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

Autonomous Institute Affiliated to VTU

February 2025 Semester End Main Examinations

Programme: B.E. **Semester: IV**
Branch: Electronics and Communication Engineering **Duration: 3 hrs.**
Course Code: 23EC4PCFAW / 22EC4PCFAW **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)	Deduce an expression for energy density in electrostatic fields.	CO1	PO1	8
	b)	Compute the total charge within following volume $0.1 \leq \lvert x\rvert, \lvert y\rvert, \lvert z\rvert \leq 0.2$ and $\rho_v = 1/(x^3\, y^3\, z^3)$.	CO1	PO1	5
	c)	Deduce the electric field intensity due to an infinite line charge using Gauss Law. Clearly mention the assumptions made.	CO1	PO1	7
		OR			
2	a)	Calculate the electric field intensity at P(1,1,1) caused due to four identical charges 3nC each located at P_1 (1,1,0), P_2 (-1,1,0), P_3 (-1,-1,0) and P_4 (1,-1,0).	CO1	PO1	7
	b)	Verify the divergence theorem for the region bounded by the surfaces $\rho = 2, \emptyset = 0$ & $\pi, z = 0$ & 5 and having flux density $\vec{D} = 6\rho \sin\left(\frac{\phi}{2}\right) \hat{a}_\rho + 1.5\rho \cos\left(\frac{\phi}{2}\right) \hat{a}_\phi$ C/m^2.	CO1	PO1	8
	c)	Analyze and obtain the electric field intensity due to an infinite sheet charge using Gauss' law.	CO1	PO1	5
		UNIT - II			
3	a)	Obtain the equation for the continuity of current.	CO1	PO1	5
	b)	Analyze and obtain the boundary conditions for electric field between conductor and free space.	CO2	PO2	10
	c)	Find the magnetic field intensity at (1.5, 2, 3) due to a current conductor carrying current of 24 A along *z*-axis extending from 0 to 6.	CO1	PO1	5
		OR			
4	a)	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 = 100V at r = a. Analyze V and 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	10

		b)	Current density in cylindrical coordinates is given as $\vec{J} = \begin{cases} -10^6 z^{1.5} \hat{a}_z \frac{A}{m^2} & in\ the\ region\ 0 \leq \rho \geq 20\ \mu m \\ 0 & for\ \rho > 20\ \mu m \end{cases}$ i. Find the total current crossing the surface z = 0.1 m $\hat{a}_z$ direction (ii) If the charge velocity is $2X10^6$ m/s at z = 0. 1 m, find volume charge density ρ_v there. (iii) If ρ_v = -2000 C/m^3 at z = 0.15 m, find charge velocity there.	**CO1**	**PO1**	**10**
			UNIT - III			
	5	a)	Explain Maxwell's equations in point and integral forms for time-varying fields.	-	-	**10**
		b)	Deduce an expression for the force on a differential current element in a steady magnetic field.	**CO 1**	**PO 1**	**10**
			OR			
	6	a)	Analyse the interface between two media of different permeability and obtain the boundary conditions for magnetic field.	**CO2**	**PO2**	**10**
		b)	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 flux density in the region, if the force on the conductor is $12X10^{-2}$ N in the direction specified by $\frac{-\hat{a}_x + \hat{a}_z}{\sqrt{2}}$	**CO1**	**PO1**	**10**
			UNIT - IV			
	7	a)	Deduce the equations for attenuation constant, phase constant and the intrinsic impedance for a uniform plane wave in a perfect dielectric.	**CO1**	**PO1**	**10**
		b)	Deduce an expression for Poynting theorem and explain each term.	**CO1**	**PO1**	**10**
			OR			
	8	a)	Deduce the equations for attenuation constant, phase constant and the intrinsic impedance of electromagnetic wave in a good conductor.	**CO1**	**PO1**	**10**
		b)	Derive the general wave equation using Maxwell's equations.	**CO1**	**PO1**	**10**
			UNIT - V			
	9	a)	Consider η_1 = 100Ω and η_2 = 300Ω. Compute the reflection coefficient for this system. If the magnitude of the incident electric field intensity is 100 V/m, what is the value of the magnitude of the electric field intensity?	**CO 2**	**PO 2**	**6**
		b)	Assume a 50-MHz uniform plane wave having electric field 10V/m. The medium is lossless with ε_r=1 and μ_r =1. The wave propagates in the *xy* plane at a 30° angle to the x axis and is linearly polarized along *z*. Deduce the phasor expression for the electric field.	**CO 2**	**PO 2**	**6**

		c)	Consider a homogeneous medium in which the refractive index varies linearly with frequency over a certain range: $$n(\omega) = \frac{n_0 \omega}{\omega_0}$$ Determine the group velocity and phase velocity of a wave at a frequency of ω_0.	**CO 2**	**PO2**	**8**
			OR			
	10	a)	With necessary equations explain Standing Wave Ratio (SWR)	-	-	**10**
		b)	Derive the expressions for i) Reflection coefficient ii) Transmission coefficient And bring the relationship between them.	**CO1**	**PO1**	**10**