Question Paper

Exam Date & Time: 02-Dec-2023 (09:30 AM - 12:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

THIRD SEMESTER B.TECH. EXAMINATIONS - NOVEMBER / DECEMBER 2023
SUBJECT: ECE 2125- ELECTROMAGNETIC WAVES

Marks: 50 **Duration: 180 mins.**

Answer all the questions.

Missing data may be suitably assumed.

1A)	Given the vectors $\mathbf{M} = -10\mathbf{a}_x + 4\mathbf{a}_y - 8\mathbf{a}_z$ and $N = 8\mathbf{a}_x + 7\mathbf{a}_y - 2\mathbf{a}_z$, find i) unit vector in the direction of $-\mathbf{M}+2\mathbf{N}$, ii) vector $\lvert\mathbf{M}\rvert\lvert 2\mathbf{N}\rvert(\mathbf{M} + \mathbf{N})$.	(4)
1B)	Express the unit vector $\mathbf{a}_x$ in spherical coordinates at the point $\rho = 2.5$, $\phi = 0.7$ and $z = 1.5$.	(3)
1C)	A 2μC point charge is located at **A**(4, 3, 5) in free space. Find E_ρ, E_ϕ and E_z at **P**(8, 12, 2).	(3)
2A)	A cylindrical surface $\rho = 8$ cm contains the surface charge density $\rho_s = 5e^{-20\lvert z\rvert}$ nC/m^2. i) What is the total amount of charge present? ii) How much flux leaves the surface $\rho = 8$ cm, $1 \text{ cm} < z < 5$ cm, $30° < \phi < 90°$?	(4)
2B)	A uniform surface charge density 20 nC/m^2 is present on the spherical surface $r = 0.6$ cm in free space. Find the absolute potential at P($r = 1$ cm, $\theta = 25°$, $\phi = 50°$).	(3)
2C)	Given the current density $\mathbf{J} = -10^{-4}(y\mathbf{a}_x + x\mathbf{a}_y)$ A/m^2, find the current crossing the $y = 0$ plane in the $-\mathbf{a}_y$ direction between $z = 0$ and 1, and $x = 0$ and 2.	(3)
3A)	The magnetic field intensity is given in a certain region of space as $H = \frac{x+2y}{z^2}\,a_y + \frac{2}{z}\,a_z$ A/m. Find i) Find current density ii) The total current passing through the surface $z = 4$, $1 \le x \le 2$, $3 \le y \le 5$ in the a_z direction. iii) Show that the same result is obtained using the other side of Stoke's theorem.	(4)
3B)	Derive the expression for magnetic field intensity due to a line charge of finite length.	(3)
3C)	A filamentary current of 10 A is directed from infinity to the origin on the positive x-axis, and then back to infinity along the positive y-axis. Use Biot-Savart law to find magnetic field intensity H at P (0,0,1).	(3)
4A)	Derive Helmholtz wave equation from Maxwell's equation.	(4)
4B)	A good conductor is planar in form and carries a uniform plane wave that has a wavelength of 0.3 mm and a velocity of 3×10^5 m/s. Assuming the conductor is non-magnetic, determine the frequency and the conductivity.	(3)
4C)	What is displacement current density? Derive an expression for displacement current density using Ampere's circuital Law.	(3)
5A)	Design a single stub matching network to match a load $(200 - j150)\ \Omega$ and $R_0 = 100\ \Omega$. The operating frequency is 30 MHz. Use the Smith Chart.	(4)
5B)	A transmission line has a characteristic impedance of $50 + j0.01\Omega$ and is terminated in a load impedance of $73 - j42.5\ \Omega$. Calculate i) Reflection coefficient ii) Standing wave ratio	(3)

5C) How impedance matching is achieved with stubs? Explain. (3)

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