

Conic Sections

Introduction

Conic Sections are curves obtained by cutting a **right circular cone** with a plane. Depending on the angle at which the plane intersects the cone, different curves such as a **circle, parabola, ellipse, and hyperbola** are formed. Conic sections have wide applications in astronomy, engineering, architecture, optics, and satellite communication.

Conic Section

What are Conic Sections?

A **conic section** is the curve formed when a plane cuts a double right circular cone.

The four main conic sections are:

- **Circle**
- **Parabola**
- **Ellipse**
- **Hyperbola**

Each has unique properties and equations.

Circle

Definition

A **circle** is the set of all points in a plane that are at a **constant distance** from a fixed point called the **centre**.

Standard equation:

$$(x - h)^2 + (y - k)^2 = r^2$$

where:

- **(h, k)** = Centre
 - **r** = Radius
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Parabola

Definition

A **parabola** is the set of all points that are **equidistant from a fixed point (Focus) and a fixed line (Directrix)**.

Important parts:

- Focus
- Directrix
- Vertex
- Axis of symmetry

Standard equation:

$$y^2 = 4ax$$

Ellipse

Definition

An **ellipse** is the set of all points for which the **sum of the distances from two fixed points (Foci) is constant**.

Important parts:

- Centre
- Major Axis
- Minor Axis
- Foci
- Vertices

Standard equation:

$$x^2/a^2 + y^2/b^2 = 1$$

where **a > b**.

Hyperbola

Definition

A **hyperbola** is the set of all points for which the **difference of the distances from two fixed points (Foci) is constant**.

Important parts:

- Centre
- Foci
- Vertices
- Asymptotes

Standard equation:

$$x^2/a^2 - y^2/b^2 = 1$$

Eccentricity

Meaning

Eccentricity (e) measures how much a conic section differs from a circle.

- **Circle:** $e = 0$
 - **Ellipse:** $0 < e < 1$
 - **Parabola:** $e = 1$
 - **Hyperbola:** $e > 1$
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Degenerate Conics

Special Cases

When the cutting plane passes through the vertex of the cone, special curves called **degenerate conics** are formed, such as:

- A Point
 - A Straight Line
 - A Pair of Intersecting Lines
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Applications of Conic Sections

Importance

Conic sections are used in:

- Astronomy
- Satellite Communication
- Architecture
- Engineering
- Physics
- Optics
- Design of Reflectors and Antennas

Key Points

- Conic sections are formed by intersecting a cone with a plane.
 - The four conic sections are **Circle, Parabola, Ellipse, and Hyperbola**.
 - A parabola is defined using a **focus** and **directrix**.
 - An ellipse has two foci, and the sum of distances from them is constant.
 - A hyperbola has two foci, and the difference of distances is constant.
 - Eccentricity distinguishes different conic sections.
 - Conic sections have many practical applications in science and engineering.
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Chapter Summary

This chapter introduces conic sections and explains how they are formed by intersecting a cone with a plane. It covers the definitions, standard equations, and important features of the circle, parabola, ellipse, and hyperbola. The concept of eccentricity and degenerate conics is also discussed. Conic sections are widely used in mathematics, astronomy, engineering, and modern technology.