

2012
Paper : 205-C

(Magnetohydrodynamics)

1. Answer any *two* questions : $6 \times 2 = 12$

(a) (i) Identify the forces experienced by a charged particle in a conducting media due to electromagnetic phenomena.

3

(ii) Define relative and absolute quantities in MHD. Give two examples for each.

3

(b) Find the total electromagnetic body force experienced by unit volume of conducting fluid.

6

(c) State and prove the Pointing theorem. 6

Or

Discuss the energetic aspects of MHD.

6

2. Answer any *two* questions : $5 \times 2 = 10$

(a) Deduce the magnetic induction equation and explain each term of this equation. 5

(b) For the perfectly conducting fluid, establish the following statement :

"The magnetic flux linking any loop, moving with perfectly conducting fluid is constant."

5

(c) State and prove Ferraro's law of isorotation.

5

3. Answer any *one* question : 10

(a) Discuss the kinematic aspects of two dimensional flow with current in the direction of no variation. 10

(b) Discuss the general approach to solve two dimensional kinematic problem with field in the direction of no variation. 10

4. Answer any *one* question : 10

(a) (i) Explain Maxwell stress system. Show that Maxwell stress system can be expressed as superposition of two stress systems. 7

(ii) Explain principal stress and shear stresses. 3

(b) (i) Give details of how idea of Maxwell stress system was developed. 3

(ii) Deduce full Maxwell stress system. 4

(iii) Show that Maxwell stresses exert pseudo elastic stresses. 3

5. Answer any *two* questions : $5 \times 2 = 10$

(a) Give details of linear pinch confinement scheme for finitely conducting fluid. 5

(b) Show Kelvin's theory on circulation is not valid in MHD in general. 5

(c) Identify forces which invalidates Kelvin's theory on vorticity. 5

6. Answer any *two* questions :

6×2=12

(a) Discuss the boundary condition on magnetic field when one of the contact media is perfectly conducting. 6

(b) Show that boundary condition on electric field may have implication for boundary condition on magnetic field and velocity. 6

(c) Obtain boundary condition on electric field when there is no contact resistance between the medias. 6

7. Answer any *one* question :

8

(a) Discuss Hartmann flow. What is Hartmann layer ? What is Hartmann Number ? State its physical significance. Develop the equation which governs the Hartmann flow. 8

(b) Discuss Hartmann flow and obtain velocity profile for Poiseuille type flow for a conducting fluid. 8

8. Answer any *one* question :

- (a) Derive the equation for propagation of linear Alfvén wave and discuss its solution. 8
- (b) Show that in a steady laminar flow in a pipe of arbitrary but symmetrical cross-section under the action of a uniform transverse field the velocity profile takes shape of the periphery of the pipe. 8

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