

Seat No. : _____

NM-103

November-2013

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

301 : Physics

[Max. Marks : 70]

Time : 3 Hours

શુદ્ધા : (1) બધા જ પ્રશ્નોના ગુણ સર્વાં છે.

Instructions : All questions carry equal marks.

(2) રંગાઓના અર્થ પ્રચલિત પ્રશ્નાંથી મુજબ છે.
Symbols have their usual meaning.

(a) હેલ્મિલોટ્સ સમીકરણને કાર્ટેઝિયન પામપદ્ધતિમાં વિભાજન કરો.

Separate Helmholtz's equation in Cartesian co-ordinate system.

અધ્યવાચ/OR:

(i) ચલ વિભાજનની રીતથી ત્રિપાદિમાળિક તર્ફાં સમીકરણને અવકાશ અને સમય ભાગમાં વિભાજન કરો. $\nabla^2 = X(x)Y(y)Z(z)T(t)$: $\frac{\partial^2 \Phi(x,y,z,t)}{\partial x^2} = \frac{1}{X(x)} \frac{\partial^2 \Phi(x,y,z,t)}{\partial y^2} = \frac{1}{Y(y)} \frac{\partial^2 \Phi(x,y,z,t)}{\partial z^2} = \frac{1}{Z(z)} \frac{\partial^2 \Phi(x,y,z,t)}{\partial t^2}$

Separate the three dimensional wave equation into space and time part using the method of separation of variable.

(ii) ચલ વિભાજનની રીતથી વિસરણ સમીકરણને અવકાશ અને સમય ભાગમાં વિભાજન કરો.

Separate the diffusion equation into space and time part using the method of separation of variable.

(b) ભौતિકજ્ઞાનની વિવિધ શાખાઓમાં આવતો વિકલ સમીકરણો વિશે ફૂકનોંધ લખો.

Write a notes on differential equations occurring in various branches of physics.

અધ્યવાચ/OR

દુદી દુદી પામ પદ્ધતિમાં લાંબાસના સમીકરણો લખો.

Write the Laplace's equation in various co-ordinate systems.

2. (a) નીચેના વિકલ સમીકરણનો ઘાત શ્રેષ્ઠ દારા ઉકેલ મેળવો :

$$\frac{d^2y}{dx^2} + 2x \frac{dy}{dx} + 2y = 0$$

Solve the following differential equation using power series method :

$$\frac{d^2y}{dx^2} + 2x \frac{dy}{dx} + 2y = 0$$

અધ્યવાચ/OR

P.T.O.

NM-103

નીચેના વિકલ સમીકરણનો ધાત શ્રેષ્ઠી દારા ઉકેલ મેળવો :

$$\frac{d^2y}{dx^2} + (\lambda - x^2)y = 0 \quad \text{જ્યાં } \lambda \text{ અચળાંક છે.}$$

Solve the following differential equation using power series method :

$$\frac{d^2y}{dx^2} + (\lambda - x^2)y = 0 \quad \text{where } \lambda \text{ in constant.}$$

(b) બેસેલ સમીકરણને ફોનેનિયસની રીતથી ઉકેલો. ઈન્ડિસિયલ સમીકરણ (Indicial equation) મેળવો. બંને ક્રિસ્ટા ગ્રાં.

Solve Bessel's equation by the method of Frobenius. Obtain indicial equation. Discuss both cases.

અથવા/OR

રોન્સ્કીયાન (Wronskian) ની મદદથી નીચે આપેલા વિકલ સમીકરણનો હેત્તીય ઉકેલ મેળવો.

$$(1) x^2 \frac{d^2y}{dx^2} + x \frac{dy}{dx} + x^2 y = 0$$

$$(2) x^2 \frac{d^2y}{dx^2} + x \frac{dy}{dx} + (x^2 - 1)y = 0$$

Using Wronskian, obtain the second solution of given differential equation:

$$(3) x^2 \frac{d^2y}{dx^2} + x \frac{dy}{dx} + x^2 y = 0$$

$$(2) x^2 \frac{d^2y}{dx^2} + x \frac{dy}{dx} + (x^2 - 1)y = 0$$

(a) ડાયલોગ્યાન્ટના સિટ્ટાન્ટની પદદથી સંરક્ષી હોલોનોમિક તત્ત્વ માટે લાગ્રાંજેના ગતિના સમીકરણો તારવો.

With the help of D'Alembert's principle, derive Lagrange's equation of motion for conservative holonomic system.

અથવા/OR

દિલોલકના ક્રિસ્ટામાં ગતિઉજ્જીવનું સમીકરણ મેળવો.

Obtain expression for kinetic energy in case of double pendulum.

(b) દુઃ પદાર્થ માટે ક્રોણીય વેગમાન અને ગતિઉજ્જીવનાં સ્તરો મેળવો.

Obtain an expression for angular momentum and kinetic energy of a rigid body.

અથવા/OR

દુઃ પદાર્થ માટે ઓઈલરના ગતિના સમીકરણ મેળવો.

$$\overline{W} \cdot \bar{N} = \frac{dT}{dt} \quad \text{સંબંધ મેળવો.}$$

Obtain Euler's equation of motion for a rigid body. Obtain the relation

$$\overline{W} \cdot \bar{N} = \frac{dT}{dt} \quad 44$$

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November-2014

B.Sc., Sem.-V

301 : Physics**Time : 3 Hours]****[Max. Marks : 70]**

1. (a) હેલ્પોલ્ટ્ડ્ઝ સમીકરણ $[\nabla^2 + k^2]u(\vec{r}) = 0$ ને ધ્રુવીય (Polar) યામ પદ્ધતિ (r, θ) માં જુદુ પાડો. 5
અથવા

- (b) લાખાસ સમીકરણ $\nabla^2 u(\vec{r}) = 0$ ને કાર્ટીયન યામ પદ્ધતિમાં જુદુ પાડો. 9
સમય પર આધારીત શ્રોડિઝર સમીકરણ

$$ih \frac{\partial \psi(\vec{r}, t)}{\partial t} = -\frac{\hbar^2}{2m} \nabla^2 \psi(\vec{r}, t) + V \vec{r} \cdot \vec{\psi}(\vec{r}, t)$$

- ને ગોલીય યામ પદ્ધતિમાં જુદુ પાડો.
અથવા

તરંગ સમીકરણ

$$\frac{1}{c^2} \frac{\partial^2 u(\vec{r}, t)}{\partial t^2} = \nabla^2 u(\vec{r}, t)$$

- ને નળાકારીય (Cylindrical) યામ પદ્ધતિમાં જુદુ પાડો.

2. (a) આપેલ સમીકરણ,

$$(1-x^2) \frac{d^2y}{dx^2} - 2x \frac{dy}{dx} + l(l+1)y = 0, જ્યાં l = ધન પૂર્ણાંક,$$

- માટે ફાઈનાઈટ સિન્યુલર પોઇન્ટ શોધો અને સિન્યુલારીટીનો પ્રકાર નક્કી કરો.
અથવા

આપેલ સમીકરણ,

$$x^2 \frac{d^2y}{dx^2} + x \frac{dy}{dx} + (x^2 - m^2)y = 0,$$

- માટે અનંત અંતરે આવેલા બિંદુ પાસે સિન્યુલારીટીનો પ્રકાર નક્કી કરો.

- (b) આપેલ વિકલ સમીકરણ,

$$\frac{d^2y}{dx^2} - xy = 0$$

- નો ચરઘાતાંકીય (પાવર સિરીઝ) ઉકેલ મેળવો.
અથવા

રોન્સ્ક્રીઅન (Wronskian) નો ઉપયોગ કરીને આપેલ વિકલ સમીકરણ

$$x^2 \frac{d^2y}{dx^2} + x \frac{dy}{dx} + (x^2 - 1)y = 0$$

- નો ઉકેલ મેળવો.

3. (a) ડી'એલેમ્બર્ટના સિદ્ધાંતનો ઉપયોગ કરીને કોન્જર્વેટીવ હોલોનોમીક તંત્ર માટે લાગ્રાંજના
ગતિના સમીકરણો મેળવો.

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અથવા

વિદ્યુત ચુંબકીય ક્ષેત્રમાં ગતિ કરતાં વિદ્યુતભારીત કણ માટે વેગ આધારીત સ્થિતિમાનનું
સમીકરણ મેળવો.

- (b) જડ પદાર્થ માટે યુલરના ગતિના સમીકરણો મેળવો.

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અથવા

સંમિતી ધરાવતા ટોપ (Top) ની ટોક મુક્ત ગતિ સમજાવો અને $\omega_1, \omega_2, \omega_3$ માટેના
સમીકરણો મેળવો.

4. (a) એક દિશામાં સરળ આવર્ત ગતિ કરતાં દોલક માટે આઈગન સમીકરણ લખો. આ
સમીકરણને ઉકેલીને તેના આઈગન વિધેયો અને આઈગન મૂલ્યો મેળવો.

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અથવા

ત્રિજ્યાવર્તી ક્ષેત્રમાં ગતિ કરતાં કણ માટે ત્રિજ્યાવર્તી તરંગ સમીકરણ મેળવો, તથા આ કણ
માટે : (i) કેન્દ્રની નજીક, (ii) કેન્દ્રથી અનંત અંતરે, (iii) સ્ટેટમાં, તેનું ત્રિજ્યાવર્તી તરંગ
વિધેય મેળવો.

- (b) પેરીટી કારક મુદ્દાસર સમજાવો.

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અથવા

લેડર (Ladder) કારકો માટે સાબિત કરો કે,

$$(a^+)^m u_0, (a^+)^n u_0 = n! \delta_{mn}, \text{ જ્યાં } m > n.$$

5. ટૂંકમાં જવાબ આપો :

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- (1) વાયુ માટે ડિફ્યુઝન (diffusion) સમીકરણ લખો.
- (2) $p(\vec{r})$ જેટલી વિદ્યુતભાર ઘનતા ધરાવતા બિંદુ પાસે સ્થિત વિદ્યુતસ્થિતિમાનનું સમાધાન કરતું
પોઈઝન (Poisson) સમીકરણ લખો.
- (3) દ્વિતીય કમના રેખીય વિકલ સમીકરણ માટે ઓર્ડિનરી પોઈન્ટ વ્યાખ્યાયિત કરો.
- (4) પેરાબોલીક યામ પદ્ધતિમાં ∇^2 કારક લખો.
- (5) દ્વિતીય કમનું રેખીય વિકલ સમીકરણ વ્યાખ્યાયિત કરો.
- (6) વિકલ સમીકરણ $x^2 \frac{d^2y}{dx^2} + x \frac{dy}{dx} + (x^2 - \frac{1}{4})y = 0$ ના બે ઉકેલો _____ અને
છે.
- (7) ડિગ્રી ઓફ ડિગ્રી એટલે શું ?
- (8) સાઈક્લીક યામો વ્યાખ્યાયિત કરો.
- (9) ગોલીય (Spherical) દોલક શું છે ?
- (10) યુલર (Euler) ની થીયેરમનું વિધાન લખો.
- (11) a અને a^+ ને લેડર કારકો શા માટે કહે છે ?
- (12) $u_0(p)$ ની કિંમત શોધો.
- (13) $u_1(p)$ ની કિંમત શોધો.
- (14) કોણીય વેગમાનના વર્ગનો કારક _____ છે.

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November-2014

B.Sc., Sem.-V

301 : Physics

Time : 3 Hours]

[Max. Marks : 70

1. (a) Separate the Helmholtz equation $[\nabla^2 + k^2]u(\vec{r}) = 0$ in two dimensions in polar coordinates (r, θ) . 5

ORSeparate the Laplace equation $\nabla^2 u(\vec{r}) = 0$ in to Cartesian coordinates.

- (b) Separate the equation time dependent Schrödinger equation. 9

$$i\hbar \frac{\partial \Psi(\vec{r}, t)}{\partial t} = -\frac{\hbar^2}{2m} \nabla^2 \psi(\vec{r}, t) + V(\vec{r})\psi(\vec{r}, t)$$

completely into spherical coordinates.

OR

Separate the wave equation ✓

$$\frac{1}{c^2} \frac{\partial^2 u(\vec{r}, t)}{\partial t^2} = \nabla^2 u(\vec{r}, t)$$

completely into cylindrical coordinates.

2. (a) Find the finite singular point of the differential equation,

$$(1-x^2) \frac{d^2y}{dx^2} - 2x \frac{dy}{dx} + l(l+1)y = 0, \text{ where } l = \text{positive integer,}$$

and determine the nature of singularity. 7**OR**

Check the nature of singularity of equation

$$x^2 \frac{d^2y}{dx^2} + x \frac{dy}{dx} + (x^2 - m^2)y = 0,$$

for the point at infinity.

- (b) Find the power series solution of the differential equation,

$$\frac{d^2y}{dx^2} - xy = 0. 7$$

OR

Using the method of Wronskian, solve the equation

$$x^2 \frac{d^2y}{dx^2} + x \frac{dy}{dx} + (x^2 - 1)y = 0.$$

3. (a) Derive Lagrange's equations of motion for a conservative holonomic system using D'Alembert's principle. 9

OR

Obtain an expression for the velocity dependent potential for a charged particle moving in an electromagnetic field.

- (b) Derive Euler's equation's of motion for a rigid body. 5

OR

Discuss the motion of a symmetric top performing torque-free motion and obtain expressions for ω_1 , ω_2 and ω_3 .

4. (a) Write the eigen value equation for one dimensional harmonic oscillator. Hence solve it to obtain its eigen functions and eigen values. 8

OR

Obtain the radial wave equation for a particle moving in central potential. Hence explain the behaviour of the radial wave function of the particle : (i) near the origin, (ii) in the asymptotic region, (iii) in the s-state.

- (b) Write note on Parity operator. 6

OR

For the ladder operators, prove that
 $((a^+)^m u_0, (a^+)^n u_0) = n! \delta_{mn}$, for $m > n$.

5. Answer in short :

- (1) Write diffusion-equation for gas.
- (2) Write Poisson equation satisfied by the electrostatic potential at a point where the electric charge density is $\rho(\vec{r})$.
- (3) Define ordinary point of the second ordered linear differential equation.
- (4) What is the operator form for ∇^2 in parabolic coordinates ?
- (5) Define the second ordered linear differential equation.
- (6) The two roots of the differential equation $x^2 \frac{d^2y}{dx^2} + x \frac{dy}{dx} + (x^2 - \frac{1}{4})y = 0$ are _____ and _____.
- (7) What do you mean by degrees of freedom ?
- (8) Define a cyclic coordinate.
- (9) What is spherical pendulum ?
- (10) Write the statement of Euler's theorem.
- (11) Why a and a^+ are called ladder operators ?
- (12) Evaluate $u_0(\rho)$:
- (13) Evaluate $u_1(\rho)$.
- (14) The operator for square of angular momentum is _____.

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December-2015

B.Sc., Sem.-V

Core Course-301 : Physics

Time : 3 Hours]

[Max. Marks : 70]

1. (a) The time dependent Schrödinger equation is given by

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$$\checkmark \quad i\hbar \frac{\partial \psi(\vec{r}, t)}{\partial t} = -\frac{\hbar^2}{2m} \nabla^2 \psi(\vec{r}, t) + V(\vec{r})\psi(\vec{r}, t)$$

Separate it into space and time parts.

OR

(a) Separate the Helmholtz equation $[\nabla^2 + k^2]u(\vec{r}) = 0$ into parabolic coordinates.

2
C
t

(b) Separate the Laplace equation $\nabla^2 u(\vec{r}) = 0$ into cylindrical coordinates.

6
D
t

OR

(b) Separate the equation $[\nabla^2 + k^2]u(\vec{r}) + zu(\vec{r}) = 0$ into cartesian coordinates.

8
C
t

2. (a) Solve the differential equation $\frac{d^2y}{dx^2} - 2x \frac{dy}{dx} + 2uy = 0$, where u is integer.

8
C
t

OR

(a) Solve the differential equation $x^2 \frac{d^2y}{dx^2} + x \frac{dy}{dx} + (x^2 - m^2)y = 0$, to get two linearly independent solutions using the Frobenius series method.

6
C
t

(b) Find the finite singular point of the differential equation,

$$x \frac{d^2y}{dx^2} + (1-x) \frac{dy}{dx} + ny = 0, \text{ (where } n \text{ is integer)}$$

and determine the nature of singularity.

OR

(b) One solution of the differential equation $x^2 \frac{d^2y}{dx^2} + x \frac{dy}{dx} + x^2y = 0$ is $J_0(x)$. Obtain the second independent solution using method of Wronskian.

8
C
t

3. (a) Explain :

- (1) Holonomic and Non-Holonomic constraints, and
 (2) Scleronomous and Rheonomous constraints

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OR

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P.T.O.

(a) What is spherical pendulum? Obtain the equation of motion and total energy for a spherical pendulum.

(b) Explain the moment of inertia tensor.

OR

(b) Obtain an expression for the kinetic energy of a rigid body.

4. (a) Write the eigen value equation for one dimensional simple harmonic oscillator. Hence solve it to obtain its eigen functions and eigen values.

OR

(a) If $u_m(\rho)$ and $u_n(\rho)$ are normalized eigen states of simple harmonic oscillator, then prove that $\langle u_m(\rho), u_n(\rho) \rangle = \delta_{mn}$.

(b) Write note on parity operator.

OR

(b) Explain, why a and a^+ are called ladder operators.

5. Answer in short:

(1) Write the diffusion equation for a gas having gas density $\rho(\vec{r}, t)$.

(2) Write Poisson equation satisfied by the electrostatic potential at a point where the electric charge density is $\rho(\vec{r})$.

(3) Write the wave equation for a wave proceeding along x -direction with velocity 'c'.

(4) The value of Wronskian of $y_1 = e^x$, and $y_2 = e^{-x}$, is $W[y_1, y_2] = \dots$

(5) If the two roots α_1 and α_2 of indicial equation differ by an integer, then the second order linear differential equation has two linearly independent solutions of the form $y_1(x) = \dots$, and $y_2(x) = \dots$

(6) Define singular point of second order linear differential equation.

(7) $x=0$ is the singular point of the differential equation $y'' + 2xy' + 2y = 0$.

(8) Write the statement of Euler's theorem for the motion of a rigid body. $\omega \cdot N = \frac{d\mathbf{T}}{dt}$

(9) What do you mean by virtual displacement?

(10) State the principle of virtual work.

(11) Write the radial wave equation for a particle moving in central potential.

(12) Write the operator for L^2 in spherical polar coordinates. $U(r, \theta, \phi)$

(13) The eigen-state ϕ_μ of ladder operator a , in terms of stationary states $u_n(\rho)$ of harmonic oscillator is $\dots e^{-\sqrt{\lambda}S} \Psi(S)$.

(14) Draw the polar diagram of $Y_{20} = \left(\frac{5}{16\pi}\right)^{\frac{1}{2}} (3 \cos^2 \theta - 1)$.

Seat No. : _____

MB-113

November-2016

B.Sc., Sem.-V

CC-301 : Physics

[Mathematical Physics, Classical Mechanics, Quantum Mechanics]

[Max. Marks : 70]

Time : 3 Hours

- Instructions :** (1) All questions carry equal marks.
(2) Symbols have their usual meaning.

1. (a) Write a notes on differential equations occurring in different branches of physics with example. 7

7

OR

Using the method of separation of variables, separate the (1) diffusion equation,

(2) three dimensional wave equation in space and time axis.

(b) The Schrodinger equation for a particle in a coulomb field has the form

$\left(\nabla^2 + K^2 + \frac{A}{r} \right) \psi(\vec{r}) = 0$, where K^2 and A are constants. Suppose $\psi(\vec{r})$ does not

depend on the angle ϕ , separate the equation in parabolic coordinates. 7

7

OR

Write the time independent Schrodinger equation for a three dimensional

harmonic oscillator. In spherical polar coordinates $\psi(\vec{r}) = R(r) Y(\theta, \phi)$, obtain the equation satisfied by the radial part $R(r)$.

2. (a) Obtain two linearly independent solutions of the following equation : 7

$$\frac{d^2y}{dx^2} - xy = 0 \text{ (Airy equation)}$$

16/11/17

OR

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P.T.O.

Find one solution of the following differential equation by the method of Frobenius :

$$x \frac{d^2y}{dx^2} + (C - x) \frac{dy}{dx} - ay = 0$$

- (b) Discuss alternative method for getting the second solution and solve the differential equation, $x \frac{d^2y}{dx^2} + y = 0$. 7

OR

Systems of linear, first order equations with constant coefficients are,

$$\frac{dx_1}{dt} = 5x_1 + 4x_2$$

$$\frac{dx_2}{dt} = -x_1 + x_2$$

Obtain second independent linear solution of given equations.

3. (a) With the help of D'Alembert's principle derive Lagrange's equation of motion for conservative holonomic system. 7

OR

Obtain Lagrangian function L for spherical pendulum. Show that corresponding momentum is conserved if variable ϕ is ignorable. 26

- (b) Obtain components of the angular momenta of a rigid body and show $L = \overset{\leftrightarrow}{I} \cdot \overset{\leftrightarrow}{W}$. 7

OR

Obtain Euler's equations of motion of a rigid body. Obtain relation $\vec{w} \cdot \vec{N} = \frac{dT}{dt}$ if torque acting on rigid body is zero. 54

4. (a) Write series solution of differential equation, $v'' - 2\wp v' + (\lambda - 1)v = 0$ for simple harmonic oscillator. Obtain the energy eigen functions: $\hat{u}_n(x) = N_n e^{-\frac{1}{2}\alpha^2 x^2}$
 $H_n(\alpha x)$, ($n = 0, 1, 2 \dots$). 7

OR

Explain :

- (1) The Ladder operators
- (2) The Eigenvalue spectrum

(b) Starting with equation :

$$(1 - w^2) \frac{d^2 k}{dw^2} - 2(|m| + 1)w \cdot \frac{dk}{dw} + [l(l+1) - |m|(|m|+1)]k = 0$$

Obtain an expression for spherical harmonics $Y_{lm}(\theta, \phi)$ for L^2 operator

$$[\text{Hint : } \Phi(\phi) = \frac{1}{\sqrt{2\pi}} e^{im\phi}]$$

OR

Explain parity operator and show that for all ψ , $PL_z = L_z P$.

5. Answer in short : [Each question is of 1 mark] 14

- (1) Write scale factors h_1, h_2 and h_3 for parabolic coordinates.
- (2) Write expressions of v, ν and ϕ for prolate spheroidal coordinates.
- (3) Write ordinary differential equations of cylindrical coordinates z and Φ .
- (4) Define ordinary point and singular point.

- (5) Define regular singular point and irregular singular point.
- (6) Write Bessel's equation.
- (7) Define Wronskian.
- (8) Write equations of constraints for simple pendulum moving in xy -plane.
- (9) Define virtual displacement.
- (10) Define cyclic coordinates.
- (11) State Chasles' theorem.
- (12) Write Norm of wavefunction u in spherical polar coordinates.
- (13) Write expression for energy eigen values E_n of the simple harmonic oscillator.
- (14) Write the generating function $G(\rho, \xi)$ of the Hermite polynomials.

Seat No. 4241

NK-105

November-2017

B.Sc., Sem.-V

CC-301 : Physics

Time : 3 Hours]

[Max. Marks : 70

- Instructions :**
- (1) All questions carry equal marks.
 - (2) Symbols have their usual meaning.

1. (a) Separate Helmholtz's equation in the Cartesian co-ordinate system. 2013 7

OR

Separate Helmholtz's equation in the Cylindrical co-ordinate system.

- (b) Separate the three dimensional wave equation into space and time part using the method of separation of variable. 2023 7

OR

Separate the diffusion equation into the space and time part using the method of separation of variable. 2013

- (a) Solve the following differential equation using the power series method : 7

$$\frac{d^2y}{dx^2} + 2x \frac{dy}{dx} + 2y = 0 \quad 2013$$

OR

Solve the following differential equation using the power series method :

$$\frac{d^2y}{dx^2} + (\lambda - x^2)y = 0; \quad 2013$$

where λ is constant.

- (b) Using the Wronskian method, solve the following differential equation : 7

$$x^2 \frac{d^2y}{dx^2} + x \frac{dy}{dx} + x^2 y = 0$$

OR

Using the Wronskian method, solve the following differential equation :

$$x^2 \frac{d^2y}{dx^2} + x \frac{dy}{dx} + (x^2 - 1)y = 0 \quad 2014$$

3. (a) Derive the D'Alembert's Principle.

OR

Derive the general expression for the Kinetic Energy.

- (b) Derive the Euler's equations of Motion for a rigid body. → 20¹⁴

OR

Derive an expression for the kinetic energy of a rigid body. → 20¹⁵

4. (a) Derive an expression for the energy Eigenvalues of the simple Harmonic Oscillator.

OR

Derive the radial wave equation for a particle moving in the central potential.

- (b) Write a note on the Ladder Operators.

OR

Write a note on the Parity Operator. → 20¹⁴, 20¹⁵

5. Answer the following questions in short :

- (1) Define ordinary point.
- (2) Define singular point.
- (3) Define regular singular point.
- (4) Define irregular singular point.
- (5) Define the degrees of Freedom.
- (6) Define Constraint.
- (7) Define Holonomic constraint.
- (8) Define Scleronomous constraint.
- (9) Define Rheonomous constraint.
- (10) Define the cyclic co-ordinate.
- (11) Define the spherical pendulum.
- (12) Define the Rigid body
- (13) State the Euler's theorem.
- (14) State the operator L^2 in the spherical polar co-ordinates.