T – 5734

Reg. No. : ....

Name : ....

Fourth Semester M.Sc. Degree Examination, July 2024

Physics with Specialization in Space Physics

Special Paper

PHSP 542 : SPACE PHYSICS

(2020 Admission Onwards)

Time : 3 Hours

Max. Marks : 75

PART – A

Answer any **five** questions. Each question carries **3** marks.

1. Explain the concept of 'Debye Shielding'.

2. What are Alfven waves?

3. Why solar corona is hotter than photosphere?

4. List any four properties of Vlasov equation.

5. Why thermosphere is hot? Will an astronaut burn up, if he exposes his body in thermosphere and why?

6. What do you meant by 'Parker's spiral'?

7. Explain the term 'diamagnetic drift' in space plasma.

8. How 'Aurora' is generated? Why magnetic field is necessary for its formation?

(5 × 3 = 15 Marks)

P.T.O.

PART – B

Answer **three** questions. Each question carries **15** marks.

9. (a) Obtain the heuristic derivation of the Vlasov equation.

    (b) Discuss the convective derivative in physical space and phase space.

OR

10. (a) What are adiabatic invariants? Show that the first adiabatic constant μ is a constant and explain its significance.

    (b) Prove that second adiabatic invariant J is a constant.

11. (a) Describe the elements of dynamo theory and solar kinematic dynamos.

    (b) Discuss the concentrating and expelling magnetic field in sun. Also discuss the Lorentz force restriction on dynamo action.

OR

12. (a) Discuss the origin of solar wind. Explain the magnetic field effects on the wind.

    (b) With the help of suitable diagrams, explain the three dimensional structure and warped heliospheric current sheet.

13. (a) With the help of suitable electron density profile, explain the composition, density and production/loss mechanisms at different layers of terrestrial ionosphere.

    (b) Explain the concept of 'Ambipolar diffusion'.

OR

14. (a) With the help of schematic diagram, discuss the basic structure of terrestrial magnetosphere.

    (b) What are Field Aligned Currents (FACs)? Distinguish between Region 1 FAC and Region 2 FAC?

(3 × 15 = 45 Marks)

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PART – C

Answer any **three** questions. Each question carries **5** marks.

15. Estimate the degree of ionization of air at 1 atm pressure and room temperature (300 K). Repeat the calculation for a temperature of 8000 K. Given, the main component of air is nitrogen, with an ionization potential of 14.5 eV?

16. Calculate the magnetic field strength at a distance of 10 Earth radii from the center of the Earth in the Earth's magnetosphere.

17. Plasma of E layer of Earth's ionosphere has electron density $\sim 10^5$ cm^{-3} and is at altitude of approximately 100 km :

    (a) Which electromagnetic waves can be reflected from this layer?

    (b) Calculate the dielectric constant of plasma for the waves with frequencies of 100 MHz and 1000 Hz.

    (c) Calculate the skin depth of the wave with frequency of 1000 Hz.

18. Consider a plasma with the following parameters:

    Magnetic field strength (B) = 2 Tesla, Plasma resistivity (η) = 10^{-6} ohm.m, Plasma density $(\rho) = 2 \times 10^{-6}$ kg/m^3, Characteristic length scale (L) = 0.1 meter. Calculate the Alfven speed.

19. Compute the Debye length for the plasma found in a typical plasma television cell with the following parameters : $Ne = 10^{19} m^{-3}$, $k_B T = 1 ev$. The cell dimensions are on the order of 100 μm and the plasma is excited using a 250 V signal at 100 kHz. Also calculate the plasma frequency.

20. Obtain the 'generalized Ohm's law' in magneto hydrodynamics.

(3 × 5 = 15 Marks)

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