647510 **BSc5PhyC501x** **Seat No :________**

B.Sc. Semester - 5 (*CBCS*) Examination
Oct/Nov - 2024 (NEW COURSE)
Mathematical Physics, Classical Mechanics & quantum Mechanics(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 Two) (10)
1. Explain fundamental theorem of Gradient.
2. Discuss the Stock's integral for Integral Calculus.
3. Write six product rules for differential Calculus.

Que.1(B) Answer the following questions. (Any One) (04)
1. Write the fundamental theorem for gradient with Geometrical Interpretation.
2. Give the relations between fundamental Theorems.

Que.2(A) Answer the following questions. (Any Two) (10)
1. Define the Fourier Series and evaluate its Co-efficient.
2. Find a series of Sine and Cosine which represent $x + x^2$ in the interval $-\pi < x < \pi$. Also deduce that $\frac{\pi^2}{6} = \sum_{n=1}^{\infty}\frac{1}{n^2} = 1 + \frac{1}{2^2} + \frac{1}{3^2} + \cdots$
3. Find the Fourier series for the square 2π-periodic wave defined on the interval
   f(x) = $\begin{cases} 0 & -\pi \le x \le 0, \\ 1 & 0 < x \le \pi \end{cases}$

Que.2(B) Answer the following questions. (Any One) (04)
1. Explain Dirac Delta Function and its properties.
2. Obtain Fourier Series for a Triangle Wave Function.

Que.3(A) Answer the following questions. (Any Two) (10)
1. Explain the Generalized Co-ordinates. Give some illustrations to choose the set of Generalized Co-ordinates.
2. Obtain equation of motion for Atwood's machine, using Lagrange's equation of motion.
3. Obtain the Lagrange's equation of motion.

Que.3(B) Answer the following questions. (Any One) (04)
1. Describe the classification of Constraints and explain the term "virtual displacement" and obtain the principle of virtual work.
2. Define: Cyclic Co-ordinate. Show that "Generalized momentum corresponding to a cyclic co-ordinate is conserved during the motion of a system." Obtain the Hamilton's equation from Lagrangian functions.

Que.4(A) Answer the following questions. (Any Two) (10)
1. Obtain the solution of a particle in a square well potential when $E < 0$.
2. Obtain the Schrodinger's equation for free particle in one and three dimensions.
3. Prove one of the Ehrenfest's theorem equations.

Que.4(B) Answer the following questions. (Any One) (04)
1. Describe admissibility conditions on the Wave Function.
2. Find the Normalized Wave Function for $\varphi(\phi) = A \sin m\phi \quad 0 < \phi < 2\pi$

Que.5(A) Answer the following questions. (Any Two) (10)
1. Prove that momentum operator is Self-adjoint. Show that eigen values of Self-adjoint operator are real.
2. Describe any three fundamental postulates of Wave Mechanics.
3. Derive Schrodinger's equation for Simple Harmonic Oscillator and find its Eigen Values and Eigen Function.

Que.5(B) Answer the following questions. (Any One) (04)
1. Prove that: $[x, P_x] = [y, P_y] = [z, P_z] = i\hbar$
2. Prove that:
   a. $(A + B)^{\dagger} = A^{\dagger} + B^{\dagger}$
   b. $(CA)^{\dagger} = C^{*}A^{\dagger}$

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