RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College under University of Calcutta)

SECOND YEAR

B.A./B.SC. THIRD SEMESTER (July – December), 2011

Mid-Semester Examination, September, 2011

Date : 12/09/2011

Time : 2 pm – 4 pm

PHYSICS (Honours)

Paper : III

Full Marks : 50

Section-I **Answer all questions**

1. a) Explain the terms :
i) Magnetization, ii) Magnetic intensity and iii) Magnetic induction. 3

b) Define magnetic susceptibility and permeability. Establish the relation between them. 2+2

c) What is Bohr magneton ? 1

d) In a material the magnetization is $\vec{M} = 2y\hat{i} - 3x\hat{k}$ Am^{-1}. What is the bound current density ? 2

2.a) Consider a wire with a square cross section of area 1 mm × 1 mm, carrying a current of one Amp. Current density in the wire is uniform along the wire, find the drift velocity of the charge carrier in it. Given: $e = 1.6 \times 10^{-19} C$, $n = 10^{22}$ electron per cc.. 3

b) State and prove Thevenin's theorem. 1+3

c) Obtain the Thevenin equivalent circuit of a Wheatstone bridge network consists of four resistsnces (R_1, R_2 R_3 and R_4), a battery (emf V volt) with zero internal resistance connected between the junctions of R_1 , R_2 and R_3 , R_4 . 3

3.a) What is meant by a Carnot cycle? Show it on a P-V diagram. 1+1
Obtain an expression for the efficiency of a Carnot cycle. 4

b) A cylinder contains 1 mole of oxygen gas at a temperature of $27^0 C$. The cylinder is provided with a friction less piston such that it maintains a constant pressure of 1 atmosphere on the gas. The gas is heated until its temperature increases to $127^0 C$. Find i) the work done by the gas in this process and ii) the change in internal energy during this process.
[Given : R=8.3 J.mol.$^{-1}$ K^{-1}, C_v=2.5 R] 2+2

Section-II. **Answer any two questions** from following.

4.a) Starting from Coulomb's law prove that $\vec{\nabla} \times \vec{E} = 0$ for electrostatic field. Explain its physical significance. 2+2

b) A charge q = 2 microC is placed at a point 10 cm from an infinite grounded conducting plane sheet. Find i) the total charge induced on the sheet and ii) the force acting on the sheet. 3+3

5.a) What is Laplace's equation ? What is its importance in electrostatics ? 1+2

b) A point charge q is placed at a distance r_o from the centre of a grounded spherical conductor of radius a ($a < r_o$). Assuming the solution of Laplace's equation, find i) the potential at an external point and ii) total charge induced on the sphere. 4+3

6.a) Find the multipole expansion of the scalar potential due to an arbitrary localized charge distribution for a point well outside the charge distribution. 6

b) If the total charge is zero in the problem above, find the dominant term in the expression of the potential. Hence find the potential at a large distance from two point charges +q, -q separated by a distance d. 4