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: 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.
3. Quantities indicated in bold represent vectors.

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 the relationship between electric flux density and electric field intensity.	1	1	**05**
	b)	State and illustrate Gauss' law.	-	-	**05**
	c)	Given the field $\mathbf{D} = 6\rho\sin(\varphi/2)\,\mathbf{a}_\rho + 1.5\rho\cos(\varphi/2)\,\mathbf{a}_\varphi$ C/m^2, evaluate both sides of divergence theorem for the region bounded by $\rho=2$, $0 \le \varphi \le \pi$, $0 \le z \le 5$.	1	1	**10**
		OR			
2	a)	Derive an expression for electric field intensity at any point due to an infinite sheet of charge.	1	1	**06**
	b)	Two uniform line charges of density 4nC/m and 6nC/m lie in x=0 plane at y = 5 and -6 respectively, in free space. Find **E** at (4,0, 3).	1	1	**07**
	c)	An electric field is expressed as $\mathbf{E} = 6x^2\,\mathbf{a}_x + 6y\,\mathbf{a}_y + 4\,\mathbf{a}_z$ V/ m. Find: (i) V_{MN}, if points M and N are specified by M (2, 6, -1) and N (-3, -3, 2). (ii) V_M, if Q (4, -2, -35) is the zero-potential point.	1	1	**07**
		UNIT - II			
3	a)	From the law of conservation of charge, it can be said that current is continuous from one side of a reference surface to the other. Considering a suitable reference surface, obtain the current continuity equation.	1	1	**07**
	b)	Evaluate the boundary conditions related to electric field at the interface of a conductor and free-space.	2	2	**07**
	c)	Derive the expression of capacitance of a coaxial capacitor having inner radius a, outer radius b and the length L.	1	1	**06**

			OR			
	4	a)	Given $\mathbf{J} = 10\ \rho^2\ z\ \mathbf{a_\rho} - 4\rho \cos^2\varphi\ \mathbf{a_\varphi}$ mA/m^2, find current density at P (3, 30˚, 2) and also determine current flowing outward through $\rho=3,\ 0 < \varphi < 2\pi,\ 2 < z < 2.8$.	1	1	**07**
		b)	Derive Poisson's equation from point form of Gauss law.	1	1	**05**
		c)	Given the potential field $V = [A\ \rho^4 + B\ \rho^{-4}] \sin(4\varphi)$ volts, show that $\nabla^2 V=0$. Also, determine the values of A and B, so that V= 100 volts and $\lvert\mathbf{E}\rvert$ = 500 V/m at P ($\rho=1,\ \varphi =22.5˚,\ z=2$).	1	1	**08**
			UNIT - III			
	5	a)	State and explain Ampere's circuital law. Using the same, derive the expression for magnetic field intensity at any point due to an infinite length filamentary current carrying conductor present on z-axis.	1	1	**07**
		b)	Given the following values for P_1, P_2 and $I_1\Delta\mathbf{L_1}$, calculate $\Delta\mathbf{H_2}$, $P_1(1, 2, 3)$, P_2 (-3, -1, 2), $2\pi(-\mathbf{a_x}+\mathbf{a_y}+2\mathbf{a_z})$ μAm.	1	1	**05**
		c)	Evaluate the boundary conditions at the interface of two magnetic media.	1	1	**08**
			OR			
	6	a)	State and explain Biot-Savart's law.	1	1	**04**
		b)	A rectangular path is formed by P_1 (2, 3, 4) to P_2 (4, 3, 4) to P_3 (4, 3, 1) to P_4 (2, 3, 1) to P_1. (i). Evaluate the closed line integral of **H** about the path, given that $\mathbf{H} = 3z\ \mathbf{a_x} - 2\ x^3\ \mathbf{a_z}$ A/m (ii). Analyze the quotient enclosed by the path as an approximation to $(\nabla \times \mathbf{H})_y$ (iii). Evaluate $(\nabla \times \mathbf{H})_y$ at the center of the area.	2	2	**10**
		c)	Two differential current elements, $I_1\Delta\mathbf{L_1}=3\times10^{-6}\mathbf{a_y}$ Am at $P_1(1,0,0)$ and $I_2\Delta\mathbf{L_2} =3\times10^{-6}(-0.5\mathbf{a_x} + 0.4\mathbf{a_y} + 0.3\mathbf{a_z})$ Am at $P_2(2,2,2)$ are located in free-space. Find the vector force exerted on $I_1\Delta\mathbf{L_1}$ by $I_2\Delta\mathbf{L_2}$.	1	1	**06**
			UNIT - IV			
	7	a)	Starting from the equation of Faraday's law, obtain the point form of Maxwell's equation concerning spatial derivative of **E** and time derivative of **H**.	1	1	**05**
		b)	Within certain region, $\varepsilon=10^{-11}$F/m and $\mu =10^{-5}$ H/m, if $B_x = 2\times10^{-4} \cos(10^5 t) \sin(10^{-3} y)$ T, find **E** and analyse the total magnetic flux passing through the surface x=0, 0<y<40m, 0<z<2m at t=1μs.	2	2	**07**
		c)	Consider the case of wave propagation in free-space in which, E-field is x-direction. Using the Maxwell's equation in phasor form, obtain Helmholtz wave equation and comment the solution for E-field.	2	2	**08**

			OR			
	8	a)	Evaluate the amplitude of displacement current density i. In the air space at point within a large power distribution transformer where $\vec{B} = 0.8\cos[1.257X10^{-6}(3X10^{8}t - x)]\ \hat{a}_y$T ii. In a metallic conductor at 60Hz, if $\varepsilon = \varepsilon_o$, $\mu = \mu_0$, $\sigma = 5.8X10^7$ S/m and $\vec{J} = \sin(377t - 117.1z)\ \hat{a}_x$ MA/m^2.	2	2	**08**
		b)	Starting from Maxwell's curl equation, obtain the equation of Poynting's theorem and analyze the same.	2	2	**12**
			UNIT - V			
	9	a)	Explain the reflection of uniform plane wave when it is incident normally on the boundary between two regions of different dielectric and hence obtain the expression of reflection coefficient.	1	1	**10**
		b)	Given $\eta_1 = 100\ \Omega$ and $\eta_2 = 300\ \Omega$ and $E^{+}_{x10} = 100$ V/m: (i). Evaluate the field values for incident, reflected and transmitted wave. (ii). Analyze average power density of incident, reflected and transmitted wave.	2	2	**10**
			OR			
	10	a)	Starting from the total instantaneous field derive an expression for Standing Wave Ratio (SWR), which has both travelling wave and standing wave terms.	1	1	**08**
		b)	Consider a 50 MHz uniform plane wave having electric field amplitude of 10 V/m. The medium is lossless, having $\epsilon_r = \epsilon'_r = 9$ and $\mu_r = 1$. The wave propagates in x, y plane at a 30° angle to the x- axis and is linearly polarized along z. Obtain the phasor expression for the electric field.	1	1	**06**
		c)	Determine the reflection and transmission coefficients of an electric field wave travelling in air and is incident normally on a boundary between air and dielectric having permittivity $\epsilon_r = 4$ and permeability, $\mu_r = 1$.	2	2	**06**

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