DAY 52

MCA CET 2025

MATHS

HYPERBOLA

INEXORABLE

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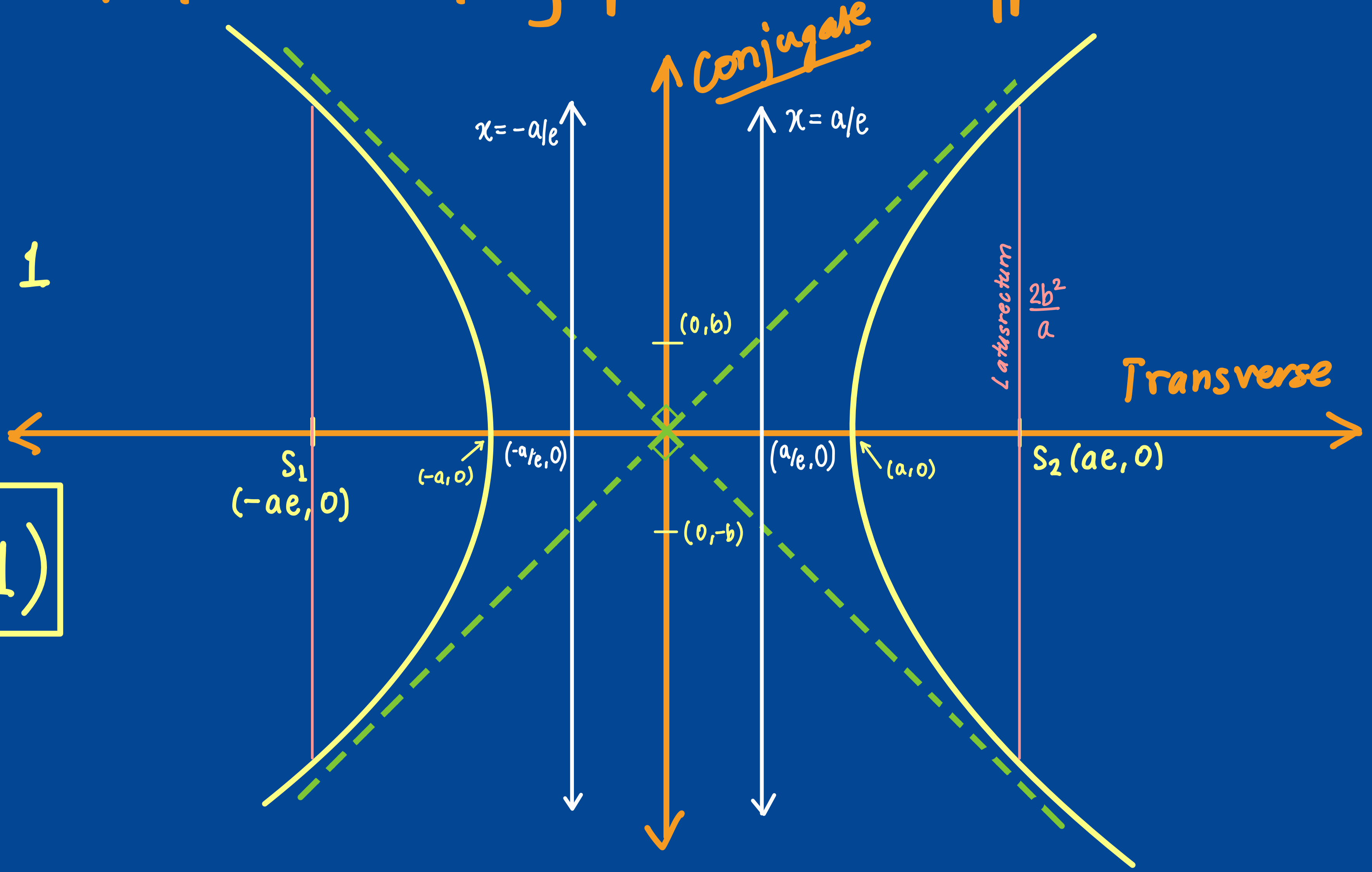
understanding parts of hyperbola

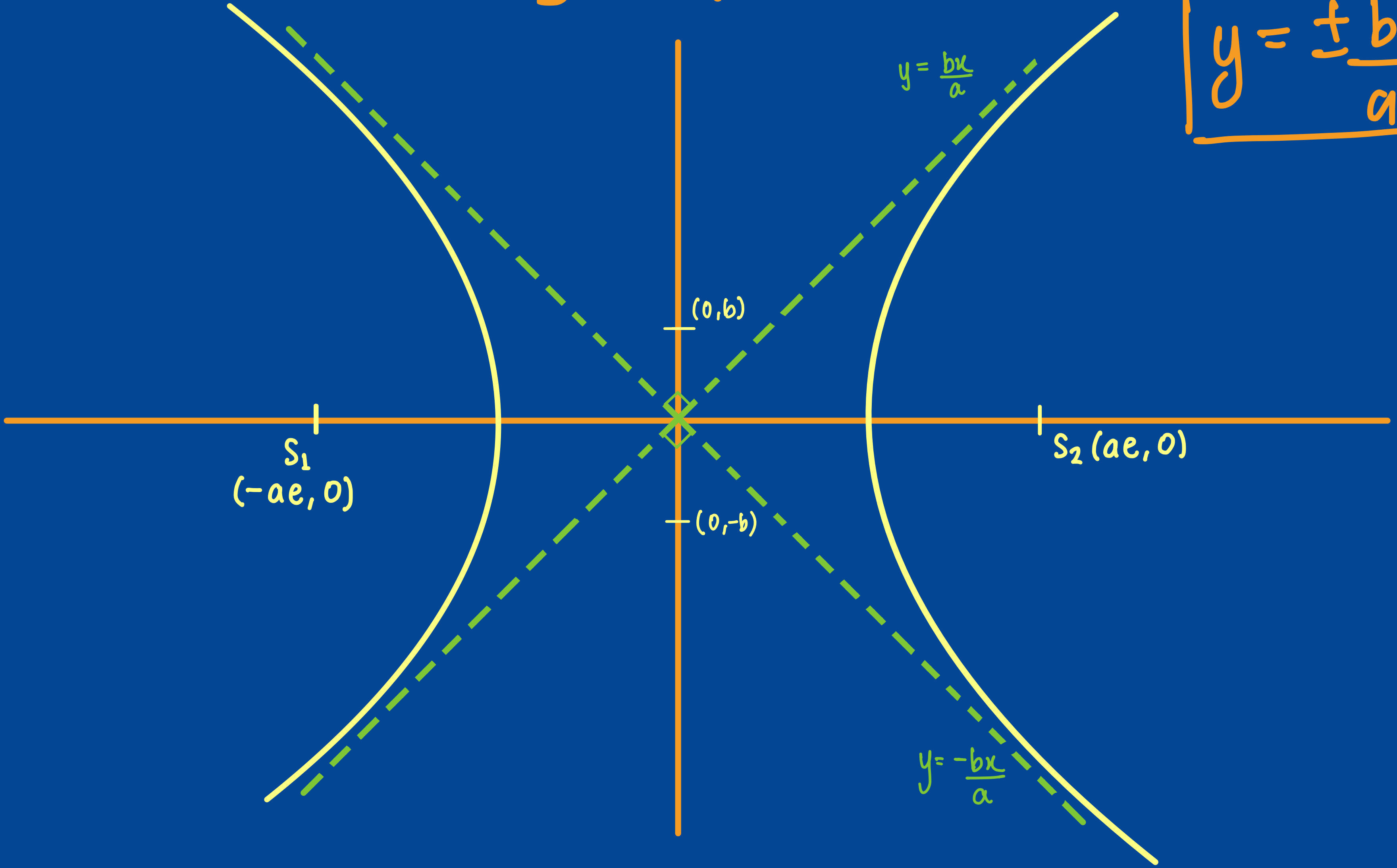
$$\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$$

$$\boxed{b^2 = a^2(e^2-1)}$$

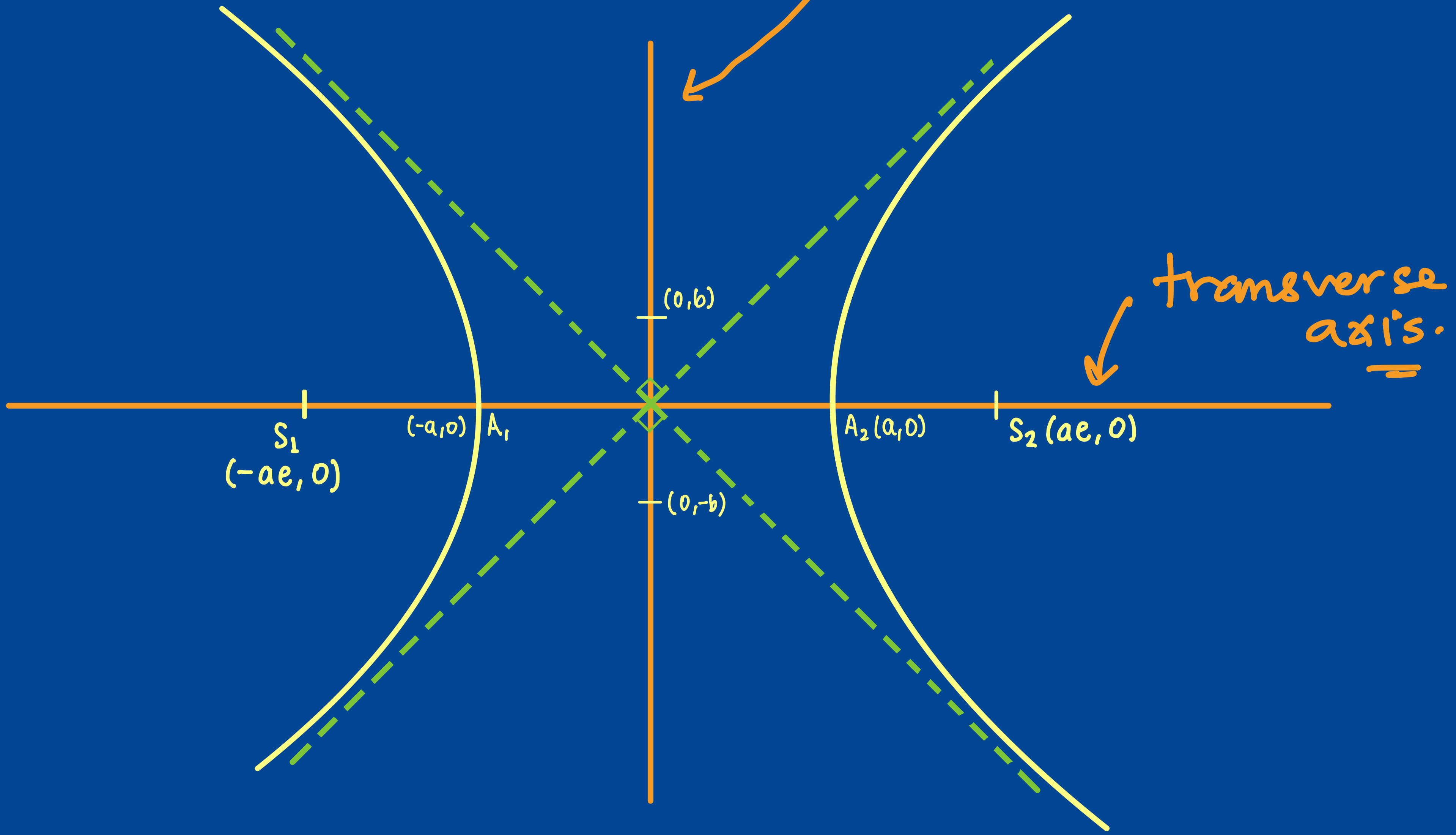


understanding asymptotes

$$\boxed{y = \pm\frac{bx}{a}}$$



understanding transverse and conjugate axis

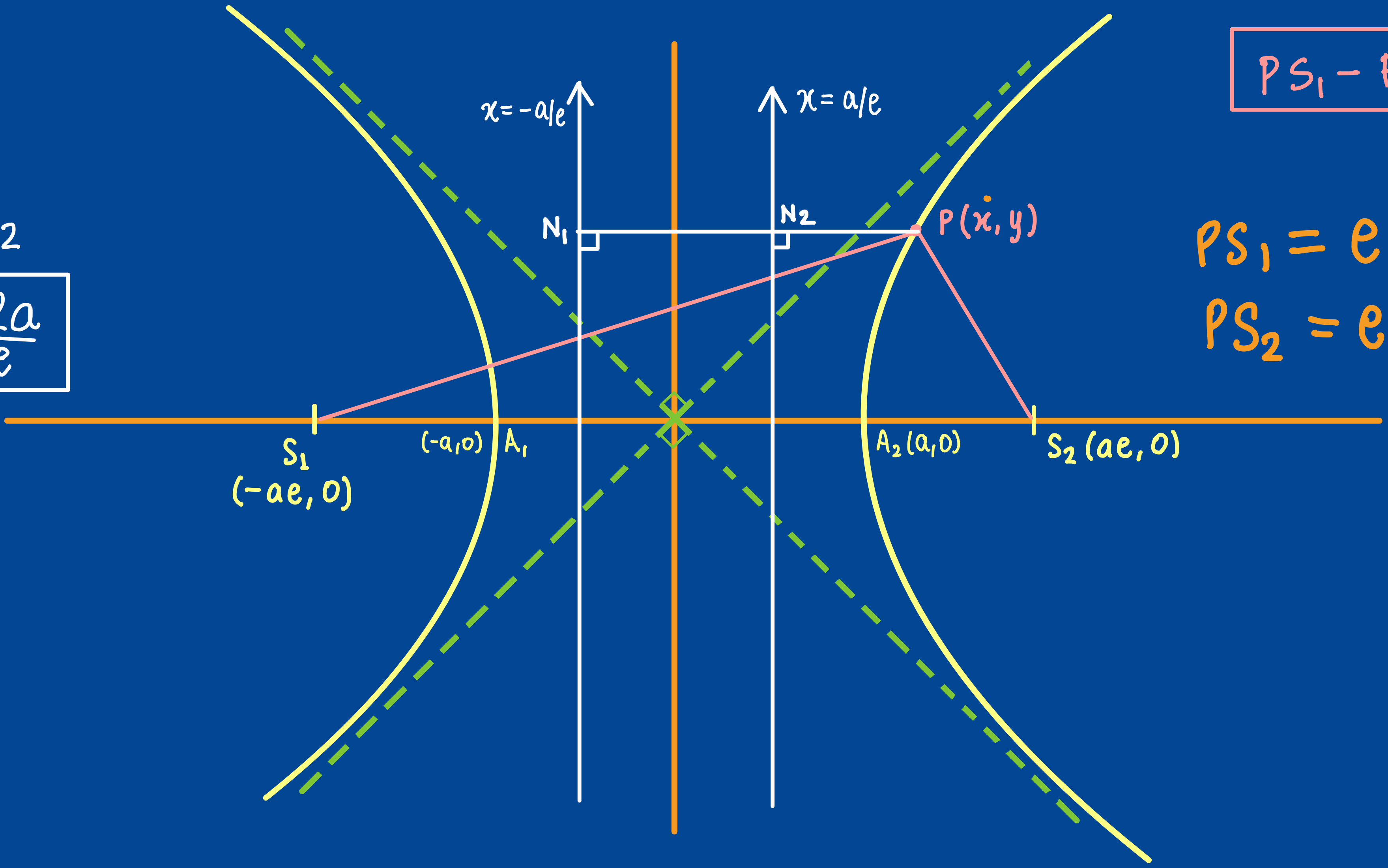


Focal distance and distance from directrix.

$PS_1 = e\,PN_1$

$PS_2 = e\,PN_2$

$$\boxed{PN_1 - PN_2 = \frac{2a}{e}}$$



$$\boxed{PS_1 - PS_2 = 2a}$$

$PS_1 = ex + a$

$PS_2 = ex - a$

understanding parts of hyperbola

Horizontal Hyperbola

$$\boxed{\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1}$$

Rel^n b/n a, b, e

$$\boxed{b^2 = a^2(e^2 - 1)}$$

Focus: $(\pm ae, 0)$

Eqn. of directrix: $x = \pm \frac{a}{e}$

$(\pm a/e, 0)$ on X-axis

Center: $(0, 0)$

Vertex: $A_1(-a, 0)$ $A_2(a, 0)$

$B_1(0, b)$ $B_2(0, -b)$

These are imaginary points

Length of transverse axis: $2a$

Length of conjugate axis: $2b$

Length of latus rectum: $\frac{2b^2}{a}$

Focal Radii: $S_1P = ex_1 + a$

$S_2P = ex_2 - a$

$PS_1 - PS_2 = 2a$

understanding parts of hyperbola

Vertical Hyperbola

$$\boxed{\frac{x^2}{a^2} - \frac{y^2}{b^2} = -1}$$

Rel^n b/n a, b, e

$$\boxed{a^2 = b^2(e^2-1)}$$

Focus: $(0, \pm be)$

Eqn. of directrix: $y = \pm \frac{b}{e}$

Center: $(0,0)$

Vertex: $B_1(0,b)$ $B_2(0,-b)$ $A_1(-a,0)$ $A_2(a,0)$

These are imaginary points

Length of transverse axis: $2b$

Length of conjugate axis: $2a$

Length of latus rectum: $\frac{2a^2}{b}$

Focal Radii: $S_1P = ey_1 + b$

$S_2P = ey_2 - b$

$PS_1 - PS_2 = 2b$

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General Equation of Hyperbola.

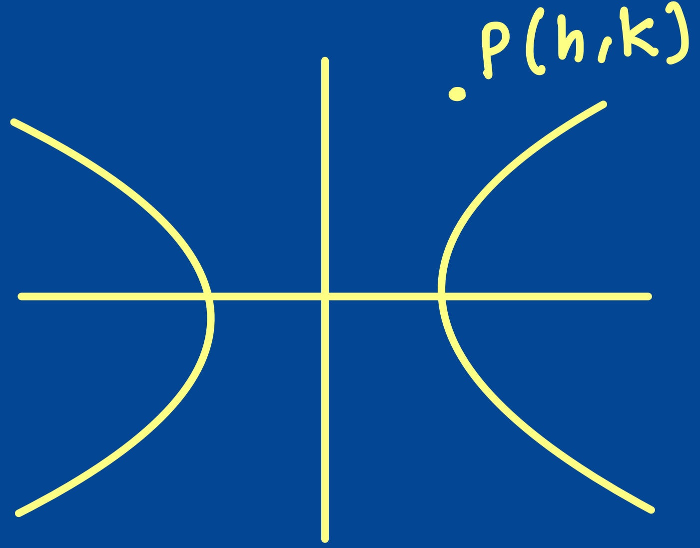
$$ax^2 + 2hxy + bx^2 + 2gx + 2fy + c = 0$$

If $\quad abc + 2fgh - af^2 - bg^2 - ch^2 \neq 0$

and $\quad ab - h^2 < 0$

and $\quad e > 1$

Position of a point w.r.t. Hyperbola.



$$\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$$

Substitute (h,k) in the above eqn.

$$\frac{h^2}{a^2} - \frac{k^2}{b^2} = 1$$

$$\therefore \text{ If } \frac{h^2}{a^2} - \frac{k^2}{b^2} - 1 = \begin{cases} > 0 & \text{inside the hyperbola.} \\ = 0 & \text{on the hyperbola} \\ < 0 & \text{outside the hyperbola} \end{cases}$$

Parametric form of Hyperbola.

$$x = a\sec\theta$$

$$y = b\tan\theta$$

Tangent to Hyperbola

$y = mx + c$ will be tangent to hyperbola $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$

if $\boxed{c^2 = a^2m^2 - b^2}$

$\therefore$ Eqn. of tangent $\Rightarrow$ $y = mx + \sqrt{a^2m^2 - b^2}$

Point of contact $\Rightarrow$ $\left(\pm \frac{a^2m}{c}, \pm \frac{b^2}{c} \right)$

The length of letusractum of the hyperbola

$16x^2 - 9y^2 = 144$ is

(a) $\frac{16}{3}$

(b) $\frac{32}{3}$

(c) $\frac{8}{3}$

(d) $\frac{4}{3}$

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

$$\frac{\overset{1}{\cancel{16}}x^2}{\underset{9}{\cancel{144}}} - \frac{\overset{1}{\cancel{9}}y^2}{\underset{16}{\cancel{144}}} = 1$$

$a^2 = 9$

$\Downarrow$

$a = 3$

$16 \leftarrow b^2$

$b = 4$

$$\frac{2 \cdot 4 \times 4}{3}$$

$$\frac{32}{3}$$

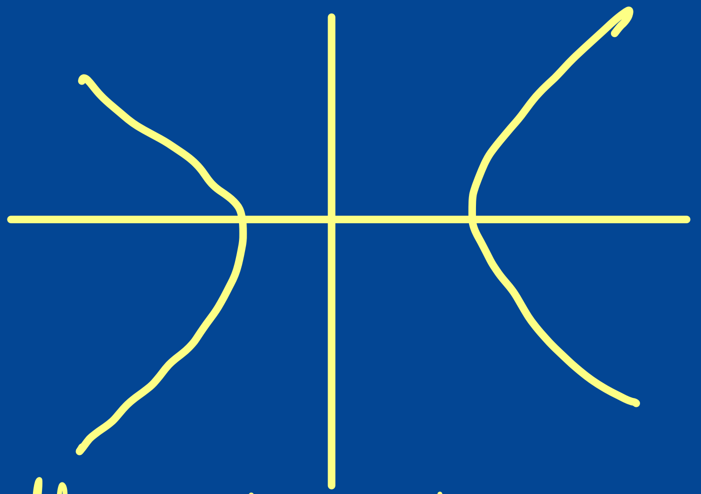
The distance between the directrices of a rectangular hyperbola is 10 units, then distance between its foci is

(a) $10\sqrt{2}$ (b) 5 (c) $5\sqrt{2}$ (d) 20

$$\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1 \quad [\text{If } a = b]$$

$$b^2 = a^2(e^2 - 1) \Rightarrow e^2 = 2$$

$$\boxed{e = \sqrt{2}}$$



for all rectangular hyperbola $e = \sqrt{2}$

Latus rectum: $\frac{2b^{\cancel{2}}}{\cancel{a}}$ $2b/2a$

The distance between the directrices of a rectangular hyperbola is 10 units, then distance between its foci is

(a) $10\sqrt{2}$ (b) 5 (c) $5\sqrt{2}$ (d) 20

$\pm \frac{a}{e}$

$\frac{2a}{e} = 10$

$\frac{2a}{\sqrt{2}} = 10$

$a = \frac{10}{\sqrt{2}}$

$(\pm ae, 0)$

$2ae$

$2 \times \frac{10}{\cancel{\sqrt{2}}} \times \cancel{\sqrt{2}}$

$= 20$

The eccentricity of the hyperbola $25x^2 - 9y^2 = 144$ is

(a) $\frac{\sqrt{34}}{12}$

(b) $\frac{\sqrt{34}}{3}$

(c) $\frac{6}{\sqrt{34}}$

(d) $\frac{3}{\sqrt{34}}$

$$\frac{25x^2}{144} - \frac{\cancel{9}^{1} y^2}{\cancel{144}_{16}} = 1$$

$$\frac{x^2}{\left(\frac{144}{25}\right)} - \frac{y^2}{16} = 1$$

$$a^2 = \left(\frac{144}{25}\right) \qquad 16 = b^2$$

$$e^2 = \frac{34}{9}$$

$$\boxed{e = \frac{\sqrt{34}}{3}}$$

$$b^2 = a^2(e^2 - 1)$$

$$16 = \frac{144}{25}(e^2 - 1) \Rightarrow e^2 - 1 = \frac{\cancel{16}^{1} \times 25}{\cancel{144}_{9}}$$

$$= \frac{25}{9} + 1 = \frac{34}{9}$$

The equation of the hyperbola in the standard form (with transverse axis along the X-axis) having the length of the letusractum = 9 unit and eccentricity = $\frac{5}{4}$ is

(a) $\frac{x^2}{16} - \frac{y^2}{18} = 1$

(b) $\frac{x^2}{36} - \frac{y^2}{27} = 1$

~~(c)~~ $\frac{x^2}{64} - \frac{y^2}{36} = 1$

(d) $\frac{x^2}{36} - \frac{y^2}{64} = 1$

$$\frac{x^2}{64} - \frac{y^2}{36} = 1$$

$$\frac{2b^2}{a} = 9$$

$$b^2 = \frac{9a}{2}$$

$$b^2 = \frac{9 \times \cancel{8}^{4}}{\cancel{2}}$$

$$\boxed{b^2 = 36}$$

$$e = \frac{5}{4}$$

$$b^2 = a^2(e^2 - 1)$$

$$\frac{9a}{2} = a^2\left(\frac{25}{16} - 1\right)$$

$$\frac{9\cancel{a}}{2} = a^{\cancel{2}}\left(\frac{9}{16}\right)$$

$$\frac{\cancel{9} \times \cancel{16}^{8}}{\cancel{2} \times \cancel{9}} = \boxed{a = 8}$$

$$\boxed{a^2 = 64}$$

The standard equation of the hyperbola having the distance between foci as 32 and eccentricity $2\sqrt{2}$ is

(a) $7x^2 - y^2 = 56$ ✗

(b) $x^2 - 7y^2 = 56$ ✗

(c) $7x^2 - y^2 = 224$

(d) $x^2 - 7y^2 = 224$

$2ae = 32$ $\quad e = 2\sqrt{2}$

$2 \times a \times 2\sqrt{2} = 32$

$a = \frac{\cancel{32}^{8}}{\cancel{4}\sqrt{2}} = \boxed{4\sqrt{2} = a}$

$\boxed{a^2 = 32}$

$b^2 = a^2[e^2 - 1]$

$= 32[8-1] = 32 \times 7$

$\boxed{b^2 = 224}$

$\frac{x^2}{32} - \frac{y^2}{224} = 1$

$\frac{\cancel{7}^{1}}{\cancel{224}_{32}}$

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