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

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

Oct/Nov - 2022 (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.

Q. 1(a) Answer the following questions (any two) (10)

1) Explain fundamental theorem for divergences – Gauss's theorem.
2) Explain fundamental theorem for curls – Stoke's theorem.
3) Explain the relations between fundamental theorems.

Q. 1(b) Answer the following questions (any one) (04)

1) Write the fundamental theorem for gradient.
2) Write six product rules for differential calculus.

Q. 2(a) Answer the following questions (any two) (10)

1) Represent f(x) = $\begin{cases} 1 & 0 < x < \frac{1}{2}, \\ 0 & \frac{1}{2} < x < 1 \end{cases}$
   in Fourier sine and cosine series.
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) Define the Fourier series and evaluate its co-efficient .

Q. 2(b) Answer the following questions (any one) (04)

1) Obtain cosine series.
2) Obtain Fourier series for a full wave rectifier function.

Q. 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) Deduce Lagrange's equations from D'Alembert's principle.
3) Obtain the Lagrange's equation of motion.

Q. 3(b) Answer the following questions (any one) (04)

1) Explain constraints motion and classify them on the base of time and work.
2) Obtain Hamilton's equation of motion for compound pendulum.

Q. 4(a) Answer the following questions (any two) (10)

1) Obtain the Schrodinger's equation for free particle in one and three dimensions.
2) Prove one of the Ehrenfest's theorem equation.
3) Prove probability of any quantum system is conserved.

Q. 4(b) Answer the following questions (any one) (04)

1) Describe admissibility conditions on the wave function.
2) Find the normalized wave function for $\varphi(\phi) = A \cos m\phi \quad 0 < \phi < \frac{\pi}{2}$.

Q. 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) Show that expectation value and eigen value of self-adjoint are real.
3) Explain Dirac delta function in detail

Q. 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. $(CA)^{\dagger} = C^* A^{\dagger}$

****