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BIEL-006

B.Tech. – VIEP – ELECTRONICS AND COMMUNICATION ENGINEERING (BTECVI)

Term-End Examination

00004

June, 2017

BIEL-006 : ELECTROMAGNETIC FIELD THEORY

Time : 3 hours *Maximum Marks : 70*

Note : *Attempt any* ***seven*** *questions. All questions carry equal marks. Symbols used have their usual meanings.*

1. (a) Explain the differences between gradient, divergence and curl. *4*

(b) A vector field is described by $\bar{F} = 500\ \bar{a}_x + 750\ \bar{a}_y$. A plane surface in the region of the field is defined by $2x + 4y + 6z = 12$. Find the vector components of $\bar{F}$ that are normal and tangential to the surface. *6*

2. (a) Prove the following identity : 6

$$\bar{A} \times (\bar{B} \times \bar{C}) = \bar{B}(\bar{A} \cdot \bar{C}) - \bar{C}(\bar{A} \cdot \bar{B})$$

(b) The vector $\bar{F} = r \sin \phi \, \bar{a}_\phi$ is given in the cylindrical coordinates. Transform the vector into rectangular coordinates. 4

3. (a) Derive the expression for the electric field intensity at a point above an infinite sheet of charge, the surface charge density given by ρ_s C/m^2. 6

(b) A charge is uniformly distributed on the plane surface S = 3x + 5y + 6z = 30 located in air. The surface charge density is 1·5 nC/m^2. Find the field intensity along the normal direction to the surface. 4

4. (a) State Gauss's law. Express it in point form and in integral form. 5

(b) A spherical surface is uniformly charged. Calculate the electric field inside, on and outside the sphere. 5

5. (a) What is an electric dipole ? Derive the expression of potential at a point due to an electric dipole. 5

(b) Show that the Laplacian of the potential function in a region of charge in a static electric field is not zero whereas the Laplacian of the potential function in the region of steady current flow is zero. 5

6. (a) State Biot-Savart Law. Express it mathematically. 5

(b) Each of the three co-ordinate axes carries a filamentary current of 1 A in the $\bar{a}_x$, $\bar{a}_y$ and $\bar{a}_z$ direction. Determine the magnetic field at (2, 3, 4). 5

7. The displacement current density is $2 \cos(\omega t - 5z)\ \bar{a}_x\ \mu A/m^2$ in a material for which $\sigma = 0$, $\varepsilon = 4\varepsilon_0$ and $\mu = 5\mu_0$.

(a) Use the definition of displacement current density to find $\bar{D}$ and $\bar{E}$.

(b) Now use the point form of Faraday's law and a time integration to find $\bar{B}$ and $\bar{H}$. 10

8. (a) Consider the reflection phenomenon of a plane wave travelling through a medium of permittivity ε_1 and permeability μ_1 is incident normally to the surface of a perfect dielectric medium with permittivity ε_2 and permeability μ_2. Derive the expression for the reflection and transmission coefficients for the electric and magnetic fields. 5

(b) The phase constant of a uniform plane electromagnetic wave travelling in a perfect dielectric medium is 10 rad/m. Calculate the phase velocity, wavelength frequency and intrinsic impedance of the field. The relative permittivity and relative permeability of the medium are 4·8 and 1·0 respectively. 5

9. (a) Define Transverse Magnetic waves, Transverse Electric waves and Transverse Electromagnetic waves. *6*

(b) Explain why TEM waves cannot exist in a single hollow metallic waveguide. *4*

10. Write short notes on any ***two*** of the following : *2×5=10*

(a) Equipotential Surface and its Properties

(b) Poynting Theorem and Poynting Vector

(c) Standing Wave Ratio and its Importance
