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

B.Sc. Semester - 5 (*CBCS*) Examination

Oct/Nov - 2023 (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 Gradient, divergence and curl with their significance.
2. Explain fundamental theorem for curl.
3. Explain the relations between fundamental theorems.

Que.1(B) Answer the following questions. (any one) (04)

1. Explain Gauss's theorem in detail.
2. Write six product rules for differential calculus.

Que.2(A) Answer the following questions. (any two) (10)

1. Represent f(x) = $\begin{matrix} 0 & -\pi \le x \le 0 \\ 1 & 0 \le x \le \pi \end{matrix}$

   Evaluate the coefficient in above interval.

2. Find a series of sine and cosine of function in the interval $-\pi < x < \pi$. Also deduce that $\frac{\pi^2}{8} = 1 + \frac{1}{3^2} + \frac{1}{5^2} + \cdots$

   $$f(x) = \begin{matrix} 0, when & -\pi < x < 0 \\ \frac{\pi x}{4}, when & 0 < x < \pi \end{matrix}$$

3. Define the Fourier series and evaluate its co-efficient.

Que.2(B) Answer the following questions. (any one) (04)

1. Explain three-dimensional Dirac delta function and properties of Dirac delta function.
2. Obtain Fourier for a full wave rectifier function.

Que.3(A) Answer the following questions. (any two) (10)

1. Explain the generalized coordinates. Give some illustrations to choose the set of generalized coordinates.
2. Explain Lagrange's undetermined multiplier and its application.
3. Obtain the Hamilton's equation of motion.

Que.3(B) Answer the following questions. (any one) (04)

1. Explain constraints in detail.
2. Obtain Lagrange's equation of motion for spherical pendulum.

Que.4(A) Answer the following questions. (any two) (10)

1. obtain the Schrodinger's equation for free particle in one dimension and three-dimensional Schrodinger's equation for force field.
2. Obtain the solution of particle in a square well potential when E < 0.
3. Prove probability of any quantum system is independent of time.

Que.4(B) Answer the following questions. (any one) (04)

1. Find the normalized wave function for $\varphi(\phi) = A \sin m\phi \quad 0 < \phi < 2\pi$.
2. Prove one of the Ehrenfest's theorem equation.

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. Derive Schrodinger's equation for simple harmonic oscillator and find its eigen values and eigen function.
3. Explain fundamental postulates of wave mechanics.

Que.5(B) Answer the following questions. (any one) (04)

1. Prove that: $[L_y, L_z] = i\hbar L_x$.
2. Prove that: 1. $(A+B)^{\dagger} = A^{\dagger} + B^{\dagger}$ 2. $(CA)^{\dagger} = C^{*}A^{\dagger}$

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