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

B.Sc. Semester - 5 (Remedial) (*CBCS*) Examination
March/April-2025 (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 for divergences – Gauss's theorem.
2) Prove the product rule: $\boldsymbol{\nabla} \cdot (\boldsymbol{A} \times \boldsymbol{B}) = \boldsymbol{B}(\boldsymbol{\nabla} \times \mathbf{A}) - \boldsymbol{A}(\boldsymbol{\nabla} \times \boldsymbol{B})$
3) Explain in detail: fundamental theorem for curls – Stoke's theorem.

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 theorem.

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

1) Find the series of sine and cosine function f(x) in the interval $-\pi < x < \pi$ which represent

   f(x) = $0, \; when \quad -\pi < x < 0$,

   = $\frac{\pi x}{4}, \; when \quad 0 < x < \pi$

   Also deduce that $\frac{\pi^2}{8} = 1 + \frac{1}{3^2} + \frac{1}{5^2} + \cdots$

2) Find the series of sine and cosine function f(x) in the interval $-\pi < x < \pi$ which represent

   f(x) = $X + X^2, \; when \; -\pi < x < \pi$,

   Also deduce that $\frac{\pi^2}{6} = 1 + \frac{1}{2^2} + \frac{1}{3^2} + \cdots$

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

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

1) Obtain cosine and sine series.
2) Obtain Fourier series for a square wave of high frequency.

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

1) Explain in detail: generalized coordinates.
2) Deduce Lagrange's equations from D'Alembert's principle.
3) 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-3(B) Answer the following questions (any one). (04)

1) Describe the classification of constraints and explain the principle of virtual work.
2) Obtain equation for simple pendulum from Lagrange's equation.

Que-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) Normalize the given wave function
   $\varphi(\phi) = A \sin m\phi, \ \ 0 < \phi < 2\pi.$

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 $\varphi(\phi) = A \cos m\phi, \ \ 0 < \phi < \frac{\pi}{2}.$

Que-5(A) Answer the following questions (any two). (10)

1) Prove that: $[x, P_x] = [y, P_y] = [z, P_z] = i\hbar$
2) Prove that momentum operator is self-adjoint. Show that eigen values of self-adjoint operator are real.
3) Describe the fundamental Postulate of wave mechanics.

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

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

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