Name: **Enrolment No:**	

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2022

Course: B.Sc. **Semester: III**
Program: Elements of Modern Physics **Time: 03 hrs.**
Course Code: PHYS-2005G **Max. Marks: 100**

Instructions: Read all the below-mentioned instructions carefully and follow them strictly:

1) Mention YOUR NAME AND ROLL NUMBER at the top of the question paper.
2) ATTEMPT ALL THE PARTS OF A QUESTION IN ONE PLACE ONLY.

SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	Define Planck's hypothesis and its importance in quantum mechanics.	**4**	**CO1**
Q 2	Ultraviolet light of wavelength 350 nm and intensity 1.00 W/m^2 is directed at a potassium surface. a. Find the maximum kinetic energy (KE) of the photoelectrons. b. If 0.50 % of the incident photons produce photoelectrons, how many are emitted per second if the potassium surface has an area of 1.00 cm^2?	**4**	**CO1**
Q 3	Elaborate on the expectation value for the quantum mechanical operators, and what are the energy and momentum operators.	**4**	**CO2**
Q 4	State Schrodinger's wave equation and its importance in solving the quantum mechanical problem.	**4**	**CO2**
Q 5	Discuss the concept of stable nuclei, and also describe the different types of decay observed in radioactive substances.	**4**	**CO4**

SECTION B
(4Qx10M= 40 Marks)

Q 1	Define the wave-particle duality nature of light or a particle and matter-waves. Derive the formula of the wavelength associated with the particle's momentum using the De-Broglie hypothesis.	**10**	**CO1**
Q 2	Explain the Photoelectric effect in detail and use sketches and equations for better understanding. How did Planck's hypothesis help Einstein explain this effect? Find the energy of a 700-nm photon and find the wavelength and frequency of a 100-MeV photon. Or Explain the effect of scattering. Explain the Compton effect in detail and use sketches for better clarity. Derive the formula Compton wavelength.	**10**	**CO2**
Q 3	State the particle in a box problem with the help of illustrations. Estimate the minimum energy of a confined particle using the uncertainty principle.	**10**	**CO3**

Q 4	Describe the atomic structure and discuss why an electron cannot reside in the nucleus with the help of the uncertainty principle.	**10**	**CO4**
SECTION-C (2Qx20M=40 Marks)			
Q 1	Derive Schrodinger's equation for time-dependent form for a free particle in 1D and 3D systems. Also, find out the Hamiltonian operator for the associated wavefunction. What is the significance of this equation in quantum mechanics? Or Derive Schrodinger's equation for steady-state form. What is the significance of this equation in quantum mechanics and how the energy quantization can be explained with the help of this?	**20**	**CO2**
Q 2	Explain and derive the energy eigenvalues and eigenfunctions using a particle in the one-dimensional box (Infinite Potential Well) problem. Use the sketches of wavefunctions and probability densities to explain the condition of normalization, and hence calculate the normalized wavefunction of a particle in a box.	**20**	**CO3**