60887

Reg. No. | | | | | | | | |

IV Semester M.Sc. Degree Examination, September/October - 2022

MATHEMATICS

Magnetohydrodynamics

Paper : M 403 T(E)

(CBCS Y2K17 Scheme)

Time : 3 Hours **Maximum Marks : 70**

Instructions to Candidates:

1. Answer any **five** questions.
2. All questions have **equal** marks.

1. a. State and explain Faraday's law of induction and show that $\nabla \times \vec{E} = \frac{\partial \vec{B}}{\partial t}$ for a stationary circuit, with the usual notation.

   b. Discuss the system of SI units as required in magnetohydrodynamic theory. **(8+6)**

2. a. State magnetic force law and also derive the expression $\vec{B} = \nabla \times \vec{A}$, with the usual notations.

   b. State Ohm's law. With usual notations, derive Ohm's law in its standard form. **(7+7)**

3. a. Derive magnetic induction equation in its usual form. Explain the physical significance of each terms involved therein.

   b. State and prove Ferraro's law of isorotation. **(7+7)**

4. a. State and prove Alfven's theorem and hence explain the concept of frozen - in - phenomenon.

   b. Show that there is no leakage of magnetic flux in a perfectly electrically conducting fluid. **(8+6)**

5. a. Establish the integrability condition $\vec{B} \times \left(\nabla \alpha . \vec{B}\right) = 0$ for a magnetic field $\vec{B}$ to be force - free at all times.

   b. Discuss kink and sausage mode of instabilities. **(8+6)**

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6. a. Explain the cause of propagation of Alfven waves and discuss the applications of Alfven waves pertaining to geophysical and astrophysical context.

   b. Describe the experiments of Lundquist and Lehnert demonstrate the existence of Alfven waves and hence derive the classical Alfven waves equations in their usual form. **(6+8)**

7. a. Show that the transverse Alfven waves transport equal amount of kinetic and magnetic energies.

   b. Show that the Lorentz force can be expressed as a surface force represented by the stress tensor $\underline{T}_M$ in the form $\vec{J} \times \vec{B} = V.\underline{T}_M$. **(7+7)**

8. a. Obtain the velocity and temperature distributions of a hydromagnetic plane Couette flow.

   b. Discuss the physical significance of Hartmann number and Prandtl number. **(10+4)**
