

Straight Lines

Introduction

A **Straight Line** is the shortest distance between two points and is one of the most important concepts in Coordinate Geometry. It helps describe the position, direction, and relationship between points on a plane. Straight lines are widely used in mathematics, engineering, architecture, physics, and computer graphics.

Coordinate Plane

Cartesian Coordinate System

The **Cartesian Coordinate System** consists of:

- **X-axis (Horizontal Axis)**
- **Y-axis (Vertical Axis)**

These two axes intersect at the **Origin (0,0)** and divide the plane into four quadrants.

Every point on the plane is represented by an ordered pair **(x, y)**.

Slope of a Straight Line

Meaning of Slope

The **slope** of a straight line measures its inclination with respect to the positive x-axis.

It is denoted by **m**.

Formula:

$$m = (y_2 - y_1) / (x_2 - x_1)$$

The slope can be:

- Positive
 - Negative
 - Zero (Horizontal Line)
 - Undefined (Vertical Line)
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Angle of Inclination

Definition

The **angle of inclination (θ)** is the angle made by a line with the positive direction of the x-axis.

The relation between slope and angle is:

$$m = \tan \theta$$

where $0^\circ \leq \theta < 180^\circ$.

Equation of a Straight Line

General Equation

The general equation of a straight line is:

$$Ax + By + C = 0$$

where **A**, **B**, and **C** are constants, and **A** and **B** are not both zero.

Forms of Equation of a Straight Line

Different Forms

The equation of a straight line can be written in different forms:

- **Slope-Intercept Form:**

$$y = mx + c$$

- **Point-Slope Form:**

$$y - y_1 = m(x - x_1)$$

- **Two-Point Form:**

A line passing through two given points.

- **Intercept Form:**

$$x/a + y/b = 1$$

- **Normal Form:**

$$x \cos \alpha + y \sin \alpha = p$$

Conditions for Parallel and Perpendicular Lines

Relationship Between Two Lines

- **Parallel Lines:** Have equal slopes.
 $m_1 = m_2$
 - **Perpendicular Lines:** Product of slopes is -1 .
 $m_1 \times m_2 = -1$
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Distance of a Point from a Line

Formula

The perpendicular distance of a point (x_1, y_1) from the line $Ax + By + C = 0$ is:

$$\text{Distance} = |Ax_1 + By_1 + C| / \sqrt{A^2 + B^2}$$

Applications of Straight Lines

Importance

Straight lines are used in:

- Coordinate Geometry
 - Engineering
 - Architecture
 - Physics
 - Computer Graphics
 - Navigation
 - Surveying
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Key Points

- A straight line is the shortest distance between two points.
 - The slope determines the inclination of a line.
 - $m = \tan \theta$.
 - The general equation of a straight line is $Ax + By + C = 0$.
 - Important forms include slope-intercept, point-slope, two-point, intercept, and normal forms.
 - Parallel lines have equal slopes.
 - Perpendicular lines have slopes whose product is -1 .
 - Straight lines have numerous real-life applications.
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Chapter Summary

This chapter introduces straight lines in coordinate geometry. It explains the Cartesian coordinate system, slope, angle of inclination, and different forms of the equation of a straight line. The chapter also covers conditions for parallel and perpendicular lines, the distance of a point from a line, and practical applications. These concepts form the foundation for advanced coordinate geometry.