Reg. No…….. Name…… **26U301**

B A, B SC, B COM DEGREE END SEMESTER EXAMINATION - APRIL 2026

UGP (HONS.) SEMESTER 2: DISCIPLINE SPECIFIC COURSE

COURSE : 24UPHYDSC102 – MODERN PHYSICS

(For Regular 2025 Admission and Improvement/Supplementary 2024 Admission)

Time : 1.5 Hours Max. Marks: 50

PART A - (Short Answers) 2 marks each - Answer any 10 questions

1. State the two fundamental postulates of special relativity. (CO1, E)

2. State the principle of equivalence. Why do objects moving near massive bodies follow curved paths instead of straight lines? (CO1, M)

3. Establish length contraction in relativity. (CO1, H)

4. State the principle of superposition for waves. (CO2, E)

5. What is the physical significance of $|\Psi|^2$ in quantum mechanics, and who first proposed this interpretation? (CO2, E)

6. State the de Broglie hypothesis and write the expression for the de Broglie wavelength of a particle of mass m moving with velocity v. (CO2, M)

7. What is meant by pair production, and what happens to the energy of a photon in this process? (CO2, M)

8. Write the general formula for the Lyman series and specify the region of the electromagnetic spectrum in which it lies. (CO3, E)

9. What is population inversion in a three-level laser, and why is it necessary for laser action? (CO4, M)

10. Why is it impossible to specify momentum as a definite function of position, p(x), in quantum mechanics? (CO5, E)

11. What are eigenvalues and eigenfunctions in the context of Schrödinger's steady-state equation? (CO5, M)

12. Why does changing the order of the momentum operator and the wave function in $\langle p \rangle = \int \Psi^* \, \hat{p} \, \Psi \, dx$ lead to an incorrect result? (CO5, H)

(2 x 10 = 20)

PART B (Short Essays or Problems) 5 marks each - Answer any 6 questions

13. Starting from the relativistic expression for momentum, derive the formula for the kinetic energy of a particle and show that $KE = (\gamma - 1)mc^2$ (CO1, M)

14. Explain how the observed frequency of light changes when an observer moves away from and toward a light source. Write the expressions for the observed frequency in both cases. (CO1, H)

15. State the two forms of the Heisenberg uncertainty principle and write their mathematical expressions. (CO2, E)

16. Explain the three key experimental observations of the photoelectric effect that could not be explained by the classical wave theory of light. (CO2, M)

17. Explain the four important properties of laser light that distinguish it from ordinary light. (CO4, E)

18. An electron in a hydrogen atom makes a transition from the level n=4 to $n_f = 2$.
(a) Identify the spectral series to which this transition belongs. (b) Using the Rydberg formula, calculate the wavelength of the emitted photon. (CO3, M)

19. What is meant by a normalizable wave function? State the conditions that a well-behaved wave function Ψ must satisfy in quantum mechanics. (CO5, M)

20. A particle is confined in a one-dimensional infinite potential box of length L.
The normalized wave functions are

$$\Psi_n(x) = \sqrt{\frac{2}{L} sin(\frac{n\Pi x}{L})}, n = 1,2,3...$$

(a) Show that the probability density is zero at x=0 and x=L.

(b) For n=1 , find the position inside the box where the probability density is maximum.

(c) For n=2 , find the position(s) inside the box where the probability density is zero (other than at the boundaries). (CO5, H)

(5 x 6 = 30)