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Reg. No. : .....

Name : .....

Fourth Semester M.Sc. Degree Examination, June 2025

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 caries **3** marks.

1. Briefly explain how plasma oscillations are created in a medium?

2. What are Alfven waves?

3. Why solar corona is hotter than photosphere?

4. Give any four applications of Space weather studies?

5. Explain the term ‘diamagnetic drift’ in space plasma?

6. Why sunspots are relative cooler than surrounding solar surface?

7. Why sun exhibits differential rotation? How it is different over equatorial and polar regions?

8. Discuss the concept of ‘frozen in magnetic field’?

(5 × 3 = 15 Marks)

P.T.O.

PART – B

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

9. (a) Derive the Vlasov equation heuristically and discuss its key properties in the context of plasma kinetics.

   (b) How does the Vlasov equation differ from the Boltzmann equation, and what are its implications for collisionless plasma dynamics?

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) Discus various features associated with quiet photosphere?

    (b) Discuss the various sources of fast and slow solar winds?

OR

12. (a) Briefly discuss the ground based observations of Sun and its interior. Also explain how the satellite based observations improved our understanding of the Sun? Also describe the major challenges and technology involved?

    (b) Distinguish between the surface magnetic field and large scale magnetic field causing the solar magnetism. Also discuss the role of Parker's spiral in creating the changes in the interplanetary medium?

13. (a) What is 'space weather'? With proper diagrams, explain the structure of magnetosphere and interaction of solar wind with the earth's magnetic field using geocentric solar ecliptic (GSE) coordinate system.

    (b) Explain the generation of ring current and how it is manifested in ground based magnetometers? What are the indices used to represent ring current and explain bow they are estimated?

OR

14. (a) What is meant by Sq current. Also explain the slab geometry model for the formation of Equatorial Electrojet.

(b) What are the different mechanisms creating ionization in the terrestrial ionosphere. With the proper diagram, explain various layers in the ionosphere and the major chemical specie in each layer?

($3 \times 15 = 45$ Marks)

PART C

Answer any t**hree** questions. Each question caries **5** marks.

15. How MSIS model is unique in explaining the upper atmosphere in context of IRI model?

16. Imagine a collisionless plasma consisting of electrons and ions. The electrons follow a Boltzmann distribution, while the ions are treated as a fluid. The system is governed by the linearized fluid equations and Poisson's equation. Derive the general dispersion relation for electrostatic waves in such a plasma and determine the ion-acoustic wave dispersion relation in the long- wavelength limit $(k\lambda_D << 1)$.

17. Explain the solar spectrum in comparison with the spectrum of a typical black body.

18. A uniform, cold, magnetized plasma with a background magnetic field B_o is directed along the z-axis. A small perturbation in the magnetic field and velocity occurs in the perpendicular direction (say, along x). Using the magnetohydrodynamic (MHD) equations, derive the dispersion relation for Alfvén waves and determine their phase velocity.

19. (a) Explain the fundamental difference between the Axford-Hines model and the Dungey model in terms of magnetic reconnection and plasma flow. (b) If the solar wind has a velocity of 400 km/s and an interplanetary magnetic field (IMF) directed southward, which model is more applicable?

20. Briefly discuss the main cycle of nuclear reactions occurring in the solar core resulting in the energy production?

($3 \times 5 = 15$ Marks)

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