

B.Sc. Semester - 5 (CBCS) Examination

July-2025 (Old Course)

MATHEMATICAL PHYSICS CLASSICAL MECHANICS AND QUANTUM MECHANIC (CORE)

Time: 2:30 Hours

Marks: 70

Instructions:

1. All questions are compulsory.
2. Figures to the right indicate marks.

Que-1(A) Answer the following questions (Any One) (07)

- 1) Write Fourier series and evaluate their coefficients.
- 2) Write in detail extension of interval of fourier series.

Que-1(B) Answer the following questions (Any One) (04)

- 1) Explain Dirac Delta function and it's properties.
- 2) Obtain Fourier cosine series.

Que-1(C) Answer the following questions (Any three) (03)

- 1) Write the formula of Fourier series.
- 2) What is fourier coefficient a_0 ?
- 3) What is fourier coefficient a_n ?
- 4) Cosine series is also known as _____.
- 5) Sine series is also known as _____.

Que-2(A) Answer the following questions (Any One) (07)

- 1) Obtain Lagrange's equation of motion from D'Alembert's principle.
- 2) Define Hamilton's variational principle and obtain Lagrange's equation of motion using $L = T - V$.

Que-2(B) Answer the following question (Any One) (04)

- 1) Explain degree of freedom in detail.
- 2) Deduce Newton's second law from Hamilton's principle.

Que-2(C) Answer the following questions (Any three) (03)

- 1) What is the generalized coordinate of a spherical pendulum?
- 2) $L = \dots - \dots$
- 3) $H = \dots + \dots$
- 4) Write the set of Lagrange's equation of motion.
- 5) Give the expression of Hamilton's principle.

Que-3(A) Answer the following questions (Any One) (07)

- 1) Explain Lagrange's method of undetermined multipliers.
- 2) Obtain the Hamilton's equation of motion.

Que-3(B) Answer the following questions (Any One) (04)

- 1) Explain cyclic co-ordinates.
- 2) Describe phase space.

Que-3(C) Answer the following questions (Any three) (03)

- 1) $\frac{\partial L}{\partial q_j} = 0$, then q_j is referred to as _____.
- 2) In the _____ formulation n coordinates q_j and n momenta p_i are taken as independent variables.
- 3) What are the Hamilton's canonical equation of motion?
- 4) In the conservative system, the potential energy is only _____ dependent.
- 5) Write Hamilton's variational principle.

- Que-4(A) Answer the following questions (Any One) (07)**
- 1) Derive one-dimensional time dependent Scrodinger equation for free particle.
 - 2) Explain particle in a box.
- Que-4(B) Answer the following questions (Any One) (04)**
- 1) Explain Compton effect.
 - 2) Describe group velocity and stationary states.
- Que-4(C) Answer the following questions (Any three) (03)**
- 1) What is the total energy E of a free particle?
 - 2) $[p_x, x] = \underline{\hspace{1cm}} = \underline{\hspace{1cm}} = -i\hbar$, fill up the blanks.
 - 3) $[x, p_x] = \underline{\hspace{1cm}} = \underline{\hspace{1cm}} = i\hbar$, fill up the blanks.
 - 4) $[p_x, p_z] = \underline{\hspace{1cm}}?$
 - 5) $[Z, y] = \underline{\hspace{1cm}}?$
- Que-5(A) Answer the following questions (Any One) (07)**
- 1) Deduce the simplified form for the oscillator.
 - 2) Obtain solution of Hermite's differential equation.
- Que-5(B) Answer the following questions (Any One) (04)**
- 1) Obtain Schrodinger wave equation for the oscillator.
 - 2) Explain coherent states.
- Que-5(C) Answer the following questions (Any three) (03)**
- 1) Fill up the blank: $L_z = -i\hbar \underline{\hspace{1cm}}$
 - 2) Which way a ket vector symbolized?
 - 3) When $\langle A|A \rangle$ becomes greater than zero?
 - 4) What is the Hamiltonian for a linear harmonic oscillator?
 - 5) What is the ground state energy of a harmonic oscilattor?
