MASTER OF SCIENCE EXAMINATIONS, 2018

(2nd Year, 1st semester)

PHYSICS

Theory of Plasma & Nonlinear Waves

PHY/TE/201

Time: Two hours

Full Marks: 40

Use *separate Answer Script* for EACH GROUP

Group - A

(Answer any two questions)

1.a) Mention the conditions under which a collection of electrons and ions can be called plasma.

b) For a typical fusion reactor plasma electron density is $10^{21}/m^3$ and temperature is 10 keV. Examine whether it can called a plasma or not.

(5+5)

2.a) What do you mean by magnetic mirror? Give a natural example of it. What is its importance in energy research?

b) In a magnetic mirror configuration with a mirror ratio R_m show that the Larmor radius of the particle at the center is $\sqrt{R_m}$ times the Larmor radius at the point of maximum magnetic field.

(6+4)

3. a) Using hydrodynamic approach derive the equation of continuity for a fluid plasma.

b) Write down the equation of motion for electrons in collisionless plasma described by a scalar pressure. Hence, show that in situations where electron inertia is negligible electron density and electron potential follow Boltzmann relation.

(4+6)

4. a) A test charge +q is immersed in a plasma consisting of electrons and ions. Show that the net charge within the Debye screening cloud exactly cancels the test charge.

b) Estimate the frequency and wavelength of electromagnetic waves radiated by the solar corona plasma having density 10^{14} particles per m^3.

(5+5)

Group - B

(Answer any two questions)

5. a) Determine the minimum plasma density at which a He-Ne laser of wavelength 632.8nm will be reflected.

b) The plasma of the ionospheric F-layer has a density $n_e \sim 2 \times 10^{12}$ per cubic meter. The typical magnetic field at mid latitude is $B = 50\mu T$. Calculate the upper hybrid frequency, electron plasma frequency and the electron cyclotron frequency.

(4+6)

6. a) Explain briefly the physics of fusion machines.

b) How plasma can be produced in different environment ?

6+4

7. a) Derive a dispersion relation for an electron cyclotron wave.

b) Calculate the Alfven speed in a region of the magnetosphere where the magnetic field (B) is equal to $10^{-8}T$, $M = M_H = 1.67 \times 10^{-27}Kg$ and the particle density is 10^8 per cubic meter.

(5+5)

8. Using the Langmuir probe, how the energy, velocity and density of the plasma particles are measured?

(10)