U.S.N.										

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

Autonomous Institute Affiliated to VTU

June 2025 Semester End Main Examinations

Programme: B.E. **Semester: V**

Branch: Electronics & Telecommunication Engineering **Duration: 3 hrs.**

Course Code: 23ET5PCEMC/22ET5PCEM1 **Max Marks: 100**

Course: ELECTROMAGNETICS

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)	Obtain expression of Electric Field Intensity due to various types of charge distribution.	CO2	PO1	**08**
	b)	The flux density $\vec{D} = \frac{r}{3}\hat{a}_r$ nC/m^2 is in the free space. i)Find $\vec{E}$ at r=0.2m. ii)Find the total electric flux leaving the sphere of r=0.2m iii)Find the total charge within the sphere of r=0.3m	CO2	PO1	**04**
	c)	The charge is distributed along the z-axis from z = -∞ to +∞ and y-axis from y = -∞ to +∞ with a charge density of 20nC/m. Find $\vec{E}$ at (2,0,0)m. Also, express the answer in cylindrical co-ordinates.	CO2	PO1	**08**
		OR			
2	a)	Obtain the expression for divergence by Appling Gauss's law to a differential volume element.	CO2	PO1	**08**
	b)	Let $\vec{D} = 5r^2\hat{a}_r$ mC/m^2 for r<0.08m and $\vec{D} = \frac{0.1}{r^2}\hat{a}_r$ mC/m^2 for r>0.08m.Find charge density for (i) r=0.06m and (ii) for r=0.1m	CO2	PO1	**04**
	c)	If a sphere of radius 'a' has a charge density $\rho_v=kr^3$ then find $\vec{D}$ and $\nabla.\vec{D}$ as a function of radius r and sketch the result. Assume k constant.	CO3	PO2	**08**
		UNIT - II			
3	a)	Define electric field intensity and electric potential. Deduce the relationship between E and V.	CO2	PO1	**06**

		b)	An electrostatic field is given by $\vec{E}$ =-8xy $\hat{a}_x$ -4x^2 $\hat{a}_y$ + $\hat{a}_z$ V/m. The charge of 6C is to be moved from B(1,8,5) to A(2,18,6). Find the work done in each of the following cases, i)The path selected is y=3x^2+z,z=x+4 ii)The straight line from B to a. show that the work done remains same and is independent of the path selected.	*CO2*	*PO1*	**08**
		c)	Given the potential field V=50x^{2}yz+20y^2 volts in free space. Find (i) V at P(1,2,3) (ii) $\vec{E}_P$ and (iii) $\hat{a}_r$ at P .	*CO2*	*PO1*	**06**
			OR			
	4	a)	Define work done and obtain the line integral to calculate the work done in moving a point charge Q in an electric field $\vec{E}$.	*CO2*	*PO1*	**06**
		b)	If three charges 3μC,4μC and 5μC are located at (0,0,0), (2,-1,3) and (0,4,-2) respectively. Find the potential at (1,0,1) assuming zero potential at infinity.	*CO2*	*PO1*	**08**
		c)	Find the total current in outward direction from a cube of 1m, with one corner at the origin and edges parallel to the coordinate axes if, $\vec{J} = 2x^2\hat{a}_x + 2xy^3\hat{a}_y + 2xy\hat{a}_z A/m^2$.	*CO2*	*PO1*	**06**
			UNIT - III			
	5	a)	Explain and derive the boundary conditions for a di-electric and di-electric interface.	*CO2*	*PO1*	**08**
		b)	Solve the Laplace's equation for the potential field in the homogeneous region between the two concentric conducting spheres with radii a and b, such that b>a if potential V=0 at r=b and V=V$_0$ at r=a. And find the capacitance between the two concentric spheres.	*CO2*	*PO1*	**08**
		c)	A potential field is given as V=100e^{-5x} sin 3y cos4z V. Let the point P(0.8, 0.6, 0) be located at a conductor free space boundary is at z = 0. At point P, find the magnitudes of, (i)V, (ii) $\vec{E}$, (iii)E$_t$, (iv)E$_N$.	*CO2*	*PO1*	**04**
			OR			
	6	a)	Explain and derive the boundary conditions for a conductor and free-space interface.	*CO2*	*PO1*	**08**
		b)	Conducting spherical shells with radii a=10cm and b=30cm are maintained at a potential difference of 100V such that V(r=b)=0 and v(r=a)=100V.Determine V and E in the region between the shells. If εr=2.5 in the region determine the total charge induced on the shells and the capacitance there on.	*CO2*	*PO1*	**08**

		c)	Determine whether or not the following potential fields satisfy the Laplace's equation: (i) $V=x^2-y^2+z^2$ (ii) $V=r\cos\theta+\phi$	*CO2*	*PO1*	**04**
			UNIT - IV			
	7	a)	Derive an expression for curl **H** using Ampere's circuital law.	*CO2*	*PO1*	**08**
		b)	Obtain the expression for $\vec{H}$ in all the regions if a cylindrical conductor carries a direct current I and its radius is 'R'm. Plot the variation of $\vec{H}$ against the distance r from the centre of the conductor.	*CO2*	*PO1*	**06**
		c)	Find the magnetic flux density at the centre 'O' of a square of sides equal to 5m and carrying 10 amperes of current.	*CO2*	*PO1*	**06**
			OR			
	8	a)	In cylindrical co-ordinates $\vec{A}=50r^2\hat{a}_z$ Wb/m is a vector magnetic potential, in a certain region of free space. Find $\vec{H}$, $\vec{B}$, $\vec{J}$ and using $\vec{J}$ find total current I crossing the surface $0\le r\le 1, 0\le\phi\le 2\pi$ and z=0.	*CO2*	*PO1*	**08**
		b)	The magnetic field intensity is given in a region of space as, $\vec{H}=\frac{x+2y}{z^2}\hat{a}_y+\frac{2}{z}\hat{a}_z$ A/m. Find (i)$\nabla\times\vec{H}$,(ii) $\vec{J}$,(iii)Use $\vec{J}$ to find the total current passing through the surface z=4,1<x<2,3<y<5 in the $\hat{a}_z$ direction.	*CO2*	*PO1*	**06**
		c)	Evaluate both sides of Stoke's theorem for the field $\vec{H}=10\sin\theta\hat{a}_\phi$ and the surface r=3,$0\le\theta\le 90^0$.Let the surface have the $\hat{a}_r$ direction.	*CO2*	*PO1*	**06**
			UNIT - V			
	9	a)	Show that $\nabla.\vec{J}=-\frac{\partial\rho_v}{\partial t}$ where $\vec{J}$ is conduction current density in A/m^2 and ρ is volume charge density in C/m^3	*CO2*	*PO1*	**06**
		b)	A two dimensional electric field is given by $\vec{E}=x^2\hat{a}_x+x\hat{a}_y$ V/m. Show that the electric field cannot arise from a static distribution of charge.	*CO2*	*PO1*	**04**
		c)	Given the retarded potentials, V=-y(x+at0V and $\vec{A}=y(\frac{x}{a}+t)\hat{a}_x$ Wb/m where a=$\frac{1}{\sqrt{\mu_0\varepsilon_0}}$ (i)Show that $\nabla.\vec{A}=-\mu\varepsilon\frac{\partial v}{\partial t}$,(ii)Find $\vec{H}$, $\vec{B}$, $\vec{E}$, $\vec{D}$.	*CO2*	*PO1*	**10**
			OR			
	10	a)	State Poynting theorem and explain its significance. Derive point	*CO2*	*PO1*	**06**

			and integral form of the Poynting theorem.			
		b)	A radio station transmits power radially around the spherical region. The desired electrical field intensity at a distance of 10km from the station is 1mV/m. Calculate the corresponding magnetic field, power density and the power transmitted by station.	*CO2*	*PO1*	**04**
		c)	A wave propagating in a lossless dielectric has components, $\vec{E} = 500\cos(10^7 t - \beta z)\hat{a}_x$ $\vec{H} = 1.1\cos(10^7 t - \beta z)\hat{a}_y$ if the wave is travelling at a velocity 0.5 times the velocity in free space, find $\mu_r, \varepsilon_r, \beta, \lambda, \eta$	*CO2*	*PO1*	**10**

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