D-003-001501 Seat No. _____

# B. Sc. (Sem. V) Examination

**March - 2022**

## Physics : P - 501

***(Mathematical Phy., Classical Mech. & Quantum Mech.)***

***(Old Course)***

**Faculty Code : 003**

**Subject Code : 001501**

Time : $2\frac{1}{2}$ Hours] [Total Marks : **70**

**Instructions :** (1) Attempt all the questions.
(2) Figures on right side indicate marks.

**1** All questions are compulsory : **20**

(1) The value of co-efficient $a_n$ is _____ for Fourier series in interval $(-\pi, \pi)$.

(2) If function is odd, we get _____ series.

(3) What is the value of $\sum_{n=1}^{\infty} \frac{1}{n^2}$ ?

(4) If $f(x) = x + x^2$, find the average value at point $-\pi$ and $\pi$.

(5) $x^3$ is an odd function. (True / False)

(6) If $f(x) = x$ in interval, $(0, \pi)$ find the value of $a_0$.

(7) If the particle move in a plane, the particle have _____ degree of freedom.

(8) When constraints are introduced into the system, its number of degree of freedom is _____.

(9) What is the equation of generalized velocity ?

(10) De'Alembert's principle is _____.

(11) Hamiltonian function $H =$ _____.

(12) What is the mathematical form of Hamilton's principle ?

(13) Phase space is 2n-dimensional space. (True / False)

(14) According to Plank's theory $E =$ _____ and De-Broglie hypothesis $P =$ _____.

(15) Write the Schrödinger's equation for a free particle in 3-dimension.

(16) $-i\hbar\nabla$ is called _____ operator.

(17) In $|\Psi|^2 = \Psi\Psi^*$ where $\Psi^*$ is called _____ conjugate of $\Psi$.

(18) For conservation of probability what is the value of $\frac{\partial}{\partial t}\int |\Psi|^2 d^3x$ ?

(19) $\left[z, P_z\right]$ = _____.

(20) $\left(A^\dagger\right)^\dagger$ = _____.

**2** (a) Give any **three** answer in brief : **6**

(1) Obtain the sine series.

(2) What are constraints ?

(3) Explain Hamilton's principle.

(4) Define the matter waves and free particle.

(5) Explain the stationary state.

(6) Prove that $\left[x, P_y\right] = 0$.

(b) Give any **three** answer : **9**

(1) Evaluate the $a_0$ and $a_n$ co-efficient of Fourier series.

(2) Describe the extension of interval.

(3) Obtain the equation of generalized force.

(4) Explain the normalization of wave function.

(5) Write short note on expectation value.

(6) Prove that

(i) $(A+B)^\dagger = A^\dagger + B^\dagger$ and

(ii) $C(A)^\dagger = C^* A^\dagger$.

(c) Answer any **two** of the following questions : **10**

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

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

$f(x) = \frac{\pi x}{4}$ when $0 < x < \pi$.

(2) Explain the Lagrange's undetermined multiplier with its application.

(3) Obtain the Schrödinger's equation for a free particle in one dimension.

(4) Explain Dirac Delta function in detail.

(5) Show that expectation value and eigen value of self adjoint are real.

**3** (a) Give any **three** answer in brief : **6**

(1) Define Fourier series.

(2) Find the value of $\sum_{n=1}^{\infty} \frac{1}{(2n-1)^2}$ using Fourier series.

(3) Discuss cyclic co-ordinates.

(4) What is the phase-space ?

(5) Explain the physical interpretation of $\Psi$.

(6) Define : Adjoint operator and Self adjoint operator.

(b) Give any **three** answer : **9**

(1) If $f(x) = x$, where interval $0 < x < \pi$, draw the graph for $X = \sum_{n=1}^{\infty} b_n \sin nx$.

(2) Explain Rayleigh's dissipation function.

(3) Explain double pendulum.

(4) Explain the configuration space.

(5) Obtain the equation $m\frac{d\langle x\rangle}{dt} = \langle P_x \rangle$.

(6) Show that $\left[L_x, L_y\right] = i\hbar L_z$.

(c) Answer any **two** of the following questions : **10**

(1) Explain the two applications of Fourier series in detail.

(2) Obtain the equation for Atwood's machine from Lagrange's equation.

(3) Explain the equivalence of Lagrange's and Newton's equation.

(4) Obtain the Ehrenfest's theorem.

(5) Describe the fundamental postulate of wave mechanics.

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