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VASAVI COLLEGE OF ENGINEERING *(Autonomous)*, HYDERABAD

B.E. (ECE: CBCS) III-Semester Main Examinations, December-2017

Electromagnetic Theory

Time: 3 hours Max. Marks: 70

*Note: Answer **ALL** questions in **Part-A** and any **FIVE** from **Part-B***

Part-A (10 × 2 = 20 Marks)

1. Given a vector function $F = (5y - k_1 z)a_x + (k_2 x + 3z)a_y + (k_3 y + 2z)a_z$. Determine the constants k_1, k_2 and k_3 if 'F' is curl-free.
2. Write down integral expressions for calculating the total charge when line, surface and volume charge distributions are given.
3. "Conduction current density under steady state conditions is divergence less". Is this statement correct? If yes, justify it.
4. Write Poisson's equation and list applications of this equation.
5. Define surface current density and volume current density.
6. State Gauss law for the magnetic field.
7. Convert the Maxwell's curl equations from integral form to differential form related to the time varying fields.
8. Mention the different ways in which an emf is induced around a loop.
9. Define plane of incidence.
10. Give significance of total internal reflection with any one application.

Part-B (5 × 10 = 50 Marks)

11. a) Obtain the expressions for electric field strength and electric displacement density due to an infinite line charge at any radial distance. [6]

    b) A uniform line charge $\rho_l = 25\eta C/m$ lies on the z axis in free space. Find the electric field intensity at a point (2, 5, 3). [4]

12. a) Derive the expression for the energy density in electrostatic field. [4]

    b) Let the region $z < 0$ be composed of a uniform dielectric material for which $\epsilon_r = 3.2$, while the region $z > 0$ is characterized by $\epsilon_r = 2$. The electric flux density in $z < 0$ is: $-30a_x + 50a_y + 70a_z\ \eta c/m^2$. [6]

    Find

    i) normal component of D

    ii) tangential component of D

    iii) total D in the region z > 0.

13. a) How is vector potential defined in steady magnetic fields? Give relations for vector potential for all the three types of current distributions. [6]

    b) Find the self inductance of a solenoid with 300 turns, length 0.5m and a circular cross section of radius 0.02 m. [4]

Contd... 2

14. a) Define and explain the terms linear, elliptical and circular polarizations. [5]

    b) In a medium $\vec{E} = 16e^{-0.05x}\sin(2\times10^8t - 2x)a_zV/m$. Find the direction of propagation, propagation constant, wavelength, speed of the wave and skin depth. [5]

15. a) Analyze the reflection of a plane wave from a plane surface of a perfect conductor for normal incidence. [6]

    b) A uniform plane wave is incident from air onto a glass sheet at an angle of 30° from normal. Determine the fraction of the incident electric field that is reflected and transmitted when wave is polarized parallel polarization. (Glass has relative permittivity = 4). [4]

16. a) Derive Maxwell's first equation for electrostatic field and give its word statement. [7]

    b) Determine the relaxation time constant for each of the following medium [3]
    Hard rubber ($\sigma = 10^{-15}\ S/m, \varepsilon = 3.1\varepsilon_o$)
    Mica ($\sigma = 10^{-15}\ S/m, \varepsilon = 6\varepsilon_o$)
    Distilled water ($\sigma = 10^{-4}\ S/m, \varepsilon = 80\varepsilon_o$)

17. Answer any ***two*** of the following:

    a) Ampere's law [5]

    b) Wave motion in perfect dielectrics. [5]

    c) Poynting theorem. [5]