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# BCF-003-1015025 Seat No. _____

## B. Sc. (Sem. V) (W.E.F. 2016) Examination

**August - 2021**

## Physics : P - 501

***(Mathematical Physics, Classical Mechanics & Quantum Mechanics) (New Course)***

**Faculty Code : 003**

**Subject Code : 1015025**

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

**Instructions :** (1) Symbols and notations have their usual meaning.
(2) Total marks of the question is indicated on right side of the question.
(3) Attempt any five questions out of the following ten questions.

**1** (a) Answer the following questions : (1 mark each) **4**

(1) The value of coefficient $a_n$ is _____ for Fourier series in interval $(-l, l)$.

(2) If $f(x)$ is an odd function, then $\int_{-\pi}^{\pi} f(x)dx$ = ?

(3) Cosine series also known as _____ series.

(4) For odd function $f(-x)$ = _____.

(b) Explain advantages of fourier series. **2**

(c) Obtain the fourier sine series. **3**

(d) Obtain fourier series for a half wave rectifier. **5**

**2** (a) Answer the following questions : (1 mark each) **4**

(1) Write the formula for fourier series.

(2) Is the half wave rectifier function even or odd ?

(3) What will be the fourier coefficient $a_0$ of a series

$$\frac{h}{2}+\frac{2h}{\pi}\left[\sin x+\frac{\sin 3x}{3}+\frac{\sin 5x}{5}+.....\right]=?$$

(4) If $f(x)$ be even, then $f(x)$ sin $nx$ is _____ and $f(x)$ cos $nx$ is _____ functions.

(b) Obtain fourier coefficient $a_0$. **2**

(c) Explain the properties of Dirac Delta function. **3**

(d) Write a fourier series for a function with period $2l$ and obtain sine and cosine series in interval $(-l, l)$. **5**

**3** (a) Answer the following questions : (1 mark each) **4**

(1) On the base of _____ the constraints holonomic and non-holonomic classified.

(2) How many degree of freedom of a simple pendulum ?

(3) Write the equation of D'Alembert's principle.

(4) Write the expression for generalised displacement.

(b) Explain generalized velocity and generalized displacement. **2**

(c) Obtain Lagrange's equation of motion for a simple pendulum. **3**

(d) ? **5**

**4** (a) Answer the following questions : (1 mark each) **4**

(1) The product of $Q_j \delta q_j$ must have the dimension of _____.

(2) The constraints conservative and dissipative are classified on the base _____.

(3) Rayleigh's dissipation function is define as $f$ = _____.

(4) Write Euler-Lagrange differential equation.

(b) Explain configuration space. **2**

(c) Obtain Newton's second law of motion from Hamilton's Principle. **3**

(d) Obtain Lagrange's equation of motion from D'Alembert's principle for conservative system. **5**

**5** (a) Answer the following questions : (1 mark each) **4**

(1) $\frac{\partial L}{\partial q_j} = 0$ then $q_j$ is refered to as _____.

(2) The 2n-dimensional space having n-corrdinates $q_i, i = 1, 2, .... n$ and n-coordinates momenta $p_i, i = 1, 2, .... n$ is known as _____ space.

(3) Write modified Hamilton's principle.

(4) A rigid body capable to oscillate in a vertical plane above a fixed horizontal axis is called _____ pendulaum.

(b) Find the hamiltonian for the Lagrangian. **2**

$$L\left(X, \dot{X}\right) = \frac{\dot{X}^2}{2} - \frac{\omega^2 X^2}{2} - \alpha X^3 + \beta X \dot{X}^2$$

(c) Obtain the hamilton's canonical equation of motion. **3**

(d) Obtain the equation of simple pendulum from Lagrange's multiplier method. **5**

**6** (a) Answer the following questions : (1 mark each) **4**

(1) Lagrange's equations of motion are invarient in form with respect to _____ transformation.

(2) Define : Phase space of n coordinates.

(3) Write the equation of motion of compound pendulum.

(4) In conservative system, the potential energy is only _____ dependent.

(b) What is called cyclic coordinate ? Explain generalized momentum from it. **2**

(c) Obtain the Hamilton's equation of linear harmonic oscillator. The Lagranglan of the oscilator $L = \frac{1}{2}mX^2 - \frac{1}{2}kX^2$. **3**

(d) Obtain Hamilton's Canonical equations from variational principle. **5**

**7** (a) Answer the following questions : (1 mark each) **4**

(1) The ejected electrone in compton effect is known as compton _____ electron.

(2) $[X, P_x]$ = _____.

(3) In one dimensional time dependent Schrodinger equation, $i\hbar \frac{\partial \Psi}{\partial t}$ = ?

(4) What is called "a" in equation $Af(x) = af(x)$ ?

(b) Explain compton effect. **2**

(c) Explain operator for momentum. **3**

(d) Derive the Schrodinger equation for free particle in one dimension. **5**

8 (a) Answer the following questions : (1 mark of each) 4

(1) For a one dimensional system $[Z, P_z]$ = _____ ?

(2) What name is given to the expression

$$\frac{\partial p}{\partial t} + \nabla \cdot J = 0 \text{ ?}$$

(3) What name is assigned to the expression

$$\Delta\lambda = \frac{2h}{MoC} \sin^2 \frac{\phi}{2} \text{ ?}$$

(4) $< X >$ = ?

(b) Derive the value of $[P_x, X]$. 2

(c) Describe the experimental study of photoelectric effect. 3

(d) Explain the particle in a three dimensional box. 5

9 (a) Answer the following questions : (1 mark each) 4

(1) Fill up the blank $L_X = -i\hbar(\ \ )$.

(2) Which way a ket vector symbolized ?

(3) If A is unit operator then, $\alpha | A >$ = _____.

(4) What is the Hamiltonian for a linear harmonic oscillator ?

(b) Prove that $[X, Y] = -[Y, X]$. 2

(c) Explain ket and bra vector. 3

(d) Obtain the Hermite's differential equation. 5

10 (a) Answer the following questions : (1 mark each) 4

(1) A _____ Operator is convert : a ket $| A >$ into another ket $| B >$.

(2) A self adjoint operator $\alpha$ = _____.

(3) The ground state energy of the harmonic oscillator is _____.

(4) $[\alpha, \beta] = -[\_\_\_\_\_, \_\_\_\_\_]$.

(b) If $H = \frac{P^2}{2m} + \frac{1}{2} m w^2 x^2$, then prove that $[X, H] = \frac{i\hbar P}{m}$. 2

(c) Explain coherent state. 3

(d) Describe the two body problem. 5

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