Register Number:

DATE:

ST. JOSEPH'S COLLEGE (AUTONOMOUS), BANGALORE-27
M.Sc. MATHEMATICS– IV SEMESTER
SEMESTER EXAMINATION: APRIL 2018

MT 0317 : MAGNETOHYDRODYNAMICS

Time- 2 ½ hrs **Max Marks-70**

This paper contains 1 printed page

ANSWER ANY 7 OUT OF THE FOLLOWING QUESTIONS. EACH CARRYING 10 MARKS

1. a. State Coulomb's law.
   b. Show that the electrostatic field is a conservative field.
   c. State Gauss's law for conducting material and derive its differential form. [2+3+5]

2. a. Define (i) Dipole (ii) Displacement current (iii) Dipole moment
   b. Find the electric field due to the dipole at a point in spherical polar coordinates. [3+7]

3. a. Show that the normal component of electric field is discontinuous across the interface in the presence of surface charge densities.
   b. State and prove Ampere's law for a general material. [5+5]

4. State Faraday's principle of Motor and Faraday's principle of dynamo. Show that the Lorentz force is in general a retarding force. [10]

5. Show that for $\vec{B}$ to be a force free magnetic field at all times it has to satisfy the integrability condition $\left(\vec{B}\times\nabla\alpha\bullet\nabla\right)\vec{B}=0$, in addition to satisfying the basic equations of force free magnetic field. [10]

6. What is poloidal magnetic field? Show that in a magnetostatic configuration with axisymmetric poloidal magnetic field. The magnetic stream function U satisfies the equation $\frac{\partial\left(r^{-2}\Delta U,U\right)}{\partial\left(r,z\right)}=0$.

   [10]

7. Discuss the instabilities of the Bennet Pinch. [10]

8. Derive the stability condition to stabilize the sausage instability of the Bennet Pinch. [10]

9. Prove that the electromagnetic body force can be expressed as the sum of two surface forces, one in the direction of magnetic field and the other in the direction normal to the surface. [10]

10. Derive the Alfven's wave equation in an incompressible non - viscous perfectly conducting fluid permeated by a uniform magnetic field in the vertical direction. [10]