USN | | | | | | | | | | | | | | | | **15EC36**

Third Semester B.E. Degree Examination, June/July 2019
Engineering Electromagnetics

Time: 3 hrs. | | Max. Marks: 80

Note: *Answer any FIVE full questions, choosing ONE full question from each module.*

Module-1

1 a. Four point charges each $20\mu c$ are on x-y axes at $\pm 4m$. find the force on a $100\mu c$ point charge at $(0, 0, 3)m$. **(06 Marks)**

   b. Define electric field intensity $(\vec{E})$ and using Coulomb's law derives the expression for $\vec{E}$ due to a point charge. **(04 Marks)**

   c. A line charge of density $\rho_\ell = 24$ n c/m is located in free space on the line $y = 1$, $z = 2$. Find electric filed intensity $\vec{E}$ at $P(6, -1, 3)$. **(06 Marks)**

OR

2 a. Derive an expression for Electric field Intensity $\vec{E}$ due to an infinite line charge of density ρ_ℓ c/m. **(08 Marks)**

   b. A point charge of $6\mu c$ is located at origin and a uniform line charge of density 180nc/m lies along x – axis,
   i) Find electric flux density D at $(1, 2, 4)$
   ii) Calculate the total electric flux leaving the surface of a sphere of 4m radius centered at origin. **(08 Marks)**

Module-2

3 a. A charge of Q coulombs is uniformly distributed throughout the volume of a sphere of radius 'R' meters. Using Gauss law Find electric field intensity 'E' everywhere. Plot the variation of E with radial distance. **(08 Marks)**

   b. Given that $D = \dfrac{5r^2}{4}a_r$ in spherical co-ordinates evaluate both sides of Divergence Theorem for the volume enclosed between $r = 1m$ and $r = 2m$. **(08 Marks)**

OR

4 a. Find the work done in moving a $5\mu c$ point charge from origin to $p(2, -1, 4)$ through $E = 2xyz\, ax + x^2 z\, a_y + x^2 y\, a_z$ v/m via the path
   i) Straight line segment $(0, 0, 0)$ to $(2, 0, 0)$ to $(2, -1, 0)$ to $(2, -1, 4)$
   ii) Straight line $x = -2y$, $z = 2x$. **(10 Marks)**

   b. Given potential function $V = 50x^2 yz + 20y^2$ V in free space find
   i) Voltage at $p(1, 2, -3)$
   ii) E at P
   iii) a_N at P **(06 Marks)**

Module-3

5 a. Using Laplace Equation derive the expression for capacitance of co-axial cylindrical capacitor. Assume the potential is a function of 'ρ' only. The boundary condition are $V = 0$ at $\rho = b$ and $V = V_0$ at $\rho = a$ $(b > a)$ (08 Marks)

   b. Conducting planes at $\phi = 10°$ and $\phi = 0°$ in cylindrical co-ordinates have voltages of 75V and 0 V respectively. Obtain the expression for Electric flux density 'D' in the region between the planes which contains a material for which $E_r = 1.65$. (08 Marks)

OR

6 a. Using Biot - Savart's law derive an expression for magnetic field intensity 'H' due to an infinite current carrying conductor at any point P. (08 Marks)

   b. In cylindrical co-ordinates magnetic field $H = (2\rho - \rho^2) a\phi$ A/m. for $0 \le \rho \le I$.
      i) Determine current density 'J'
      ii) What total current passes through a surface $z = 0$, $0 \le \rho \le 1$. (08 Marks)

Module-4

7 a. Derive Lorentz force equation for a moving charge in both electric and magnetic fields. (04 Marks)

   b. The point charge $Q = 18nc$ has a velocity of 5×10^6 m/s in the direction $q_v = 0.60\ a_x + 0.75\ a_y + 0.30a_z$. Calculate magnetic force exerted on the charge by
      i) $B = -3ax + 4ay + 6az$ MT
      ii) $E = -3ax + 4ay + 6az$ KV/m (06 Marks)

   c. The magnetization in a magnetic material for which $\chi_m = 8$ is given in a certain region as $150z^2\ a_x$ A/m. At $z = 4$cm, find the magnitude of J and J_b. (06 Marks)

OR

8 a. Derive the expression for boundary conditions for magnetic flux density B, magnetic field intensity H and magnetization M for both normal and tangential field. (08 Marks)

   b. Let $\mu_1 = 5\ \mu H/m$ in region A where $x < 0$ and $\mu_2 = 20\mu H/m$ in region B where $x > 0$. If there is a surface current density $K = 150\ a_y - 200\ a_z$ A/m at $x = 0$ and if $H_A = 300\ a_x - 400a_y + 500a_z$ A/m find (i) $|H_{tA}|$ (ii) $|H_{NA}|$ (iii) $|H_{tB}|$ (iv) $|H_{NB}|$ (08 Marks)

Module-5

9 a. What was the inconsistency of Ampere's law with continuity equation? How was it modified by Maxwell? (06 Marks)

   b. Show that the displacement current in the dielectric of parallel plate capacitor is equal to conduction current between the two plates. (04 Marks)

   c. Given $E = E_m \sin(wt - \beta z)\ a_y$ V/m in free space find, D, B and H. (06 Marks)

OR

10 a. Show that the intrinsic impedance defined as $\eta = \dfrac{|E|}{|H|}$ is equal to $\sqrt{\dfrac{\mu}{\in}}$ for a perfect dielectric and hence prove that for free space $\eta = 377\Omega$. (08 Marks)

   b. A wave propagation in a lossless dielectric has the components
      $E = 500 \cos (10^7t - \beta z)\ a_x$ V/m
      $H = 1.1 \cos (10^7t - \beta z)\ a_y$ A/m
      If the wave is travelling at $v = 0.5C$, where 'C' is velocity of light in free space find $\mu_r, \in_r, \beta, \lambda$. (08 Marks)