Total number of printed pages–6

2 PGDE MTH 5(C)

2013

(December)

MATHEMATICS

Paper : 205-C

(Magnetohydrodynamics)

Full Marks : 80

Time : 3 hours

The figures in the margin indicate full marks for the questions.

1. Answer ***any two*** questions : 6×2=12

   (a) *(i)* What are different kinds of forces experienced by a charged particle in a conductor ? 5

   (ii) What is magnetic vector potential ? 1

   (b) Discuss the low frequency approximations in MHD. 6

(c) Estimate the total electromagnetic body force acting upon unit volume element of a conducting fluid and hence deduce the governing equation for flow of conducting fluid. 6

2. Answer ***any one*** question : 10

(a) (i) What are Maxwell's electromagnetic field equations ? Deduce the magnetic induction equation. Explain each term of magnetic induction equation.

1+3+1=5

(ii) What is geodynamo problem ? What is the role of magnetic Reynold number of earth's liquid core in geodynamo problem ? 5

(b) (i) Show that the magnetic flux linking any loop moving with a perfectly conducting fluid is constant. 6

(ii) Define magnetic Reynold number. Show that low magnetic Reynold number approximation is to ignor the induce field. 4

3. Answer ***any one*** question : $10\times1=10$

(a) (i) Discuss the governing equations of MHD problem for a 2-D flow.

(ii) Discuss the 2-D kinematic problem with field in the direction of no variation.

$2+8=10$

(b) Deduce the differential equation for 2-D flow with current in the direction of no variation which governs the magnetic field in terms of magnetic vector potential. Discuss the solution in details. 10

4. Answer ***any one*** question : $10\times1=10$

(a) (i) Explain the concept of Maxwell stress system and the electromagnetic body force.

(ii) Deduce the full Maxwell Stress System.

(iii) Show that Maxwell Stress System can be expressed as sum of two superposing stress systems.

(iv) Discuss the case when $B=(B_x,0,0)$.

$3+4+2+1=10$

(b) (i) Write a brief note on magnetic forces and its effect.

(ii) Find the equivalent stress system for $\bar{J} \times \bar{B}$ force and the inertia force in the momentum equation. 4+6=10

5. Answer ***any one*** question : 10

(a) (i) What is pinch effect ?

(ii) Describe the linear pinch confinement scheme for finitely conducting fluid.

(iii) Describe the simplest pinch confinement scheme for confinement of plasma that may arise in short duration fusion experiments. 2+4+4=10

(b) (i) Show that the Kelvin's theorem on vorticity is not valid in general for the case if conducting fluid.

(ii) Identify the forces and discuss their role for invalidation of Kelvin's theorem. 5+5=10

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

(a) Obtain boundary condition on magnetic field for solid / liquid interface where non of the contact media is perfectly conducting. 6

(b) Discuss boundary condition on electric field when current sheet is present at the interface and no contact resistance is present. 6

(c) Discuss boundary condition on electric field when there is no current sheet at the interface but contact resistance is present. 6

7. Answer ***any one*** question : $8 \times 1 = 8$

(a) (i) When is a flow said to be Hartmann flow ?

(ii) What is Hartmann Layer ? How do you estimate the thickness of Hartmann Layer ?

(iii) What is Hartmann number ? What is its physical significance ? $2+3+3=8$

(b) Find the solution of Hartmann flow problem for Poiseulle type of flow. 8

8. Answer ***any one*** question : $8 \times 1 = 8$

(a) Derive governing equations for Linear Alfven Waves. What is Alfven velocity ? 8

(b) Discuss about the ultimate state of MHD Rayleigh problem when a mechanical excitation is applied and wall is non conducting. 8
