Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

III SEMESTER B.TECH (ELECTRICAL & ELECTRONICS ENGINEERING)

END SEMESTER EXAMINATIONS, NOV/DEC 2015

SUBJECT: ELECTROMAGNETIC THEORY [ELE 207]

Time: 3 Hours 05 DECEMBER 2015 MAX. MARKS: 50

Instructions to Candidates:

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

1A. A circular disc of radius **a** carries a uniform charge $\boldsymbol{\rho_s}$ C/m^2 and is placed on the **x-y** plane with the axis same as z-axis. Derive the expression for electric field at (0, 0, h) from the center. **3**

1B. Spherical surfaces at r = 2, 4, and 6m carry uniform surface charge densities of 20nC/m^2, - 4nC/m^2 and ρ_{so} respectively. (a) Find **D** at r = 1m and 3m. (b) Determine ρ_{so} such that **D** = 0 at r = 7m. **4**

1C. Two parallel conducting planes in free space are at y = 0 and y = 0.02 m with potential **0** and **V** volts respectively. If **D** = 253 $\mathbf{a_y}$ nC/m^2 between the conductors, determine the conductor voltage. **3**

2A. In the region of free space that included the volume 2 < x, y, z < 3, **D** =2xy $\mathbf{a_x}$ + x^2 $\mathbf{a_y}$ + 6z^3 $\mathbf{a_z}$ C/m^2. Verify both sides of divergence theorem. **4**

2B. A cylindrical capacitor has radii a =1 cm and b = 2.5 cm. If the space between the plates is filled with an inhomogeneous dielectric with ε_r = (10+ρ)/ ρ where ρ is in centimeters, find the capacitance per meter of the capacitor. **4**

2C. Three point charges - 2nC, 6nC and 2nC are located at (0,0,0), (0,0,2) and (2,0,0) respectively. Find the total energy in the system. **2**

3A. An infinitely long filamentary wire carries a current of 2A in the +z direction. Calculate

I. **B** at (-3, 4, 4)

II. The flux through the square loop described by 2 ≤ ρ ≤ 6, 0 ≤ z ≤ 4, ϕ = 90^o. **2**

3B. Determine the self-inductance of a co-axial cable per unit length of inner radius **a** and outer radius **b**. **4**

3C. Region 1 described by $2x+5y \geq 10$ is free space while region 2 described by $2x+5y \leq 10$ is a magnetic material for which $\mu = 8\mu_0$. Assuming that boundary between the material and free space is current free , if $\mathbf{B_1} = 0.2\,\mathbf{a_x} + 0.4\,\mathbf{a_y} + 0.1\,\mathbf{a_z}$ Wb/m^2 find $\mathbf{B}_2$, $\mathbf{H_2}$ **4**

4A A charged particle of mass 2 kg and charge 3C starts at point (1,-2,0) with velocity $4a_x+3a_z$ m/s in electric filed $2a_x+10a_y$ V/m . At t = 1s, determine

a) Acceleration of the particle

b) Its velocity

c) Its kinetic energy **4**

4B If $H=(4z-y)a_x+6xza_y$, then find the current density and current passing through the plane y = 2, -2 < x < 2, 1 < z < 3. Verify both sides of stokes theorem. **4**

4C. A circular conducting loop of radius 20 cm and resistance 5 Ω lies in z = 0 plane in a magnetic field $\mathbf{B} = 10\cos(377t)a_z$ mWb/m^2. Calculate the current induced in the loop **2**

5A. In free space $\mathbf{E} = 20\cos(\omega t - 50x)a_y$ V/m. Calculate $\mathbf{J}_d$, **H** and ω. **3**

5B. In a certain medium $\mathbf{E} = 16e^{-0.05x}\sin(2\times10^8 t - 2x)a_z$ V/m. Find (a) The propagation constant (b) the wavelength (c) the speed of the wave (d) the skin depth. **3**

5C. In a nonmagnetic medium ($\mu_r = 1$) $\mathbf{E} = 50\cos(10^9 t - 8x)a_y + 40\sin(10^9 t - 8x)a_z$ V/m. Find the dielectric constant ε_r, Direction of wave propagation, the corresponding **H** Field. **4**

6A. Derive pointing 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, $\mathbf{E}(z , t) = 150\sin(\omega t - \beta z)a_x$ V/m. Find the total power passing through the rectangular area, of sides 30 mm and 15 mm, in the z = 0 plane. **2**

6C. An EM wave travels in free space with electric field component $\mathbf{E} = (10a_y + 5a_z)\cos(\omega t + 2y - 4z)$ in free space. (a) Calculate λ and ω (b) The angle of incidence (c) The reflected **E** and **H** field. **4**