DBJ-003-1015025 Seat No. _____

B. Sc. (Sem. V) (CBCS) Examination

June – 2022

Physics : Paper - 501

(Mathematical Physics, Classical Mechanics & Quantum Mechanics)

Faculty Code : 003

Subject Code : 1015025

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

Instructions :

(1) Attempt any **five** questions.

(2) Make suitable assumption wherever **necessary**.

(3) Figure on the **right** indicates full marks.

(4) Non programmable calculator is permitted

(5) Notations have their usual meaning.

1 (a) Write short answer of following questions : **4**

(1) Integration of Fourier series yields more rapid convergence. (True / False)

(2) Write any one properties of Dirac delta function.

(3) Write the complex form of Fourier Series.

(4) Define Dirac delta function.

(b) Develop $f(x)$ in Fourier series in the interval $(-2, 2)$ if $f(x) = 0$ for $-2 < x < 0$ and $f(x) = 1$ for $0 < x < 2$. **2**

(c) Derive Cosine Series of Fourier Series **3**

(d) Derive co-efficient of the Fourier Series. **5**

2 (a) Write short answer of following questions. **4**

(1) Write the complex form of Fourier Series.

(2) Write Pareseval's Theorem.

(3) Write one advantage of Fourier series.

(4) Write any one property of Dirac delta function.

(b) Find Fourier's series for $f(x)$ in the interval $(-\pi, \pi)$, where **2**

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

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

(c) Obtain Fourier series for a triangle wave. **3**

(d) Obtain Fourier series for a full wave rectifier. **5**

3 (a) Write short answer of following questions : **4**

(1) In Lagrangian approach we consider Vector quantities. (True/ False)

(2) What is the degree of freedom for a particle move in a plane?

(3) Lagrangian L = _____.

(4) The virtual work done by the forces of constrain is _____.

(b) To find the Lagrange's equations of motion for an electrical circuit comprising an inductance L and capacitance C. The condenser is charged to q coulombs and the current flowing in the circuit is I amperes. **2**

(c) Derive Newton's second law of motion from Hamilton's principle. **3**

(d) Derive Lagrange's equations from D'Alembert's principle. **5**

4 (a) Write short answer of following questions : **4**

(1) Define the term Constraint.

(2) What are generalised coordinates?

(3) For system of N particle moving independently each other, what is the degree of freedom?

(4) Define the Lagrange's of any particle.

(b) Find the equation of motion of one dimensional harmonic oscillator using Hamilton's principle. **2**

(c) Derive the Euler-Lagrange differential equation. **3**

(d) State and prove Hamilton's principle. **5**

5 (a) Write short answer of following questions : 4

(1) Define phase space.

(2) Give one advantage of Lagrangian approach.

(3) Configuration space is a _____ dimensional space.

(4) According to Hamilton's principle, the path followed by a system is such that Time integral of L is minimize. (True / False)

(b) A particle moving near the surface of earth. The kinetic and pole energy of the particle is $T = \frac{1}{2}m\left(\dot{x}^2 + \dot{y}^2 + \dot{z}^2\right)$ and $V = mgz$. Deduce Hamilton's equations of motion for such conservative system. 2

(c) Write note on Physical significance of H. 3

(d) Derive Hamilton's canonical equations of motion. 5

6 (a) Write short answer of following questions. 4

(1) Define cyclic coordinate.

(2) What is generalised momentum ?

(3) What is H of any mechanical system?

(4) Lagrange's undetermined multiplier is denoted by _____.

(b) Obtain Hamiltonian of motion of a charged particle in an electromagnetic field. 2

(c) Explain application of Lagrange's method of undetermined multipliers in simple pendulum. 3

(d) Derive the equation of motion for linear harmonic oscillator using Hamiltonian. 5

7 (a) Write short answer of following questions. 4

(1) Give M.K.S. unit of h.

(2) What is orthogonally condition ?

(3) Write Hamiltonian operator.

(4) Define commutator.

(b) An electron of momentum 8×10^{-19} gm cm/sec is passed through a circular hole of radius 10^{-4} cm. What is the uncertainty introduced in the angle of emergence ? Take $h = 10^{-27}$ erg sec. 2

(c) Give Physical interpretation of Wave function Ψ. 3

(d) Explain particle in a one dimensional potential well of finite depth. 5

8 (a) Write answer of following questions : 4

(1) Who discovered photo electric effect?

(2) Give the De-Broglie wavelength relation of particle.

(3) Write Ehrenfest's theorem.

(4) Define stationary state.

(b) Show that $\langle p_x x \rangle - \langle x p_x \rangle = -ih$. 2

(c) Explain Probability current density. 3

(d) Derive general solution of the one dimensional Schrodinger equation for a free particle. 5

9 (a) Write short answer of following questions. 4

(1) The scalar product of the ket $|A\rangle$ and bra $\langle B|$ is _____ number.

(2) Give necessary and sufficient condition for an operator to be a null operator.

(3) Write the potential energy function of hydrogen like atom.

(4) The bra vector corresponding to the state A is described by _____.

(b) If $H = \frac{P^2}{2m} + \frac{1}{2} m\omega^2 x^2$, then Prove $[x, H] = \frac{ihP}{m}$. 2

(c) Explain ket vector. 3

(d) Derive the solution of the Schrodinger equation corresponding to the hydrogen like atom. 5

10 (a) Write short answer of following questions : 4

(1) Define angular momentum.

(2) The Eigen values of L^2 are _____.

(3) Give the symbol of bra vector.

(4) When two bra are said to be equal?

(b) Prove $[x, y] = -[y, x]$. 2

(c) Explain linear operators. 3

(d) Derive the Hermite equation. 5