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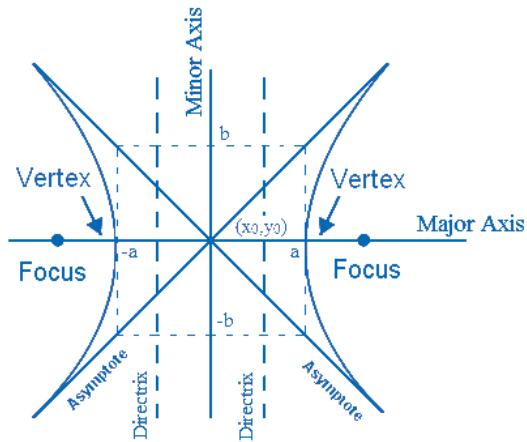
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HYPERBOLA FORMULA

In simple sense, hyperbola looks similar to two mirrored parabolas. The two halves are called the branches. When the plane intersects the halves of a right circular cone at an angle which will be parallel to the axis of the cone, a parabola is formed.

A hyperbola contains two foci and two vertices. The foci of the hyperbola are away from the hyperbola's center and vertices. Here is an illustration to make you understand:



The equation for hyperbola is,

$$\frac{(x - x_0)^2}{a^2} - \frac{(y - y_0)^2}{b^2} = 1$$

Where,

(x_0, y_0) are the center points.

a = semi-major axis.

b = semi-minor axis.

Let us learn the basic terminologies related to hyperbola formula:

MAJOR AXIS

The line that passes through the center, focus of the hyperbola and vertices is the Major Axis. Length of the major axis = $2a$. The equation is given as:

$$y = y_0$$

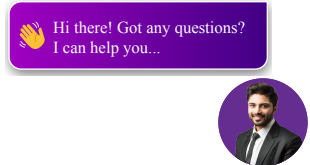
MINOR AXIS

The line perpendicular to the major axis and passes by the middle of the hyperbola is the Minor Axis.

Length of the minor axis = $2b$. The equation is given as:

$$x = x_0$$

ECCENTRICITY



The variation in the conic section being completely circular is eccentricity. It is usually greater than 1 for hyperbola. Eccentricity is $2\sqrt{2}$ for a regular hyperbola. The formula for eccentricity is:

$$\frac{\sqrt{a^2 + b^2}}{a}$$

ASYMPTOTES

Two bisecting lines that is passing by the center of the hyperbola that doesn't touch the curve is known as the Asymptotes. The equation is given as:

$$y = y_0 + \frac{b}{a}x - \frac{b}{a}x_0$$
$$y = y_0 - \frac{b}{a}x + \frac{b}{a}x_0$$

Directrix of a hyperbola

Directrix of a hyperbola is a straight line that is used in generating a curve. It can also be defined as the line from which the hyperbola curves away from. This line is perpendicular to the axis of symmetry. The equation of directrix is:

$$x = \frac{\pm a^2}{\sqrt{a^2 + b^2}}$$

VERTEX

The point of the branch that is stretched and is closest to the center is the vertex. The vertex points are

$$(a, y_0) \text{ and } (-a, y_0)$$

Focus (foci)

On a hyperbola, focus (foci being plural) are the fixed points such that the difference between the distances are always found to be constant. The two focal points are:

$$\left(x_0 + \sqrt{a^2 + b^2}, y_0\right)$$
$$\left(x_0 - \sqrt{a^2 + b^2}, y_0\right)$$

Solved examples

Question: The equation of the hyperbola is given as: $\frac{(x-4)^2}{9^2} - \frac{(y-2)^2}{7^2} = 1$

Find the following: Vertex, Asymptote, Major Axis, Minor Axis and Directrix?

Solution:

Given,
 $x_0=4$
 $y_0=2$
 $a=9$
 $b=7$

The vertex point: (a, y_0) and $(-a, y_0)$ are $(9, 2)$ and $(-9, 2)$

Asymptote



$y = \frac{7}{9}(x - 4) + 2$

$y = -\frac{7}{9}(x - 4) + 2$

Major Axis

a = 9

Minor Axis

b = 7

Directrix

$$x = \frac{\pm 9^2}{\sqrt{9^2 + 7^2}} = \pm \frac{81}{\sqrt{81 + 49}} = 7.1$$

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