PSG COLLEGE OF ARTS & SCIENCE
(AUTONOMOUS)

MSc DEGREE EXAMINATION MAY 2024
(Second Semester)

Branch – **PHYSICS**

QUANTUM MECHANICS - II

Time: Three Hours   Maximum: 75 Marks

SECTION-A (10 Marks)
Answer **ALL** questions
ALL questions carry **EQUAL** marks   (10 × 1 = 10)

Module No.	Question No.	Question	K Level	CO
1	1	What is the semi classical treatment in quantum mechanics? a) A combination of classical and quantum mechanical principles b) A purely classical approach to describing quantum phenomena c) A purely quantum mechanical approach to describing classical phenomena d) None of the above	K1	CO1
	2	Which of the following is a unique property of Laser? a) Directional b) Speed c) Coherence d) Wavelength	K2	CO1
2	3	In a finite potential well, potential energy outside the box is _____ a) Zero b) Infinite c) Constant d) Variable	K1	CO2
	4	In what kind of potential does the Born approximation work best? a) Weak and short-range potentials b) Strong and long-range potentials c) Infinite potentials d) Time-dependent potentials	K2	CO2
3	5	What is the variation method primarily used for in quantum mechanics? a) Solving the Schrödinger equation analytically b) Estimating the ground state energy of a quantum system c) Describing scattering processes involving particles and Potentials d) Calculating wave functions for bound states	K1	CO3
	6	Which of the following is a key feature of the variation method? a) It provides exact solutions to the Schrödinger equation b) It relies on guessing an approximate wave function and minimizing the energy c) It neglects the effect of potentials on the system d) It is only applicable to one-dimensional problems	K2	CO3
4	7	What is the concept of a "hole" in the context of the hole theory? a) A region of zero energy density in a solid b) An absence of electrons in an otherwise filled electronic state c) A virtual particle with positive charge d) A region of high energy density in a solid	K1	CO4
	8	How does the hole theory explain the behavior of electrons in a solid? a) By treating the absence of an electron as a positively charged particle b) By describing the movement of electrons as the movement of holes c) By introducing the concept of virtual particles d) By considering the interactions between electrons and photons	K2	CO4

5	9	What is the commutation relation between creation and annihilation operators for fermionic particles? a) $\{a, a^\dagger\} = 0$ b) $\{a, a^\dagger\} = 1$ c) $[a, a^\dagger] = 0$ d) $[a, a^\dagger] = 1$	K1	CO5
	10	What is the action of the annihilation operator on the vacuum state? a) It creates a particle in the vacuum state b) It annihilates the vacuum state c) It creates a superposition of particle and antiparticle states d) It leaves the vacuum state unchanged	K2	CO5

SECTION - B (35 Marks)
Answer ALL questions
ALL questions carry EQUAL Marks   (5 × 7 = 35)

Module No.	Question No.	Question	K Level	CO
1	11.a.	Explain the Einstein's coefficients of spontaneous and induced emission of radiation.	K2	CO1
		(OR)		
	11.b.	Obtain the selection rules for electric dipole transition.		
2	12.a.	Derive external and internal logarithmic derivaties using Scattering theory.	K2	CO2
		(OR)		
	12.b.	Explain Scattering cross- section and the optical theorem.		
3	13.a.	What is a muonic atom? Explain how the energy levels of the muonic atom are modified due to the finite size of the nucleus and deduce the corrections to the energy using the perturbation method.	K4	CO3
		(OR)		
	13.b.	What is central field approximation? How did Hartree obtain the central field in this theory of many electron atom?		
4	14.a.	Explain Pionic atoms and Pion-nucleus Scattering.	K3	CO4
		(OR)		
	14.b.	Derive Dirac's relativistic wave equation.		
5	15.a.	Explain the Poisson Bracket formulation of field variables.	K5	CO5
		(OR)		
	15.b.	Write short notes on creation, annihilation and number operators.		

SECTION -C (30 Marks)
Answer ANY THREE questions
ALL questions carry EQUAL Marks   (3 × 10 = 30)

Module No.	Question No.	Question	K Level	CO
1	16	Explain the Semi- Classical treatment in electromagnetic radiation with atom.	K2	CO1
2	17	Obtain the Rutherford Scattering formula using the Born approximation.	K2	CO2
3	18	Write down the Hamiltonian for the hydrogen molecule ion (H_2^+) Choose a suitable variation function and explain how you will find the equilibrium distance between the two nuclei and binding energy of the hydrogen molecule ion.	K3	CO3
4	19	Explain how the spin and magnetic moment of the electron are obtained in Dirac's relativistic theory.	K3	CO4
5	20	Obtain the Lagrangian formulation on field.	K4	CO5