EASTERN UNIVERSITY, SRI LANKA
EXTERAL DEGREE EXAMINATION IN SCIENCE - 2010/2011
SECOND YEAR SECOND SEMESTER (March/May, 2017)
EXTMT 218 - FIELD THEORY
(SPECIAL REPEAT)

Answer 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 distance d far away along the rod direction from one of its end.

(b) A spherical volume charge density distribution is given by

$$\rho = \begin{cases} \rho_0 \left(1 - \dfrac{r^2}{a^2}\right) & r \leq a; \\ 0 & r > a, \end{cases}$$

where ρ_0 is a constant and a is the radius of the spherical volume.

(i) Calculate the total charge Q;

(ii) Find the electric field intensity E outside the sphere;

(iii) Find the electric field intensity E inside the sphere;

(iv) Show that the maximum value of E is attained at $r = .0.745a$.

(P.T.O)

Q2. (a) Define the terms *electric potential* and *electric dipole.*

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

Prove that the electric potential ϕ at a point P with position vector $\underline{r}$ form t 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 coordinates 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 $\nabla^2\phi = 0$, where is scalar potential.

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

(c) Particle A with charge q and mass m_A and particle B with charge $2q$ and ma m_B are accelerated from rest by a uniform magnetic field into semi-circul paths. The radii of the trajectories of the particles A and B are R and $2R$ respectively. The direction of the magnetic field is perpendicular to the veloci of the particle. Show that $m_A : m_B = 1 : 8$.

Q4. (a) Define the term *magnetic flux density* and the *magnetic dipole.*

Show that $\overrightarrow{\nabla}.\overrightarrow{B} = 0$ in space, where $\overrightarrow{B}$ is a magnetic field.

(b) Find the magnetic field at the center of a current carrying square coil of a wi with sides $2a$.

(c) Let an amount of charge Q be uniformly distributed over a disk of radius R If the disk spins about its axis with angular velocity ω, then find the magnet dipole moment of the disk.