Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

III SEMESTER B.TECH (ELECTRICAL & ELECTRONICS ENGINEERING)

MAKE UP EXAMINATIONS, DEC 2015 / JAN 2016

SUBJECT: ELECTROMAGNETIC THEORY [ELE 207]

Time: 3 Hours 7 January 2016 MAX. MARKS: 50

Instructions to Candidates:

- Answer any **FIVE FULL** questions.
- Missing data may be suitable assumed.

1A. Determine the field intensity at a point 'P' at a distance 'h' meters above a straight, uniformly charged wire with a linear density of $+\lambda$ coulomb per meter length. Find the electric field intensity if the point under consideration is along the perpendicular bisector of the wire. **4**

1B. A uniform sheet charge with $\boldsymbol{\rho}_s = (1/3\pi)$ nC/m^2 is located at z = 5m and a uniform line charge with $\boldsymbol{\rho}_L$ = - (25/9) nC/m at z= -3 , y = 3 m . Find **E** at (x, -1, 0) **3**

1C. If $\mathbf{D} = (2y^2 + z)\,\mathbf{a_x} + 4xy\,\mathbf{a_y} + x\,\mathbf{a_z}$ C/m^2, find

a) The volume charge density at (-1, 0, 3)

b) The flux through the cube defined by $0 \le x \le 1$, $0 \le y \le 1$, $0 \le z \le 1$

c) The total charge enclosed by the cube **3**

2A. Two extensive homogeneous isotropic dielectric meet on z = 0. For $z \ge 0$, $\varepsilon_r = 4$ and for $z \le 0$, $\varepsilon_r = 2$. A uniform electric field $\mathbf{E_1} = 6\mathbf{a_x} + 2\mathbf{a_y} - 3\mathbf{a_z}$ exists for $z \ge 0$. Find:

a) $\mathbf{E_2}$

b) Angle made by $\mathbf{E_2}$ to the interface. **4**

2B. A spherical capacitor with a = 1.5 cm and b = 4 cm has an inhomogeneous dielectric of $\varepsilon = (10\varepsilon_0) / r$. Calculate capacitance of the capacitor. **3**

2C. A point charge of 5 nC is located at the origin. If V = 2 V at (0, 6, -8), find

a) The potential at A(-3, 2,6) ,

b) The potential at B(1, 5, 7)

c) The potential difference V_{AB} **3**

3A. The positive y-axis with a semi-infinite line with respect to origin carries a current of 2 A in the $-\mathbf{a_y}$ direction. Find **H** at :

a) A (2, 3, 0)

b) B (3, 12, -4) **3**

3B. Derive the expression for **H** at any point due to infinite sheet carrying current in the x-y plane using Ampere's circuital law. **4**

3C. Given $\boldsymbol{H} = y^2z\,\boldsymbol{a_x} + 2(x+1)yz\boldsymbol{a_y} - (x+1)z^2\boldsymbol{a_z}$.

a) Find the total current enclosed in the square path from P (0, 2, 0) to Q (0, 3, 0) to R (0, 3, 1) to S (0, 2, 1) to P

b) Prove that the line integral of **H** over a closed path is equal to the surface integral of curl of **H** for the given field. **3**

4A. A current filament carrying 8 A in the $\mathbf{a_z}$ direction lies along the entire **z-axis** in free space. A rectangular loop connecting A (0, 0.2, 0) to B (0, 0.2, 0.3) to C (0, 0.7, 0.3) to D (0, 0.7, 0.2) to A lies in the x = 0 plane. The loop current is 3 mA and it flows in the $\mathbf{a_z}$ direction in the AB segment.

a) Find force **F** on the side AB

b) Find force **F** on the side DA **3**

4B. The core of a toroid is 12 cm^2 and is made of material $\mu r = 200$. If the mean radius of the toroid is 50 cm, calculate the number of turns needed to obtain an inductance of 2.5 H. **3**

4C. Consider the loop of **Fig.1**. If **B** = 0.5 $\mathbf{a_z}$ Wb/m2 , R = 20 Ω, l = 10 cm, and the rod is moving with a constant velocity of 8 $\mathbf{a_x}$ m/s, find:

a) The induced emf in the rod

b) The current through the resistor

c) The motional force on the rod

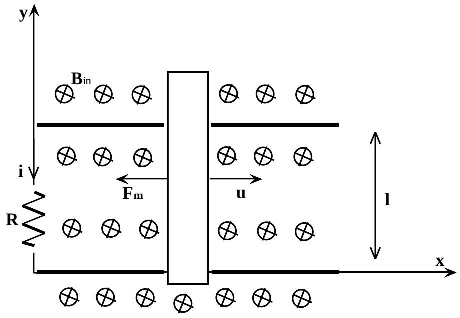

Fig.1 **4**

5A. In a medium characterized by σ =0 ,ε = ε_o, μ= μ_o E(z , t) = 20sin(10^8t – βz)$\mathbf{a_y}$ V/m. Calculate β and **H.** **2**

5B. At 50MHz, a lossy dielectric material is characterized by ε = 3.6ε_o, μ=2.1μ_o, and σ = 0.08 S/m. If $\mathbf{E_s}$ = 6$e^{-\gamma x}$ a_z V/m. Calculate (a) γ (b) λ (c) η (d) $\mathbf{H_s}$ and (e) velocity of wave. **4**

5C. In free space (z ≤ 0) a plane wave with $\mathbf{H_i}$= 100 sin(10^8t - βz) $\mathbf{a_x}$ A/m is incident normally on a lossless medium (ε = 2ε_o, μ=8μ_o) in region z ≥ 0 . Determine reflected wave $\mathbf{E_r}$ and the transmitted wave $\mathbf{H_t}$. **4**

6A. Derive poynting theorem and show that total power leaving the volume is equal to rate of decrease in energy stored in electric and magnetic fields minus power dissipated **4**

6B. In free space, **H** (z , t) = 0.2sin(ωt – βz)$\mathbf{a_y}$ A/m. Find the total power passing through the circular disk of radius 5 cm on plane z =1. **2**

6C. An EM waves travels in free space with electric field component $\mathbf{E_s} = 60e^{j(0.5y + 0.866z)}$ $\mathbf{a_x}$ V/m. Determine

a) ω and λ

b) The magnetic field component

c) The time average power in the wave. **4**