60887

Reg. No.

IV Semester M.Sc Degree Examination, September- 2021

MATHEMATICS

Magnetohydrodynamics

(CBCS Scheme -Y2K17)

Paper M403T(E)

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

Note : *1. Answer any FIVE questions*

2. All questions Carries Equal Marks.

1. a) Derive Ohm's law in its usual form.

   b) Define electrodynamics and hence derive Faraday's law of induction in its usual form.

   c) Discuss briefly about electromagnetic units. **(5+5+4)**

2. a) Using Ampere's law, show that Newton's third law is valid and hence obtain vector potential, scalar potential, Lorentz force and solenoidal property.

   b) Prove that the tangential component of the electric field is continuous across the interface.

   c) Derive the equation of conservation of charges in its usual form. **(5+5+4)**

3. a) Derive the energy equation in its usual form.

   b) State and prove Chandrasekhar's theorem. **(7+7)**

4. a) Derive Bernoulli's equation in MHD in its usual form.

   b) Define and explain force free magnetic field and derive basic equations of force free magnetic field.

   c) Prove that in a force free magnetic field the magnetic field lines will lie on the boundary. **(5+5+4)**

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~~5.~~ 6. a) State and prove Ferraro's law of isorotation.

   b) Prove that the abnormality parameter a is either a constant or function of both position and time. **(7+7)**

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7. a) Derive the Alfven wave equation in an incompressible perfectly conducting fluid in the presence of a suitable magnetic field.

b) Examine the nature of $\vec{B}(x)$ in the rectangular co-ordinate system. (8+6)

8. Explain Hartmann flow and hence obtain its velocity distribution. (14)

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5. (a). State and explain approximations in MHD.

(b). For any force free magnetic field show that

(i) $\alpha = \dfrac{\bar{B}\cdot(\nabla\times\bar{B})}{|\bar{B}|^2}$ (ii) $\alpha = \dfrac{(\nabla\times\bar{B})\cdot(\nabla\times(\nabla\times\bar{B}))}{|\nabla\times\bar{B}|^2}$

(c). If $B = \nabla\phi + \psi\nabla\eta$ is force free magnetic field then prove that

$$\alpha = \frac{(\nabla\phi)\cdot(\nabla\psi\times\nabla\eta)}{|\nabla\phi|^2 - \psi^2|\nabla\eta|^2}.$$

(5+5+4).