Indian Statistical Institute

Physics III: Electromagnetism & Electrodynamics
March 2004

Time: Two Hours Maximum : 50 marks

Instructions: (i) All questions carry equal marks
(ii) Answer any THREE full questions from PART-A
(iii) Answer any TWO questions from PART-B

PART-A

1. a) State and explain Coulomb's Law.

   b) Define electrostatic potential and electric field intensity.

   c) Derive a relation between electric field intensity and electrostatic potential

2. a) State the Faraday's Law of electromagnetic induction.

   b) Derive Maxwell's equation connected with Faraday's Law.

   c) Derive an expression for the motional e.m.f using Faraday's Law.

3. a) Write down Maxwell's equations in free space for the time varying fields both in differential and integral forms.

   b) Derive the equation of continuity.

   c) Show that the conduction current in a parallel plate

capacitor is the same as the displacement current through it.

4. a) State and explain Biot-Savart's law.

b) Using Biot-Savart's law derive an expression for the magnetic flux density at any point on the axis of a solenoid.

5. a) State and prove Gauss Law.

b) Using Gauss Law find the electric field due to a spherical shell of charge
(i) at a point outside the surface.
(ii) at a point on the shell.
(iii) at a point inside the shell.

PART-B

1. a) Find the capacitance of a parallel plate capacitor:

(i)When the plate area is $1m^2$, distance between the plates is 1mm, voltage gradient is 10^5 V/m and charge density on the plates is 2 micro coulomb/m^2.

(ii) When the stored energy is 5 micro joules and the voltage across the plate is 5V.

2. a) A solenoid of 10 cm diameter and 30 cm length is wound with 150 turns and carries a current of 5A. Find magnetic flux density at a point on the axis at a distance 10 cm from the mid-point of the solenoid.

b) A solenoid with air-core has 2000 turns and a length of 500 mm. Core radius is 40 mm. Find its inductance

3. a) It is required to hold four equal point charges each in equilibrium at the corners of a square. Find the point charge which will do this, if placed at the center of the square.

4. a) Given the potential field $V = 50\ x^2yz + 20\ y^2$ Volts in free space. Find,
(i) Voltage at a point P(1,2,-3)
(ii) Field strength at P