

**MASTER OF SCIENCE EXAMINATIONS, 2019**(2<sup>nd</sup> Year, 1<sup>st</sup> semester)**PHYSICS****Theory of Plasma & Nonlinear Waves**

PHY/TE/201

Time: Two hours

Full Marks: 40

**Use separate Answer Scripts for EACH GROUP****Group-A**

(Answer any TWO questions)

1. a) Consider the non-relativistic motion of a charged particle in crossed static uniform magnetic and electric fields. Assuming that  $E/B \ll c$  (velocity of light in free space) find the velocity of a moving frame in which electric field is zero.
- b) What do you mean by magnetic mirror? Give a natural example of it. What is its importance in energy research? 5+5
2. a) Describe the concept of Debye shielding in a plasma? With suitable approximation find the expression for Debye potential for a test charge  $q$  immersed in a plasma consisting of electrons and ions.
- b) Estimate the plasma frequency of stellar interior plasma having density  $10^{14}$  particles per  $m^3$ . 2+5+3
3. a) Write one complete set of two-fluid model equations for a simple two-component electron-ion plasma.
- b) Discuss the so-called cold and warm plasma approximations that lead to a closed system of fluid equations 5+5
4. (a) Using hydrodynamic approach derive the equation of continuity for a fluid plasma.
- (b) Write down the equation of motion for electrons in a collisionless plasma described by a scalar pressure. Hence show that in situations where electron inertia is negligible electron density and electric potential follow Boltzmann relation. 5+5

## **GROUP - B**

Answer any TWO questions.

5. Considering  $T_i \ll T_e$ , the ion acoustic wave has the dispersion relation

$$\omega(k) = [\omega_{pi} k \lambda_{De}] / [1 + k^2 \lambda_{De}^2]^{1/2}$$

- i) Explain the result in terms of 'acoustic behaviour' at  $k \lambda_{De} \ll 1$ .  
ii) Derive an expression for the phase velocity  $v_\phi(k)$  and the group velocity  $v_g(k)$  as a function of the wave number  $k$ .

(4+6)

6. Derive the expression for an electrostatic wave in plasma not influenced by any external magnetic field.

(10)

7. What are different processes for the generation of plasma? Briefly, explain the importance of confinement and containment issues of plasma in laboratory.

(7+3)

8. Explain clearly, by which process one can measure the plasma density and plasma temperature. What do you mean by diagnostic tools in plasma?

(8+2)