Vellore Institute of Technology

Course: BEEE202L - Electromagnetic Theory

Time: Three Hours Max. Marks: 100

KEEPING MOBILE PHONE/SMART WATCH, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE

Answer any TEN Questions

(10 X 10 = 100 Marks)

01. State and verify Gauss's Divergence Theorem for the vector field given by $\vec{A} = zy\hat{a}_x + z\hat{a}_y + z\hat{a}_z$ and the cubic region defined by $0 \le x \le 1, \quad 0 \le y \le 1, \quad 0 \le z \le 1$.

02. Express the Cartesian vector $2\hat{a}_x + 3\hat{a}_y + \hat{a}_z$ in Cylindrical coordinates at the point $(x, y, z) = (-1, -1, 0)$.

03. Consider two dielectric regions separated by a boundary. The region 2 with z < 0 is characterized by ε_{r2}=2 and region 1 with z ≥ 0 by ε_{r1}=4. If $\vec{D}_1 = -2\hat{a}_x + 4\hat{a}_y + 10\hat{a}_z$ nC/m^2, find $\vec{D}_2$. Also find the angles (degrees) between $\vec{D}_1$, $\vec{D}_2$ and the normals to the boundary between the two dielectric regions.

04. Line charge with uniform line charge density of 1nC/m along the z-axis and two point charges -20 nC and 10 nC are located at (-10, 2, 3)m and (-1, 11, 10)m, respectively. Calculate the electric field intensity $\vec{E}$ at (1, 0, 0)m.

05. A unit normal vector from region 2 with permeability $2\mu_0$ to region 1 with permeability μ_0 is $\vec{a}_{n21} = (6\hat{a}_x + 2\hat{a}_y - 3\hat{a}_z)/7$ .If $\vec{H}_1 = 10\hat{a}_x + \hat{a}_y + 12\hat{a}_z\ A/m$ and $\vec{H}_2 = H_{2x}\hat{a}_x - 5\hat{a}_y + 4\hat{a}_z\ A/m$, determine (a) H_{2x} (b) the surface current density $\vec{K}$ on the interface.

06. Derive an expression for the internal and external self-inductance of a coaxial cable designed with inner radius 'a' and outer radius 'b'.

07. Planes $y = 0m$, $y = -10m$ and $y = 20m$ carry surface currents $\vec{K}_1$ = $2\hat{a}_z$ mA/m, $\vec{K}_2$ = -$2\hat{a}_z$ mA/m and $\vec{K}_3$ = $4\hat{a}_z$ mA/m, respectively. Compute $\vec{H}$ (-200, 10, 0)m.

08. Find the amplitude of the displacement current density,

(a) In free space, where $\vec{E} = 80\cos(6.277X10^8t - 2.092y)\,\hat{a}_z V/m$

(b) Inside a capacitor, where $\vec{D} = 3X10^{-6}\sin(6X10^6t - 0.3463x)\,\hat{a}_z C/m^2$.

09. A plane wave propagating through a medium with ε_r= 8 μ_r=2 has $\vec{E} = 0.5e^{-\frac{z}{3}}\sin(10^8t - \beta z)\hat{a}_x$ V/m. Determine the wave impedance and β.

10. A 5 GHz uniform plane wave $\vec{E}_{is} = 10e^{-j\beta z}\,\hat{a}_x$V/m in free space is incident normally on a large plane, lossless dielectric slab (z > 0) having $\varepsilon = 4\varepsilon_0$, $\mu = \mu_0$. Find the reflected wave $\vec{E}_{rs}$ and the transmitted wave $\vec{E}_{ts}$.

11. In free space, $\vec{H}$ = 0.2 cos(ωt – βx) $\hat{a}_z$ A/m. Find the total power passing through a square plate of side 5 cm on plane $x + y = 1$ and a circular disk of radius 5cm on plane $x = 1$.

12. Propose appropriate control techniques for Intersystem EMI.

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