□ Class 12 Mathematics – Chapter: Differential Equations

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1. Introduction

- A differential equation relates a function with its derivatives.
- Used to model real-world phenomena involving rates of change.

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2. Order and Degree

- **Order:** Highest derivative in the equation.
- **Degree:** Power of the highest derivative (after removing radicals and fractions).

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3. General Form

- Equation involving derivatives of an unknown function $y=f(x)$:

  $F(x,y,y',y'',\ldots,y(n))=0F(x, y, y', y'', \dots, y^{(n)}) = 0F(x,y,y',y'',\ldots,y(n))=0$

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4. Types of Differential Equations

- **Ordinary Differential Equations (ODE):** Involves functions of one variable and derivatives.
- **Partial Differential Equations (PDE):** Involves partial derivatives with respect to multiple variables.

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5. Solutions of Differential Equations

- **General solution:** Contains arbitrary constants equal to the order.
- **Particular solution:** Obtained by applying initial/boundary conditions.
- **Singular solution:** Solution not obtainable from the general solution by particular values of constants.

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6. Methods of Solving First-Order Differential Equations

a) Variable Separable Method

- When equation can be written as:

  dydx=g(x)h(y)\frac{dy}{dx} = g(x) h(y)dxdy=g(x)h(y)
- Separate variables and integrate:

  ∫1h(y)dy=∫g(x)dx\int \frac{1}{h(y)} dy = \int g(x) dx∫h(y)1dy=∫g(x)dx

b) Homogeneous Equations

- Equation of the form:

  $$\frac{dy}{dx} = f\left(\frac{y}{x}\right)$$
- Substitute $v = \frac{y}{x}$ and solve.

c) Linear Differential Equations

- Form:

  $$\frac{dy}{dx} + P(x)y = Q(x)$$
- Use integrating factor $IF = e^{\int P(x)\,dx}$ to solve.

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7. Applications

- Population growth.
- Radioactive decay.
- Motion under gravity.
- Electrical circuits.

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8. Exam Tips

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Understand order and degree.

- Practice variable separation and linear methods.
- Memorize integrating factor formula.
- Solve many examples with initial conditions.