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

□□283   **Term-End Examination**

December, 2016

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) Explain the differences between gradient, divergence and curl.   5

   (b) $\overline{A}$ and $\overline{B}$ are the vector fields given by $\overline{A} = 2x\,\overline{a}_x + \overline{a}_y + yz\,\overline{a}_z$ and $\overline{B} = xy\,\overline{a}_z - y^2\overline{a}_y + xyz\,\overline{a}_z$. Find (i) the component of $\overline{A}$ along $\overline{B}$ at $(1, 2, 3)$, (ii) a vector perpendicular to both $\overline{A}$ and $\overline{B}$ at $(0, 1, -3)$ whose magnitude is unity.   5

2. (a) State Gauss' law. What is Gaussian surface ?   5

(b)   A spherical volume of radius 'a' has a volume charge density $\rho_v = kr$, where k is a constant and r is the radial distance. Find the expressions for $\overline{E}$ in the region (i) $r > a$, (ii) $r = a$, (iii) $r < a$. Plot the field.   5

3. (a)   What is meant by conservative field ? Find the work done in carrying 5 C of charge from a point P(1, 2, – 4) to a point Q(3, – 5, 6) in an electric field $\overline{E} = \overline{a}_x + z^2 \overline{a}_y + 2yz\,\overline{a}_z$.   5

(b)   Given the potential function

$$V = 5x^2yz + ky^3z.$$

Determine k so that the Laplace's equation is satisfied. For the value of k, specify the direction of electric field intensity at P(2, 1, – 1).   5

4. (a)   State Biot-Savart law. Express it mathematically.   5

(b)   A circular loop of radius 'a' is located on the x-y plane with its centre at the origin. The loop current is I. Show that the magnetic field intensity at (0, 0, z) is given by $\overline{H} = \dfrac{I\,a^2}{2(a^2 + z^2)^{3/2}}\,\overline{a}_z$. What will be the value of $\overline{H}$ at the centre ?   5

5. **(a)** What is displacement current ? Show that the displacement current density is equal to $\frac{\partial \overline{D}}{\partial t}$.   *5*

   (b) In free space $\overline{E} = 20 \cos (\omega t - 50x) \overline{a}_y$ V/m. Calculate (i) $\overline{J}_D$, (ii) $\overline{H}$, and (iii) ω.   *5*

6. **(a)** What is a plane wave ? Derive the condition for uniform plane wave.   *5*

   (b) A uniform plane wave at frequency $f = 20$ MHz is travelling along the positive z-direction in a medium having $\sigma = 4 \cdot 5 \times 10^{-5}$ S/m, $\varepsilon_r = 8 \cdot 0$ and $\mu_r = 1 \cdot 0$. Calculate the (i) attenuation constant, (ii) phase constant, (iii) propagation constant, (iv) intrinsic impedance, and (v) phase velocity of the wave.   *5*

7. Determine the transmission line differential equations. From the solutions of the equations obtain the expressions for propagation constant and characteristic impedance. Hence find out the expressions for the above two quantities for (i) loss-less, and (ii) distortion-less conditions.   *10*

8. Define transverse magnetic waves. An ideal parallel plate waveguide has conducting plates located at x = 0 and x = a. The TM wave is travelling along positive z-direction between the plates. Derive the expressions for the electric field in x and z directions and magnetic field in y-direction. *10*

9. Distinguish between the following : *2×5=10*

    (a) Scalar magnetic potential and Vector magnetic potential

    (b) Intrinsic impedance and Surface impedance

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

    (a) Continuity of current equation

    (b) Energy stored in magnetic field

    (c) Complex Poynting Vector

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