

Seat No. : _____

JG-121

January-2021

B.Sc., Sem.-V

CC-301 : Physics

(Mathematical Physics, Classical Mechanics, Quantum Mechanics)

(Old Course)

Time : 2 Hours]

[Max. Marks : 50

- Instructions :** (1) Wear mask and keep safe distance to each other.
(2) Symbols have their usual meaning.

SECTION – I

Answer any **three**.

1. (A) Separate the Helmholtz equation in Cartesian coordinates. 7
(B) Using the method of separation of variable, separate the diffusion equation into space and time parts. 7
2. (A) Separate the Helmholtz equation in Spherical polar coordinates. 7
(B) Write a notes on differential equations occurring in different branch of physics. 7
3. (A) Solve, $\frac{d^2y}{dx^2} + (\tau - x^2) y = 0$, where τ is constant, using the power series method. 7
(B) Check the nature of singularity of equation
 $x^2 \frac{d^2y}{dx^2} + \frac{dy}{dx} + (x^2 - m^2) y = 0$ for the point at infinity. 7
4. (A) Solve, $\frac{d^2y}{dx^2} + 2x \frac{dy}{dx} + 2y = 0$, using the power series method. 7
(B) State and prove Wronskian theorem. 7
5. (A) What are Constraints ? Explain giving the examples types of constraints. 7
(B) Obtain D'Alembert's principle. 7

6. (A) Establish (Derive) a relation between the rate at which work done by the torque and the rate of change of kinetic energy with respect to time. 7
- (B) Obtain a general expression for kinetic energy and explain the significance of three terms involved in it. 7
7. (A) Derive an expression for the energy eigen values of the simple harmonic oscillator. 7
- (B) Write a notes on Ladder operator. 7
8. (A) Derive energy eigen functions of harmonic oscillator. 7
- (B) Explain parity operator and show that for all Ψ , $PL_z = L_zP$. 7

SECTION – II

9. Answer any **eight** in short. 8
- (1) Write ∇^2 for cylindrical coordinate system.
 - (2) Write expressions for parabolic coordinates.
 - (3) Write expressions for inverse transformation for parabolic coordinates.
 - (4) Write scale factors for parabolic coordinates.
 - (5) Two solutions of second order differential equation y_1 and y_2 are linearly independent then write general solution for it.
 - (6) Define ordinary point and singular point.
 - (7) Define regular singular and irregular singular point.
 - (8) Write general solution of $x^2 \frac{d^2y}{dx^2} + x \frac{dy}{dx} + \left(x^2 - \frac{1}{4}\right) y = 0$.
 - (9) Define cyclic coordinates.
 - (10) Define degrees of freedom.
 - (11) Write two constraint equations for a simple pendulum moving in $x - y$ plane.
 - (12) Define rigid body.
 - (13) In three dimensions write the differential operators P and E.
 - (14) $[x, p] = \underline{\hspace{2cm}}$. (Fill in the blank)
 - (15) What is coherent states ?
 - (16) Define zero-point energy.