1963   *Your Roll No.* ....

B.Sc. (Prog.) / II   E

MP-202 : Thermal Physics and
Electromagnetism

(Admissions of 2005 and onwards)

Time : 3 Hours   *Maximum Marks : 75*

*(Write your Roll No. on the top immediately
on receipt of this question paper.)*

Attempt **five** *questions in all.*
All *questions carry equal marks.*

1. (a) Explain the terms adiabatic and isothermal
    changes.   (2,2)

    (b) State the first law of thermodynamics and discuss
    its physical significance.   (5)

    (c) Derive for a perfect gas the expression
    connecting pressure and volume during an adiabatic
    process.   (6)

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2. (a) Give Kelvin-Planck and Clausius statements of second law of thermodynamics and explain its physical significance.   (6)

    (b) Prove that all reversible engines working between the same two temperatures have the same efficiency.   (5)

    (c) What is mean free path ? Calculate the mean free path of a gas molecule whose diameter is $3 \, A^0$ and number of molecules per c.c. is 3×10^{19}.   (1,3)

3. (a) Define the following terms :

    (i) microstate

    (ii) macrostate

    (iii) phase space

    (iv) thermodynamic probability   (8)

    (b) What is entropy ? Establish Boltzmann relation connecting entropy and probability.   (3,4)

4. What is electron gas ? Derive distribution law of Fermi-Dirac statistics. What is meant by Fermi energy ?   (2,11,2)

5. (a) Define electric potential. Find the expression for electric field intensity in a region where potential is given by

$$V = -A \ xy \qquad (2,3)$$

(b) State Gauss's law in electrostatics. Explain it in differential form. (2,2)

(c) Prove that electric field near the surface of a conductor is σ/ε_0 where σ is the surface charge density. (6)

6. (a) State and explain Biot-Savart's law. (3)

(b) Using Biot-Savart's law show that

(i) $\nabla.B = 0$. Explain its significance.

(ii) $\nabla \times B = \mu_0 J$

where symbols have their usual meaning. (6,6)

7. (a) Write Maxwell's equations for electromagnetic waves in free space. Derive the wave equation satisfied by electric and magnetic fields. (8)

(b) Write the plane wave solution of the wave equation and show that the electromagnetic waves are transverse in nature. (7)

8. Write short notes on any **two** of the following :

(a) Thermodynamic potentials

(b) Maxwell's distribution law of molecular velocities

(c) Faraday's laws of electromagnetic induction

(d) Poynting theorem   (2×7.5)