Ex/M.Sc/M/B-1.31/37/2017

MASTER OF SCIENCE EXAMINATION, 2017

(2nd Year, 1st Semester)

MATHEMATICS

Unit - 3.5 (B-1.31)

(Plasma Mechanics - I)

Full Marks : 50 Time : Two Hours

The figures in the margin indicate full marks.

Use a separate Answer Script for each Part.

(Symbols / Notations have their usual meanings.)

Part - I

(Marks - 25)

Answer Question No. 1 and any *one* question from the rest.

1. (a) Derive the induction equation for electrically conducting fluid.

   (b) Derive the expression of magnetic pressure term in the equation of motion for highly conducting fluid.

[*Turn over*]

(c) Modify Navier-Stokes equation of classical fluid dynamics in MHD for the electro-magnetic force experienced by an electrically conducting fluid due to the interaction of the charged particle with electromagnetic field.

(d) State Alfvén theorem. 3+3+7+2=15

2. Show that the orbit of a charged particle in static (time independent) uniform (space independent) magnetic field is a helix. In this connection, define Larmor radius or radius of gyration and Larmor frequency or cyclotron frequency. 8+2=10

3. Describe the motion of a charged particle in a constant electric field and also in a constant magnetic field. Hence derive the $\vec{E} \times \vec{B}$ drift velocity and show that in neutral plasma this drift velocity produces no net current. 6+(2+2)=10

Part - II

(Marks - 25)

Answer Question No. 4 and any *one* question from the rest.

4. (a) What are the basic assumptions required for deriving distribution function under equilibrium condition ?

[*Turn over*]

(b) State general principle of detailed balance in Binary Collission.

(c) State briefly about summation invariance.

(d) Derive expression for Maxwell-Boltzmann distribution function.

(e) Determine the constant coefficients in terms of observed physical properties of the system. 2+2+3+4+5=16

5. Derive the expression for distribution of speed.

Using this expression, determine average value of speed, root mean square speed and most probable speed.

3+2+2+2=9

6. Derive the expression for number density of charge q in equilibrium under the action of electrostatic potential $\Phi(r)$. Using distribution of thermal kinetic energy E, show that velocity of particles which have this energy is equal to $\left(\kappa T/m\right)^{0.5}$. 5+4=9