EASTERN UNIVERSITY, SRI LANKA

SECOND EXAMINATION IN SCIENCE - 2013/2014

SECOND SEMESTER (Oct./Nov., 2016)

AM 218 - FIELD THEORY

(PROPER)

nswer all Questions | Time: Two hours

Q1. State the *Coulomb's law* and *Gauss's Law* in Electric field.

(a) A total amount of charge Q is uniformly distributed along a thin, straight, plastic rod of length L. Find the electric force acting on a point charge q located at a point P, at a horizontal distance d from one end of the rod.

(b) A spherical conductor of radius a carrying a charge e_1 is surrounded by a concentric spherical conducting sheet of radius b and carrying a charge e_2, both conductors being insulated. Find the potential at a point between the spheres. If the inner conductor is connected by a fine insulated conducting wire passing through a small hole in the outer conductor to a distant uncharged and insulated spherical conductor of radius c, prove that the latter will be raised to a potential $\dfrac{e_1 b + e_2 a}{4\pi\epsilon_0 b(a+c)}$, where ϵ_0 is the permittivity of free space.

2. (a) Define the terms *electric potential* and *electric dipole*.

A total charge Q is distributed along a straight rod of length L. Find the potential at a point P at a vertical distance h from the mid point of the rod.

Prove that the electric potential ϕ at a point P with position vector $\underline{r}$ form the dipole moment $\underline{p}$ is given by

$$\phi = \frac{\underline{p}.\underline{r}}{4\pi\epsilon_0 r^3}.$$

(b) State the Poisson's equation in electric field.

Show that the solution of the equation $\nabla^2\phi = 0$ in rectangular coord given by

$$\phi = e^{\pm i\alpha x} e^{\pm i\beta y} e^{\pm\sqrt{\alpha^2+\beta^2}z},$$

where α and β are arbitrary constants.

Q3. (a) Using Ampere's circuit law and Biot-Savart law, prove that $\nabla^2\phi = 0$, is scalar potential.

(b) Show that the equivalence between Biot-Savart and Ampere's laws brought out by determining the magnetic field $\vec{B}$ due to an infinit conductor carrying a steady current through it.

(c) Particle A with charge q and mass m_A, and particle B with charge mass m_B are accelerated from rest by a uniform magnetic field in circular paths. The radii of the trajectories of the particles A and B a 2R, respectively. The direction of the magnetic field is perpendicula velocity of the particle. Show that $m_A : m_B = 1 : 8$.

Q4. (a) Define the terms magnetic flux density and the magnetic dipole. Show that $\vec{\nabla}.\vec{B} = 0$ in space, where $\vec{B}$ is the magnetic field.

(b) If the magnetic field normal to the plane of a circular coil of n turns and r which carries a current I is measured on the axis of the coil, show t magnetic field at a small distance h from the center of the coil is

$$\frac{\mu_0 nI}{2r}\left(1 - \frac{3h^2}{2r^2}\right) \qquad \text{where } r >> h.$$

(c) An amount of charge Q is uniformly distributed over a disk of radius disk spins about its axis with angular velocity ω. Find the magnetic moment of the disk.