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

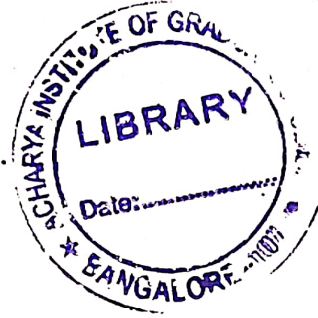
MATHEMATICS
Magnetohydrodynamics
Paper : M 403 T(E)
(CBCS Y2K17 Scheme)

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 $\vec{B} \times (\nabla \alpha \cdot \vec{B}) = 0$ for a magnetic field \vec{B} to be force - free at all times.
- b. Discuss kink and sausage mode of instabilities. (8+6)

[P.T.O.]



6. a. Explain the cause of propagation of Alfvén waves and discuss the applications of Alfvén waves pertaining to geophysical and astrophysical context.
- b. Describe the experiments of Lundquist and Lehnert demonstrate the existence of Alfvén waves and hence derive the classical Alfvén waves equations in their usual form. (6+8)
7. a. Show that the transverse Alfvén 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 $\vec{J} \times \vec{B} = \nabla \cdot \underline{T}_M$. (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)

