PG – 227

IV Semester M.Sc. Examination, June 2016
(CBCS)
MATHEMATICS
M403TA : Magnetohydrodynamics

Time : 3 Hours Max. Marks : 70

*Instructions : Answer **any five** questions.*
*All questions carry **equal** marks.*

1. a) Explain the SI system of units as required by MHD. 6
   b) Show that an electrostatic field is both solenoidal and irrotational in the absence of free charges. 8

2. Prove or disprove the following :
   a) The normal component of magnetic field is always continuous at the interface.
   b) The tangential component of electric field $\vec{E}$ is always continuous at the interface between two media. (7+7)

3. a) Derive the magnetic induction equation in its usual form and give the physical significance of each term involved therein. 6
   b) Derive the equation of motion for an incompressible electrically conducting fluid in its standard form. 8

4. a) State and prove Alfven's theorem and hence explain the concept of frozen-in phenomenon. 8
   b) Show that the angular velocity of a perfectly conducting fluid body rotating steadily about the axis of symmetry in a magnetic field does not change along the magnetic field lines. 6

5. a) Show that the Lorentz force is always conservative in magnetostatics and further deduce that $p + \rho\Omega =$ constant along $\vec{B}$ and $\vec{J}$ lines. 8
   b) Prove that $\vec{B} \times (\nabla \times \nabla)\vec{B} = 0$, where $\vec{B}$ is a force-free magnetic field. 6

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6. a) State and prove Chandrasekhar's theorem on a force-free magnetic field. 7

   b) Explain, Bennet pinch and any two instabilities associated with it. 7

7. a) Explain briefly the experiments of Lundquist and Lehnert to demonstrate the existance of Alfvén waves. 4

   b) Establish the relation, $\vec{J} \times \vec{B} = \nabla \cdot T_m$, where T_m is a stress tensor. 6

   c) Discuss an application of Alfvén waves. 4

8. Obtain the velocity and temperature distributions for one-dimensional hydromagnetic plane couette flow. 14