ $= 2.864\bar{a}_y + 5.72\bar{a}_z nC/m^2$ & $\bar{D}_3 = \rho_s/2\,\bar{a}_z = 12.5\times10^{-9}\bar{a}_z C/m^2$ $\bar{D} = \bar{D}_1 + \bar{D}_2 + \bar{D}_3 = 4.96\bar{a}_x + 12.78\bar{a}_y + 38.07\bar{a}_z nC/m^2$ ii) Total flux leaving = charge enclosed $= Q + \rho_L \times L + \rho_s S$ $= 8.69 \mu C$	2 2 2	CO206.1

Course Coordinator

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HOD