MANIPAL
ACADEMY of HIGHER EDUCATION

Reg. No.										

DEPARTMENT OF SCIENCES, I/III SEMESTER M.Sc (Physics)
END SEMESTER EXAMINATIONS, NOVEMBER/DECEMBER 2019

ELECTROMAGNETIC THEORY [PHY- 5103]

(REVISED CREDIT SYSTEM-2017)

Time: 3 Hours | Date: 18/11/2019 | MAX. MARKS: 50

Note: (i) Answer **ALL** questions
(ii) Assume missing data, if any

1. (a) Discuss the need for introducing Dirac delta function and explain how the issues related to divergence theorem are resolved using Dirac delta function.

(b) Consider a point charge q which is held a distance d above an infinite grounded conducting plane. Using classical image problem, determine the potential in the region above the plane. Also estimate the surface charge induced on the conductor.

(c) Suppose the electric field in some region is found to be $\mathbf{E} = k\mathbf{r}^3$ which is in the direction of r. Estimate the charge density. Here k is some constant. **[3+5+2]**

2. (a) Consider a localized current distribution. Using the method of multipole expansion, derive the expression for vector potential at distant points.

(b) Derive Gauss's law in presence of dielectrics.

(c) Two metal objects are embedded in weakly conducting material of electrical conductivity σ. Show that the resistance between them is inversely proportional to the capacitance of the arrangement. **[4+3+3]**

3. (a) Derive the expression for energy in magnetic fields.

(b) Write down the equations of electrodynamics before Maxwell. Discuss how Maxwell modified Ampere's law.

(c) The intensity of sunlight hitting the earth is about 1300 W/m^2. If the sunlight strikes a perfect absorber, what pressure does it exert? **[3+4+ 3]**

4. (a) Consider an *EM* wave incident normal to the boundary between two linear media. Derive the expressions for reflection and transmission coefficients.

(b) In the context of an *EM* wave in conductors, derive the expression for skin depth and also discuss its dependence with frequency of the *EM* wave. **[5+5]**

5. (a) Using the concept of retarded time, introduce the expressions for retarded potentials.

(b) Consider two tiny metal spheres separated by a distance s and connected by a fine wire. Let the system be driven at a frequency ω. Using various approximations, derive the expression for Poynting vector.

(c) Discuss scalar and vector potentials in electrodynamics. **[3+5+2]**