U.S.N.										

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

Autonomous Institute Affiliated to VTU

September / October 2023 Semester End Main Examinations

Programme: B.E. **Semester: IV**
Branch: Electronics and Communication Engineering **Duration: 3 hrs.**
Course Code: 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.

		UNIT - I	CO	PO	Marks
1	a)	Applying Gauss' law, develop an expression for electric field intensity due to infinite line charge	CO1	PO1	**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 $x = 0\ to\ 1; y = 0\ to\ 2; z = 0\ to\ 3$ having flux density $\vec{D} = 2xy\ \hat{a}_x + x^2\ \hat{a}_y$ C/m^2.	CO2	PO2	**8**
		OR			
2	a)	An electric field is expressed in Cartesian coordinates by $\vec{E} = 6x^2\ \hat{a}_x + 6y\ \hat{a}_y + 4\hat{a}_z$ V/m. Determine the following: (a) V_{MN} if points M and N are specified by M(2, 6, −1) and N(−3, −3, 2). (b) V_N if V = 2 V at P(1, 2, −4).	CO 2	PO 2	**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 illustrate the same with relevant examples.	CO 1	PO 1	**6**
	c)	Evaluate the electric flux density vector $\vec{D}$ in rectangular coordinates at point P (2, -3, -6) produced by each of the following: (i) A point charge Q_A = 55 mC located at Q(-2, 3, -6) (ii) An infinite line charge ρ_{LB} = 20 mC/m located on the x-axis	CO 2	PO 2	**6**

			UNIT - II			
	3	a)	Analyze and develop an expression for the boundary conditions for electric field at the interface between a conductor and a dielectric.	*CO 2*	*PO 2*	**8**
		b)	Determine whether the following potential fields satisfy Laplace's equation: i. $V = x^2 + y^2 - z^2$ ii. $V = \rho cos\varphi + z$	*CO 1*	*PO 1*	**6**
		c)	Derive the equation for the continuity of current in point form.	*CO 1*	*PO 1*	**6**
			OR			
	4	a)	Analyze and obtain the expression for potential distribution in the space between two concentric spherical shells.	*CO 2*	*PO 2*	**8**
		b)	Calculate the magnitude of current density in a sample of Silver with 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: (i) The drift velocity is 1.5μm/s (ii) The electric field intensity is 1 mV/m (iii) The sample is a cube 2.5 mm on a side having a voltage of 0.4 mV between opposite faces.	*CO 2*	*PO 2*	**6**
		c)	Using Ampere's circuital law, determine the magnetic field intensity due to an infinite long straight conductor.	*CO 1*	*PO 1*	**6**
			UNIT-III			
	5	a)	Analyse and articulate the fundamental principles embodied by Maxwell's equations in the differential form and integral form for time varying fields.	*CO 2*	*PO 2*	**10**
		b)	Investigate the interface between two materials with different permeability and deduce the boundary conditions governing the behavior of the magnetic field at this interface.	*CO 2*	*PO 2*	**10**
			UNIT - IV			
	6	a)	Using Maxwell's equations, develop a general wave equation by relating the space and time variations of electric and magnetic fields.	*CO 1*	*PO 1*	**10**
		b)	Analyse a plane wave traveling in fresh water with the following parameters: $f = 300$ MHz, $\epsilon_r = 78, \mu_r = 1$ and $\sigma = 0$. Calculate the following: i. Attenuation constant ii. Phase constant iii. Wavelength iv. Intrinsic Impedance v. Loss tangent and hence determine if the medium is lossless or not	*CO 2*	*PO 2*	**10**

			UNIT- V			
	7	a)	Consider a homogeneous medium in which the refractive index varies linearly with frequency over a certain range given by $n(\omega) = \frac{n_0 \omega}{\omega_0}$. Determine the group velocity and phase velocity of a wave at the frequency of ω_0.	*CO 2*	*PO 2*	**10**
		b)	With relevant equations, analyse an electromagnetic wave propagating from one medium to another of different permittivity and obtain the coefficients of reflection and transmission at normal incidence.	*CO 2*	*PO 2*	**10**

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