U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

October 2024 Supplementary Examinations

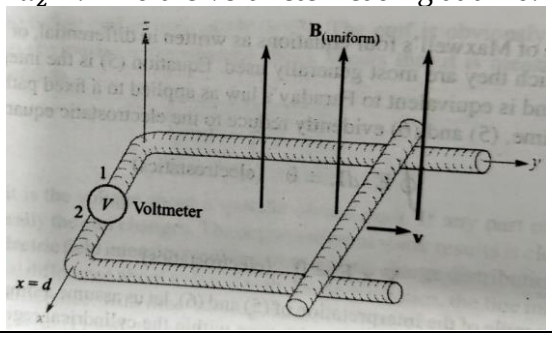
Programme: B.E. **Semester: IV**
Branch: Electronics and Communication Engineering **Duration: 3 hrs.**
Course Code: 23EC4PCFAW **Max Marks: 100**
Course: Fields and Waves

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

		UNIT - I	CO	PO	Marks
1	a)	Two small identical conducting spheres have charges of 2 nC and -1nC respectively separated by 4 cm. i) Find the magnitude of force between them. ii) If they brought into contact and separated by 4 cm what will be the force between the two spheres?	CO1	PO1	6
	b)	Show that $\nabla \cdot \vec{D} = \rho_V$ by applying Gauss's law to a differential volume element.	CO1	PO1	7
	c)	If $V = x - y + xy + 2z$ V, find $\vec{E}$ at (1, 2, 3) and the energy stored in a cube of side 2 m centered at the origin.	CO1	PO1	7
		OR			
2	a)	Define electric field intensity and derive an expression for the same at a general point due to point charge in vector form.	CO1	PO1	6
	b)	Given the field $\vec{D} = \frac{5 \sin\theta \cos\Phi}{r} \hat{a}_r$ C/m^2, find i) Volume charge density. ii) The total electric flux leaving the surface of the spherical volume of radius 2 m with centre at the origin.	CO1	PO1	7
	c)	What is the potential at the centre of a square with a side 2 m with charges 2 μC, -4 μC, 6 μC and 2 μC are located at its four corners.	CO1	PO1	7
		UNIT - II			
3	a)	Derive the equation for the continuity of current in point and integral form.	CO1	PO1	6
	b)	Current density in cylindrical coordinates is given as $\vec{J} = \begin{cases} -10^6 z^{1.5} \hat{a}_z \text{ A/m}^2 & \text{in the region } 0 \le \rho \le 20 \text{ μm} \\ 0 & \text{for } \rho > 20 \text{ μm} \end{cases}$ (i) Find the total current crossing the surface z = 0.1 m $\hat{a}_z$ direction (ii) If the charge velocity is 2×10^6 m/s at z = 0. 1 m, find volume charge density ρ_v there.	CO1	PO1	7

			(iii) If ρ_v = -2000 C/m^3 at z = 0.15 m, find charge velocity there.			
		c)	Conducting spherical shells with radii a = 10cm and b = 30cm are maintained at a potential difference of 100V such that $V = 0$ at $r = b$ and V = 100 V at $r = a$. Analyze and obtain V and $\vec{E}$ in the region between the shells. If ε_r = 2.5 in the region, determine the total charge induced on the shells and the capacitance there on.	**CO2**	**PO2**	**7**
			UNIT - III			
	4	a)	Magnetic field intensity in free space is $\vec{H} = 10\rho^2 \hat{a}_\Phi$ A/m. Determine the current density, $\vec{J}$. Hence determine the current through the unit circle in the plane $z = 0$.	**CO1**	**PO1**	**6**
		b)	Analyze the interface between two media of different permeability and obtain the boundary conditions for magnetic field.	**CO2**	**PO2**	**7**
		c)	A conductor of length 2.5m in z = 0 and x = 4m carries a current of 12 A in $-\hat{a}_y$ direction. Calculate the uniform magnetic flux density in the region, if the force on the conductor is 12×10^{-2} N in the direction specified by $\frac{-\hat{a}_x+\hat{a}_z}{\sqrt{2}}$.	**CO1**	**PO1**	**7**
			UNIT - IV			
	5	a)	Explain Faraday's law and obtain the corresponding Maxwell's equation.	-	-	**6**
		b)	Derive the general form of EM-wave equation for uniform plane wave and show that for free space, the velocity of the wave is 3×10^8 m/s.	**CO1**	**PO1**	**8**
		c)	Analyze a plane wave travelling in sea water with parameters ε_r = 81, μ_r = 1 and σ = 4 S/m, having the electric field given by $\vec{E}(z,t) = 0.2e^{-z/\delta}\cos\left(4\pi\times10^5 t - \frac{z}{\delta} + 75^\circ\right)\hat{a}_x$ V/m. Hence determine the skin depth, intrinsic impedance and Poynting vector.	**CO2**	**PO2**	**6**
			OR			
	6	a)	Find the amplitude of displacement current density in each of the following cases: (i) In the air space at point within a large power distribution transformer where $\vec{B}(x,t) = 0.8\cos[1.257\times10^{-6}(3\times10^8 t - x)]\ \hat{a}_y$ T. (ii) In a metallic conductor at 60 Hz, if $\varepsilon = \varepsilon_o$, $\mu = \mu_0$, $\sigma = 5.8\times10^7$ S/m and $\vec{J} = \sin(377t - 117.1z)\ \hat{a}_x$ MA/m^2.	**CO1**	**PO1**	**8**

		b)	Analyze the sliding bar given in below figure the location of bar is given by x = 5t + 2t^3, the separation between the two rails ab is 20 cm and $\vec{B}$ =0.8x^2 $\hat{a}_z$ T. Find the voltmeter reading at t = 0.4s. 	**CO2**	**PO2**	**6**
		c)	List the point form of Maxwell's equations for steady and time varying fields.	-	-	**6**
			UNIT - V			
	7	a)	With necessary equations explain Standing Wave Ratio (SWR).	-	-	**10**
		b)	For an EM-wave traveling from one medium to another, derive the expressions for i) Reflection coefficient ii) Transmission coefficient and bring-out the relationship between them.	**CO1**	**PO1**	**10**

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