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BIEL-006

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

00659

Term-End Examination

December, 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.*

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1. (a) Write down gradient of any scalar and divergence of any vector $\bar{A}$ in different coordinate systems. *5*

(b) Given the two vectors

$\bar{r}_A = -\bar{a}_x - 3\,\bar{a}_y - 4\,\bar{a}_z$ and

$\bar{r}_B = 2\,\bar{a}_x + 2\,\bar{a}_y + 2\,\bar{a}_z$ and a point (1, 3, 4). Find (i) $\bar{r}_{AB}$, (ii) $\bar{a}_{AB}$, and (iii) a unit vector directed from C toward A. *5*

2. (a) Prove the following identity : 6

$\nabla \times \nabla \times \bar{A} = \nabla (\nabla . \bar{A}) - \nabla^2 A$

(b) Transform each of the following vectors to cylindrical coordinates at the point specified : 4

(i) $5\ \bar{a}_x$ at P ($\rho = 4$, $\phi = 120°$, $z = -1$)

(ii) $5\ \bar{a}_x$ at Q ($x = 3$, $y = 4$, $z = -1$)

3. (a) Define the term Electric Field Intensity. State its unit. 3

(b) An infinite uniform line charge λ_L = 2nC/m, lies along the x-axis in free space, while point charges of 8 nC are located at (0, 0, 1) and (0, 0, −1). Find $\bar{E}$ at (2, 3, −4). To what value should λ_L be changed to cause $\bar{E}$ to be zero at (0, 0, 3) ? 7

4. Derive the expression for the capacitance of a spherical capacitor formed of two concentric spherical conducting shells of radius r and R, R > r, by using

(a) Gauss law,

(b) Laplace's equation.

What will be the capacitance of an isolated spherical conductor of radius r ? 8+2

5. (a) State Ampere's circuital law. Express it in integral form. 4

(b) The radius of the inner solid conductor of a coaxial transmission line a = 5 mm. The internal and external radii of the outer conductor are b = 7 mm and c = 8·6 mm respectively. The transmission line supplies 120 kW at 1500 V. Find the magnitude of magnetic field intensity at (i) r = 3 mm, and (ii) r = 6 mm. 6

6. (a) Write Maxwell's equation for harmonic fields in differential form. Give the physical meanings of each equation. 6

(b) Calculate the ratio of conduction current density to displacement current density in a good conductor for which the conductivity is $3·8 \times 10^7$ S/m and relative permittivity is 1·0. The frequency of field intensity that varies harmonically with time is 10^9 Hz. 4

7. State Poynting's theorem starting from Maxwell's equations. Derive the relation expressing the theorem. Hence define Poynting vector and state its unit and also its importance. 6+4

8. (a) What is a Plane Wave ? Derive the general expression of a uniform plane wave and comment on its direction of propagation. 6

(b) Consider that a plane wave at $1 \cdot 5 \times 10^6$ Hz is travelling along positive z-direction in a good conductor for which $\sigma = 3 \cdot 8 \times 10^7$ S/m, $\mu = \mu_0$. Calculate the attenuation constant, phase constant, propagation constant and skin depth. *4*

9. (a) Derive the expressions of the reflection and transmission coefficients. Derive the relationship between the two. Explain what is the basis of that relationship. *6*

(b) The characteristic impedance of an ideal two-conductor transmission line is 75 Ω. It is transmitted with a load of resistance 150 Ω and inductive reactance of 20 Ω. Find the voltage reflection and voltage transmission coefficients at the load terminals. *4*

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

(a) Scalar Magnetic Potential and Vector Magnetic Potential

(b) Impedance Matching by the Use of Quarter-wave Line

(c) Characteristics of TE and TM Waves