	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)

THIRD INTERNAL ASSESSMENT

Sem: III
Date: 20-11-2017

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
1	a	Whetcher the following potential fields satisfy the Laplace's equation or not? i) $V = [Ar^4 + B r^{-4}]\sin 4\Phi$ ii) $V = r\cos\Theta + \Phi$	6	CO206.3
	b	Derive an expression for magnetic field intensity H due to a long straight conductor.	6	CO206.3
OR				
2	a	Use Laplace's equation to find the capacitance per unit length of a co-axial cable of inner radius 'a' m and outer radius 'b' m. Assume $V=V_0$ at r=a and V=0 at r=b.	6	CO206.3
	b	State and prove Stoke's theorem including the concept of curl.	6	CO206.4
3	a	A current element $I_1\Delta L1 = 10^{-5} a_z$ A.m is located at P1(1,0,0) while the other element $I_2\Delta L2 = 10^{-5}(0.6a_x - 2a_y + 3a_z)$ A.m is at P2 (-1,0,0) both in free space. Find the vector force exerted on $I_2\Delta L2$ by $I_1\Delta L1$.	6	CO206.4
	b	Explain the concept of displacement current with relevant equations.	7	CO206.5
OR				
4	a	Derive the boundary conditions at the interface of two magnetic materials	6	CO206.5
	b	Briefly explain Maxwell's equations.	7	CO206.5

PO1-PO3
PO6-PO8
PO12

Course Coordinator   Module Coordinator   HOD

III - IA SCHEME OF EVALUATION

Sem : 3	Subject : EMT		Sub Code : 15EC36	Date : 20-11-17	
Q. No.	Bit	Description		Marks	Mapped CO's
1	a.	i) $V = [Ar^4 + Br^{-4}] \sin 4\phi$ Cylindrical system. $\nabla^2 V = \frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial V}{\partial r}\right) + \frac{1}{r^2}\left(\frac{\partial^2 V}{\partial \phi^2}\right) + \frac{\partial^2 V}{\partial z^2}$ $\frac{1}{r}\frac{\partial}{\partial r}\left[r\frac{\partial V}{\partial r}\right] = \frac{\sin 4\phi}{r}\left[16Ar^3 + 16Br^{-5}\right]$ $\frac{1}{r^2}\frac{\partial^2 V}{\partial \phi^2} = -\sin 4\phi\left[16Ar^2 + 16Br^{-6}\right]$ $\frac{\partial^2 V}{\partial z^2} = 0.$ $\nabla^2 V = \sin 4\phi\left[16Ar^2 + 16Br^{-6}\right] - \sin 4\phi\left[16Ar^2 + 16Br^{-6}\right] = 0.$		1/2 2 1/2	CO206.4
	b	ii) $V = r\cos\theta + \phi$. Spherical system. $\nabla^2 V = \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial V}{\partial r}\right) + \frac{1}{r^2\sin\theta}\frac{\partial}{\partial \theta}\left(\sin\theta\frac{\partial V}{\partial \theta}\right) + \frac{1}{r^2\sin^2\theta}\frac{\partial^2 V}{\partial \phi^2}$ $\frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial V}{\partial r}\right) = r^2\frac{\partial}{\partial r}\left[r\cos\theta + \phi\right] = r^2\cos\theta$ $\sin\theta\frac{\partial V}{\partial \theta} = \sin\theta\frac{\partial}{\partial \theta}\left[r\cos\theta + \phi\right] = -r^2\sin\theta$ $\frac{1}{r^2\sin^2\theta}\frac{\partial^2 V}{\partial \phi^2} = \frac{1}{r^2\sin^2\theta}\frac{\partial^2}{\partial \phi^2}\left[r\cos\theta + \phi\right] = 0.$ $= \frac{2}{r}\cos\theta - \frac{2}{r}\cos\theta = 0.$		1/2 2 1/2	
	b.	An expression for H due to infinite length long straight conductor.			

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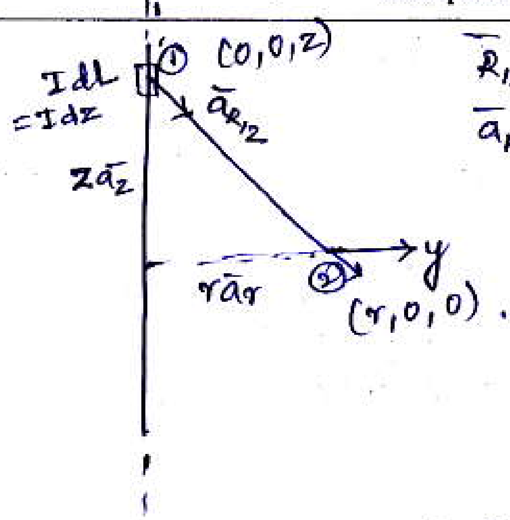
II - IA SCHEME OF EVALUATION

Sem : 3	Subject : EMI.	Sub Code : 15EC36	Date : 20-11-17

Q. No.	Bit	Description	Marks	Mapped CO's
1.	b.			CO206.5

$$\bar{R}_{12} = r\bar{a}_r - z\bar{a}_z$$

$$\bar{a}_{R_{12}} = \frac{r\bar{a}_r - z\bar{a}_z}{\sqrt{r^2+z^2}}$$

$$d\bar{L}\times\bar{a}_{R_{12}} = rdz\bar{a}_\phi$$

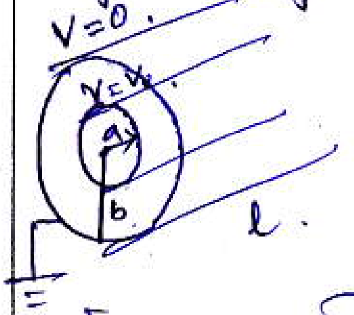
$$\begin{vmatrix} \bar{a}_r & r\bar{a}_\phi & \bar{a}_z \\ 0 & 0 & dz \\ r & 0 & -z \end{vmatrix}$$

$$Id\bar{L}\times\bar{a}_{R_{12}} = \frac{Irdz\bar{a}_\phi}{\sqrt{r^2+z^2}};\quad d\bar{H} = \frac{Irdz\bar{a}_\phi}{4\pi(r^2+z^2)^{3/2}}$$

$$\bar{H} = \int_{z=-\infty}^{\infty}\frac{Irdz\bar{a}_\phi}{4\pi(r^2+z^2)^{3/2}};\quad z = r\tan\theta,\ dz = r\sec^2\theta$$ — 6.

$$= \int_{-\pi/2}^{\pi/2}\frac{I}{4\pi r}\cos\theta d\theta = \frac{2I}{4\pi r}\bar{a}_\phi = \frac{I}{2\pi r}\bar{a}_\phi\ \mathrm{wb/m^2}.$$

Q. No.	Bit	Description	Marks	Mapped CO's
2	a.	Capacitance per unit length of co-axial cable.		CO206.5



$$\nabla^2 V = \frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial V}{\partial r}\right) = 0.$$

$$V = c_1 \ln r + c_2.$$

$$V = \frac{-V_0}{\ln(b/a)}\ln r - \frac{V_0\ln(b)}{\ln(a/b)}$$

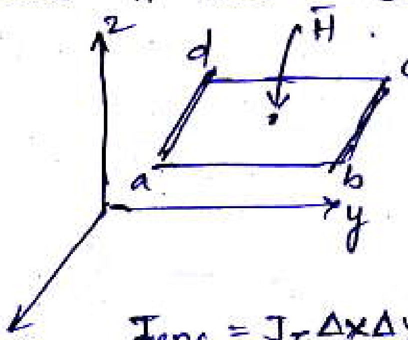
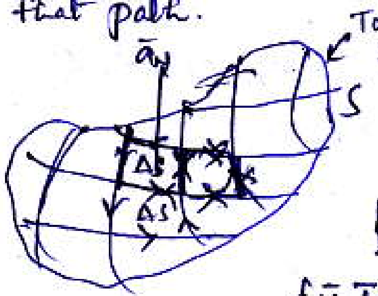
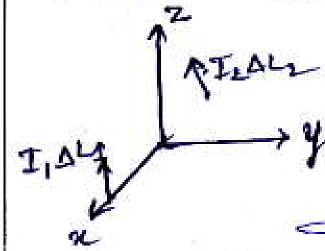
$$\bar{E} = -\nabla V = -\frac{\partial V}{\partial r}\bar{a}_r = \frac{-V_0}{r\ln(a/b)}\bar{a}_r\ \mathrm{V/m}.$$

$$\bar{D} = \epsilon\bar{E} = \frac{-V_0\epsilon}{r\ln(a/b)}\bar{a}_r = \frac{V_0\epsilon}{r\ln(b/a)}\bar{a}_r\ \mathrm{C/m^2}.$$ — 6

$$C = Q/V = \frac{V_0\epsilon 2\pi L\ \cancel{V_0}}{\ln(b/a)\ \cancel{V_0}} = \frac{2\pi\epsilon L}{\ln(b/a)}\ F$$ //

III - IA SCHEME OF EVALUATION

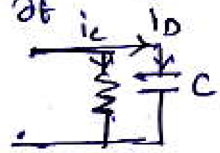
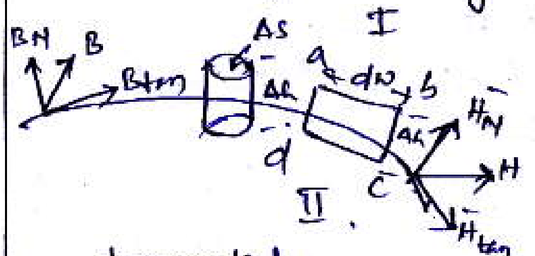
Sem : 3	Subject : EMT .	Sub Code : 15EC36	Date : 20/11/17

Q. No.	Bit	Description	Marks	Mapped CO's
2.	b.	Curl. $\bar{H} = H_{x0}\bar{a}_x + H_{y0}\bar{a}_y + H_{z0}\bar{a}_z$ ·  $\bar{J} = J_x\bar{a}_x + J_y\bar{a}_y + J_z\bar{a}_z$ $\oint \bar{H}\cdot d\bar{l} = \Delta x \Delta y \left[\frac{\partial H_y}{\partial x} - \frac{\partial H_x}{\partial y}\right]$ $\frac{\oint \bar{H}\cdot d\bar{l}}{\Delta S_z} = \frac{\partial H_y}{\partial x} - \frac{\partial H_x}{\partial y}$ $I_{enc} = J_z \Delta x \Delta y$ $\lim_{\Delta y \Delta z \to 0} \frac{\oint \bar{H}\cdot d\bar{l}}{\Delta y \Delta z} = J_x = \frac{\partial H_z}{\partial y} - \frac{\partial H_y}{\partial z}$; $\lim_{\Delta s \to} \frac{\oint \bar{H}\cdot d\bar{l}}{\Delta x \Delta z} = \left[\frac{\partial H_x}{\partial z} - \frac{\partial H_z}{\partial x}\right] J_y$. $\text{Curl}\,\bar{H} = \nabla \times \bar{H} = \bar{J}$ .. Stoke's theorem : " The line integral of a vector around a closed path L is equal to the integral of curl of $\bar{A}$ over the open surface S enclosed by that path.  $(\nabla \times \bar{H})_N = \frac{\oint \bar{H}\cdot d\bar{l}_{\Delta s}}{\Delta s}$ $(\nabla \times \bar{H})_N = (\nabla \times \bar{H}) \cdot \bar{a}_N$ $\oint \bar{H}\cdot d\bar{l}_{\Delta s} = (\nabla \times \bar{H}) \cdot \bar{a}_N \Delta s$. $\oint \bar{H}\cdot d\bar{l} = \int_S (\nabla \times \bar{H}) \cdot d\bar{s}$.	6	CO206.5
3.	a.	$I_1\bar{\Delta L}_1 = 10^{-5}\bar{a}_z$, $I_2\bar{\Delta L}_2 = 10^{-5}(0.6\bar{a}_x - 2\bar{a}_y + 3\bar{a}_z)$  $F_2 = I_2\bar{\Delta L}_2 \times d\bar{B}_1$ $= 10^{-5}(0.6\bar{a}_x - 2\bar{a}_y + 3\bar{a}_z) \times d\bar{B}_1$. $= (7.5\bar{a}_x - 1.5\bar{a}_z)\, 10^{-18}\, N$. $dB_1 = \mu_0 d\bar{H}_1 = \frac{\mu_0 I_1\bar{\Delta L}_1 \times \bar{a}_{R12}}{4\pi (R_{12})^2}$ $= \frac{4\pi \times 10^{-7}(10^{-5}\bar{a}_z) \times (-\bar{a}_x)}{4\pi\, 2^2} = \frac{-10^{-5}}{16\pi} \bar{a}_y\, A/m$.	6	CO205.5

Course Coordinator Module Coordinator HOD

III - IA SCHEME OF EVALUATION

Sem : 3	Subject : EMT	Sub Code : 15E36	Date : 20/11/17

Q. No.	Bit	Description	Marks	Mapped CO's
3.	b.	$\nabla \times \bar{H} = J.$ $\nabla \cdot (\nabla \times \bar{H}) = \nabla \cdot J.$ $\therefore$ $\nabla \times \bar{H} = \bar{J} + \bar{N}$ $0 = \nabla \cdot \bar{J}$ $\quad \nabla \cdot (\nabla \times \bar{H}) = \nabla \cdot \bar{J} + \nabla \cdot \bar{N}$ but $\nabla \cdot \bar{J} = -\frac{\partial \rho_v}{\partial t}.$ $\quad \Rightarrow \nabla \cdot \bar{N} = \nabla \cdot \frac{\partial \bar{D}}{\partial t}$ $\nabla \times \bar{H} = J_c + \frac{\partial \bar{D}}{\partial t}.$ $\quad \bar{N} = \frac{\partial \bar{D}}{\partial t}$ $J_c = \sigma \bar{E},$ $\quad i_2/A = C\frac{dV}{dt} = \frac{\partial \bar{D}}{\partial t}$  	6M	CO206.6
4	a.	Derivation of boundary conditions  $\oint \bar{B} \cdot d\bar{s} = 0.$ $\Rightarrow B_{N1} = B_{N2}$ tangential. $\oint \bar{H} \cdot d\bar{l} = \bar{K} \cdot \Delta W = \bar{H}_{tan_1} \Delta W - \bar{H}_{tan_2} \Delta W.$ $\oint \bar{H} \cdot d\bar{l} = \bar{K} \quad \bar{a}_{N12} \times \bar{K} = (\bar{H}_{tan_1} - \bar{H}_{tan_2})$	6	CO206.5
	b.	Brief Explanation of Maxwell's eqns. differential form $\qquad$ Integral form. $\nabla \times E = -\frac{\partial \bar{B}}{\partial t}$ $\qquad \oint \bar{E} \cdot d\bar{l} = -\int \frac{\partial \bar{B}}{\partial t} \cdot d\bar{s}$ $\nabla \times \bar{H} = J + \frac{\partial \bar{D}}{\partial t}$ $\qquad \oint \bar{H} \cdot d\bar{l} = I + \int_s \frac{\partial \bar{D}}{\partial t} \cdot d\bar{s}$ $\nabla \cdot \bar{D} = \rho_v$ $\qquad \oint_s \bar{D} \cdot d\bar{s} = \int_v \rho_v dV$ $\nabla \cdot \bar{B} = 0.$ $\qquad \oint_s \bar{B} \cdot d\bar{s} = 0.$	7	CO206.6

Course Coordinator $\qquad$ Module Coordinator $\qquad$ HOD