



EASTERN UNIVERSITY, SRI LANKA

EXTERNAL DEGREE EXAMINATION IN SCIENCE - 2008/2009

SECOND YEAR SECOND SEMESTER (April/May, 2016)

EXTMT 218 - FIELD THEORY

(REPEAT)

Answer all Questions

Time: Two hours

Q1. State the Coulomb'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

- (i) at a distance d far away along the rod direction from one of its end;
- (ii) at a perpendicular distance y from the midpoint of the rod.

(b) Suppose a very large sheet has a uniform charge density of σ coulomb per square meter. Find the electric field strength where the location of the point of intersection coincides with z - axis.

Q2. (a) Define the term electric dipole.

Prove that the electric potential ϕ at a point P at a distance r from the dipole of moment p is given by

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

and the electric field components due to the dipole is given by

$$E_r = \frac{p \cos \theta}{2\pi\epsilon_0 r^3} \text{ and } E_\theta = \frac{p \sin \theta}{4\pi\epsilon_0 r^2},$$

where E_r and E_θ are field components along the radial and angular directions.

(P.T.O)

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

Q3. (a) State the Biot-Savart law and prove that $\vec{\nabla} \cdot \vec{B} = 0$.

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

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

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

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

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