U.S.N.										

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

Autonomous Institute Affiliated to VTU

August 2024 Semester End Main 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)	Applying Gauss' law, develop an expression for electric field intensity due to infinite line charge	CO1	PO 1	6
	b)	Obtain the force exerted on Q_2 by Q_1, when a charge of $Q_1 = 3 \times 10^{-4}$ C is located at M (1, 2, 3) and charge $Q_2 = -10^{-4}$ C is located at N (2, 0, 5) in vacuum.	CO1	PO1	6
	c)	Analyze and verify the divergence theorem for the region bounded by a closed cylinder having flux density $\vec{D} = 2xy\,\hat{a}_x + x^2\,\hat{a}_y \quad \text{C/m}^2$ where $x = 0$ to 1; $y = 0$ to 2; $z = 0$ to 3.	CO2	PO2	8
		OR			
2	a)	An electric field is expressed in Cartesian coordinates by $E = 6x^2\,a_x + 6y + 4a_z$ V/m. analyse and determine the following: (i) V_{MN} if points M and N are specified by M(2, 6, −1) and N(−3, −3, 2); (ii) V_N at N(−3, −3, 2) if V = 2 V at P(1, 2, −4).	CO2	PO2	8
	b)	"The electric flux passing through any closed surface is equal to the total charge enclosed by that surface." Identify the law with reference to the above statement and prove the same for a point charge.	CO1	PO1	6
	c)	Evaluate the electric flux density vector $\vec{D}$ in rectangular coordinates at point P(2, -3, -6) produced by: (i) A point charge Q_A = 55 mC at Q(-2, 3, -6) (ii) A line charge ρ_{LB} = 20 mC/m on the *z*-axis.	CO1	PO1	6

			UNIT - II			
	3	a)	Analyze and obtain the expression for potential distribution in the space between two concentric spherical shells.	**CO2**	**PO2**	**8**
		b)	Calculate the magnitude of the current density in a sample of Silver for which conductivity $\sigma = 6.17 \times 10^7$ S/m and electron mobility $\mu e = 0.0056$ m^2 /V.s in each of the following cases. (a) The drift velocity is 1.5 μm/s (b) The electric field intensity is 1 mV/m (c) The sample is a cube 2.5 mm on a side having a voltage of 0.4mV between opposite faces.	**CO1**	**PO1**	**6**
		c)	Derive the equation for continuity of current in point form.	**CO1**	**PO1**	**6**
			UNIT-III			
	4	a)	Using Ampere's circuital law, determine magnetic field intensity due to infinite long straight conductor.	**CO1**	**PO1**	**10**
		b)	Investigate the interface between two materials with different permeabilities and deduce the boundary conditions governing the behavior of the magnetic field at this interface.	**CO2**	**PO1**	**10**
			UNIT - IV			
	5	a)	Analyze and articulate the fundamental principles embodied by Maxwell's equations in the differential form and integral form for time varying fields.	**CO2**	**PO2**	**10**
		b)	Analyze and 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 $\vec{B}(x,t) = 0.8\cos[1.257 \times 10^{-6}(3 \times 10^8 t - x)]\ \hat{a}_y$ T. (ii) In a metallic conductor at 60 Hz, if $\varepsilon = \varepsilon_o$, $\mu = \mu_0$, $\sigma = 5.8 \times 10^7$ S/m and $\vec{J} = \sin(377t - 117.1z)\ \hat{a}_x$ MA/m^2.	**CO2**	**PO2**	**10**
			OR			
	6	a)	Using Maxwell's equations develop a general wave equation by relating the space and time variations of electric and magnetic fields.	**CO2**	**PO2**	**10**
		b)	Analyze a plane wave traveling in fresh water with parameters $f = 300$ MHz, $\epsilon_r = 78$, $\mu_r = 1$ and $\sigma = 0$. Calculate the following 1. Whether the medium is lossless or not? 2. Attenuation constant 3. Phase constant 4. Wavelength 5. Intrinsic Impedance	**CO2**	**PO2**	**10**

			UNIT- V			
	7	a)	Analyze the properties of wave propagation within a homogeneous medium characterized by a linear variation of refractive index with frequency, represented as $$n(\omega) = \frac{n_0 \omega}{\omega_0}$$ Calculate both the group velocity and phase velocity of a wave specifically at the frequency ω_0.	**CO2**	**PO2**	**10**
		b)	With relevant equations, discuss the reflection phenomena of uniform plane waves at normal incidence at the interface between 2 media.	**CO 1**	**PO1**	**10**

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