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ECE Dept.
Exam.
Internal Assessment
Odd Sem(2018-19)

FIRST INTERNAL ASSESSMENT

Sem: III
Date: 12-09-2018

Sub: Engg. Electromagnetics
Time: 3.00-4.00PM

Sub. Code:17EC36
Max. Marks:30

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

Q. No		Description of Question	Marks	CO	RBT LEVEL
1	a	Two point charges 20nC and -20nC are situated at (1,0,0)m and (0,1,0)m in free space. Determine Electric field intensity at (0,0,1)m.	8	C206.1	L2
	b	Calculate the total charge within each of the indicated volumes a) $\rho_v = r^2z^2\sin 0.6\varphi$; for $0 \leq r \leq 0.1, 2 \leq z \leq 4$ b) $\rho_v = (e^{-2r})/r^2$; over the universe.	7	C206.1	L2
		OR			
2	a	State and explain the electric field intensity and obtain an expression for Electric field intensity due to 'N' number of charges	8	C206.1	L1
	b	Ten identical charges of 500μC each are spaced equally around a circle of radius 2m. Find the force on a charge of -20μC located on the axis, 2m from the plane of the circle.	7	C206.1	L3
3	a	Derive an expression for electric field intensity due to a uniform line charge.	8	C206.1	L2
	b	Infinite uniform line charge of 5nC/m lie along the x and y axes in free space. Find E at P (0,3,4).	7	C206.1	L2
		OR			
4	a	A 60μC point charge located at the origin, find the total electric flux passing through: i)The portion of the sphere with r = 26cm bounded by $0 \leq \theta \leq \pi/2$, $0 \leq \varphi \leq \pi/2$, ii) The closed surface defined by r= 26cm, and z= ±26cm iii) The plane z= 26cm	8	C206.1	L3
	b	State and prove gauss law for a point charge	7	C206.1	L2

Course Coordinator

(Prof. S. S. Kamate)

M.M. Gadag

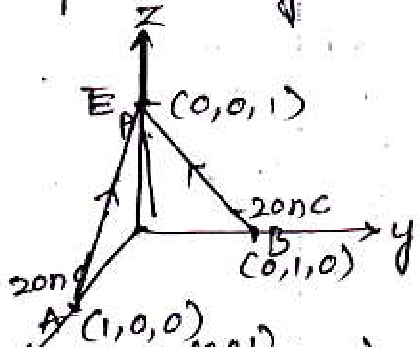
Module Coordinator

(Prof. M. M. Gadag)

HOD

(Dr. V. G. Kasabegoudar)

IA -I SCHEME OF EVALUATION

Sem : 3.		Subject : EMT Sub Code : 17EC36	Date : 12-09-2018		
Q. No.	**Bit**	**Description**	**Marks**	**CO's**	**RBT LEVEL**
1.	a.	Two point charges 20nC, -20nC.  $\bar{E}_p = \bar{E}_1 + \bar{E}_2$ $\bar{E}_1$ field due to the charge at at (1,0,0). $\bar{E}_1 = \frac{Q}{4\pi\varepsilon_0 r_{AP}^2}\bar{a}_{r_{AP}}$ $\bar{E}_2 = \frac{Q}{4\pi\varepsilon_0 r_{BP}^2}\bar{a}_{r_{BP}}$ $\bar{r}_{AP} = \overset{(0,0,1)}{\bar{P}} - \overset{(1,0,0)}{\bar{A}} = -\bar{a}_x + \bar{a}_z ; \bar{a}_{r_{AP}} = \frac{-\bar{a}_x + \bar{a}_z}{\sqrt{2}}$ $\bar{r}_{BP} = \bar{P} - \bar{B} = -\bar{a}_y + \bar{a}_z ; \bar{a}_{r_{BP}} = \frac{-\bar{a}_y + \bar{a}_z}{\sqrt{2}}$ $\therefore \bar{E} = \frac{20\times10^{-9}\times8.98\times10^{9}}{2}\left\{\frac{-\bar{a}_x + \cancel{\bar{a}_z} + \bar{a}_y - \cancel{\bar{a}_z}}{\sqrt{2}}\right\}$ $= -63.49\bar{a}_x + 63.49\bar{a}_y$ V/m.	8	C206.1	L2
	b.	Charge density with the volume Cylinder is, a) $\rho_v = r^2 z^2 \sin 0.6\phi$; $\therefore Q = \int_v \rho_v dv = \int_r \int_\phi \int_z r^2 z^2 \sin 0.6\phi \, r\,dr\,d\phi\,dz$ $= \frac{r^3}{3}\Big\rvert_0^{0.1} \frac{z^3}{3}\Big\rvert_2^4 \frac{-\cos 0.6\phi}{0.6}\Big\rvert_{\phi=0}^{2\pi}$ $= 1.018$ mC	7	C206.1	L2
		b) $\rho_v = e^{-2r}/r^2$; over the universe $Q = \int_{Vol} \rho_v dv = \int_{r=0}^{\infty}\int_0^{\pi}\int_0^{2\pi} \frac{e^{-2r}}{r^2} r^2 \sin\theta\, d\theta\, dr\, d\phi$ $= \left[\frac{e^{-2r}}{-2}\right]_{r=0}^{\infty} \cdot 4\pi.$ $= 2\pi$ $Q = 6.28C$.			

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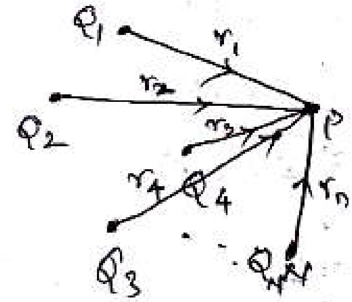
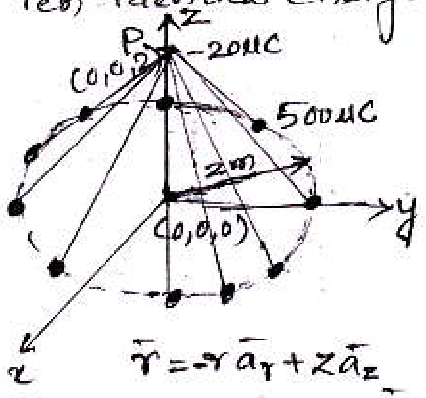
IA -1 SCHEME OF EVALUATION

Sem : 3 | **Subject :** EMT | **Sub Code :** 17EC36 | **Date :** 12-09-18

Q. No.	**Bit**	**Description**	**Marks**	**CO's**	**RBT LEVEL**
2.	a.	Electric Field Intensity : Force experienced by a unit positive charge placed at a point in the field region of base charge Q. $(\bar{E})$ V/m $\bar{E} = \bar{F}/c = \frac{Q}{4\pi\epsilon_0 r^2}\bar{a}_r$ V/m.  If N charges are located at different places.  $\bar{E}_p = \bar{E}_1 + \bar{E}_2 + \bar{E}_3 + \bar{E}_4 \ldots$ $= \frac{Q_1}{4\pi\epsilon_0 r_1^2}\bar{a}_{r_1} + \frac{Q_2}{4\pi\epsilon_0 r_2^2}\bar{a}_{r_2} + \ldots$ $= \sum_{i=1}^{N} \frac{Q_i}{4\pi\epsilon_0 r_i^2}\bar{a}_{r_i}$ V/m.	8	C0206.1	L1
	b.	Ten identical charges  $\bar{F} = \bar{E}QN.$ $\bar{E} = \frac{Q}{4\pi\epsilon_0 r^2}\bar{a}_r$ $= \frac{500\times10^{-6}\times8.98\times10^{9}}{(\sqrt{8})^2}10\times\bar{a}_z 2$ $\bar{r} = -r\bar{a}_r + z\bar{a}_z$ $= -2\bar{a}_r + 2\bar{a}_z$ $\lvert\bar{r}\rvert = \sqrt{4+4} = \sqrt{8}$ $= 1.984\bar{a}_z \times 2\times10^{6}$ Now, $\bar{F} = -20\times10^{-6}\times1.984\bar{a}_z 2\times10^{6}$ $= -79.44\,\bar{a}_z$ N. This is the Force on the charge at P. As charges are located diametrically opposite they will cancel the radial Components of each other.	7	C206.1	L3

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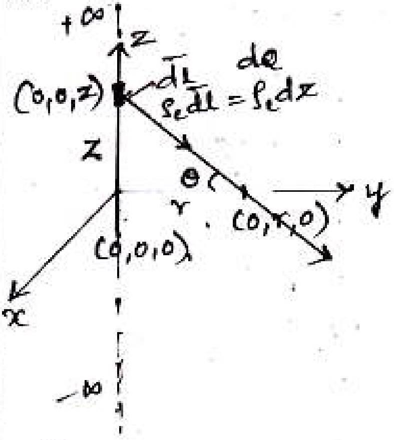
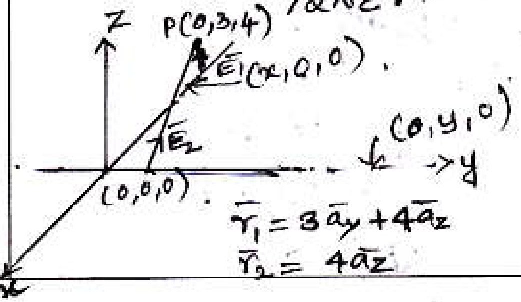
IA -I SCHEME OF EVALUATION

Sem : 3	**Subject :** EMT	**Sub Code :** 17EC36	**Date :** 12-09-18

Q. No.	**Bit**	**Description**	**Marks**	**CO's**	**RBT LEVEL**
3.	a.	An $\bar{E}$ due to entire line charges along the z-axis  The E due to line charge along z-axis with ρ_L(C/m) density, running from $-\infty$ to ∞. $dE = \frac{dQ.}{4\pi\epsilon_0 r^2}\bar{a}_r$ $\bar{r}_{dlp} = P - dl = r\bar{a}_y - z\bar{a}_z$ $\lvert\bar{r}_{dlp}\rvert = \sqrt{r^2+z^2}$ $\bar{a}_{r_{dlp}} = \frac{r\bar{a}_y - z\bar{a}_z}{\sqrt{r^2+z^2}}$ As $d\bar{E} = \frac{\rho_L dz}{4\pi\epsilon_0 (r^2+z^2)^{3/2}}(r\bar{a}_y - z\bar{a}_z)$ Now, when another element is considered at (0, 0, -z) then dE_2 of which is going to have $+z\bar{a}_z$ Component. ∴ z component will Cancel. $\therefore d\bar{E} = \frac{\rho_L dz\, r\bar{a}_y}{4\pi\epsilon_0 (r^2+z^2)^{3/2}}$ $\therefore \bar{E} = \int_{-\infty}^{\infty} d\bar{E} = \int_{-\infty}^{\infty} \frac{\rho_L dz\, r\bar{a}_y}{4\pi\epsilon_0 (r^2+z^2)^{3/2}}\, r\bar{a}_y$ when $z = r\tan\theta$, $dz = r^2\sec^2\theta d\theta$, $\bar{E} = \int_{-\pi/2}^{\pi/2} \frac{\rho_L r^2 \sec^2\theta d\theta\, r\, \bar{a}_y}{4\pi\epsilon_0 (r^2+r^2\tan^2\theta)^{3/2}} = \frac{\rho_L}{4\pi\epsilon_0 r}\int_{-\pi/2}^{\pi/2}\cos\theta d\theta.$ $= \rho_L / 2\pi\epsilon r\, \bar{a}_y$	8 7	C206.1 C206.1	L_2
	b.	 $\bar{r}_1 = 3\bar{a}_y + 4\bar{a}_z$ $\bar{r}_2 = 4\bar{a}_z$ $\bar{E} = \bar{E}_1 + \bar{E}_2 = 10.78\bar{a}_y + 36.4\bar{a}_z$ V/m $\bar{E}_1 = \frac{\rho_L}{2\pi\epsilon_0 r}\bar{a}_y = \frac{5\times10^{-9}}{2\pi\epsilon_0 \times 5}\frac{(3\bar{a}_y+4\bar{a}_z)}{5}$ $10.78\bar{a}_y + 14.37\bar{a}_z$ $\bar{E}_2 = \frac{\rho_L}{2\pi\epsilon_0 r}\bar{a}_r = \frac{5\times10^{-9}}{2\pi\epsilon 4}\frac{4\bar{a}_z}{4}$ $= 22.46$ V/m.		c206.1	L_2

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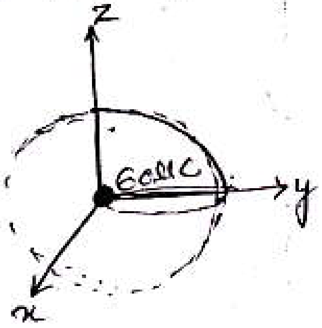
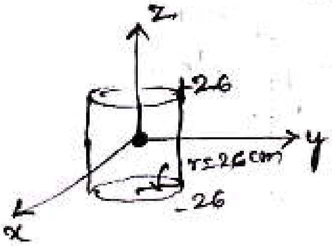
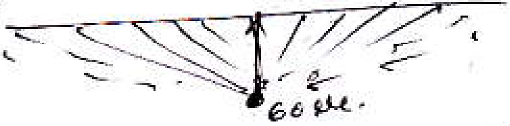
IA - SCHEME OF EVALUATION

Sem : 3	Subject : EMT	Sub Code : 17EC36	Date : 12-09-18

Q. No.	Bit	Description	Marks	CO's	RBT LEVEL
A.	a.	$Q = 60\mu C$,  i) $r = 26cm, 0<\theta<\pi/2, 0<\phi<\pi/2$ The area covered is, $S_{r_a} = \int_{0}^{\pi/2}\int_{\phi=0}^{\pi/2} r^2 \sin\theta\, d\theta\, d\phi$ $= \frac{\pi}{2} r^2$	1		
		∴ The total area of the Sphere is, $4\pi r^2$ Which encloses 60µC of charge. ∴ Total area of the region is $\frac{1}{8}Q = 7.5\mu C$.	8	C206.1	L3
		ii) The closed surface defined by $r = 26cm$, $z = \pm 26cm$  As the closed surface encloses total charge $Q = 60\mu C$.			
		iii) $z = 26cm$  The plane is infinite so, it can pass almost half the flux as that of the charge. ∴ $\psi = Q = \frac{60\mu C}{2}$ $= \underline{30\mu C}$	7	C206.1	L2
	b.	<u>Gauss law</u>: The electric flux passing through any of the closed surface is equal to the charge enclosed by that~~ev~~ surface. $\psi = Q$  $\psi = \bar{D}.\bar{s}$ $d\psi = \bar{D}_n ds$ $\psi = \int \bar{D}.d\bar{s}$.  $\Psi = \int \bar{D}.d\bar{s}$ $= \int \frac{Q}{4\pi r^2} \bar{a}_r d\bar{s}_r$ $\Psi = Q$.			

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