

Differentiability : Standard Result of Differentiability

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Standard Result of Differentiability

Talking: Vivek Varshney



Functions $f(x)$	Interval in which $f(x)$ is Differentiable
Polynomial	$(-\infty, \infty)$
Exponential ($a^x, a > 0$)	$(-\infty, \infty)$
Constant	$(-\infty, \infty)$
Logarithmic	Each point in its domain
Trigonometric	Each point in its domain
Inverse Trigonometric Function	Each point in its domain

$x^2 + 3x$

① $\log(x)$ Domain $(0, \infty)$

② $\log(x-1)$ Domain $(1, \infty)$

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Standard Result of Differentiability

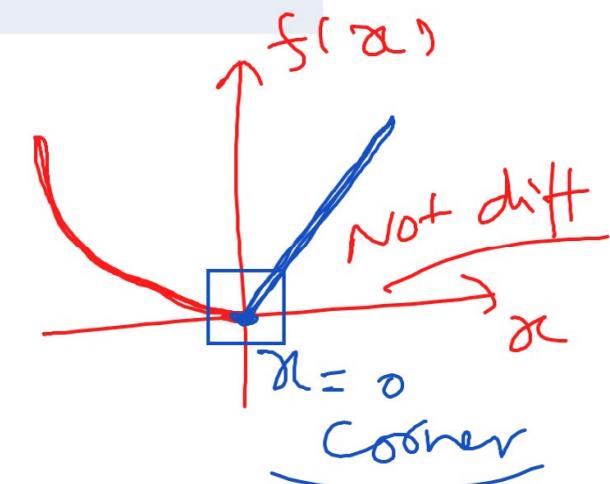
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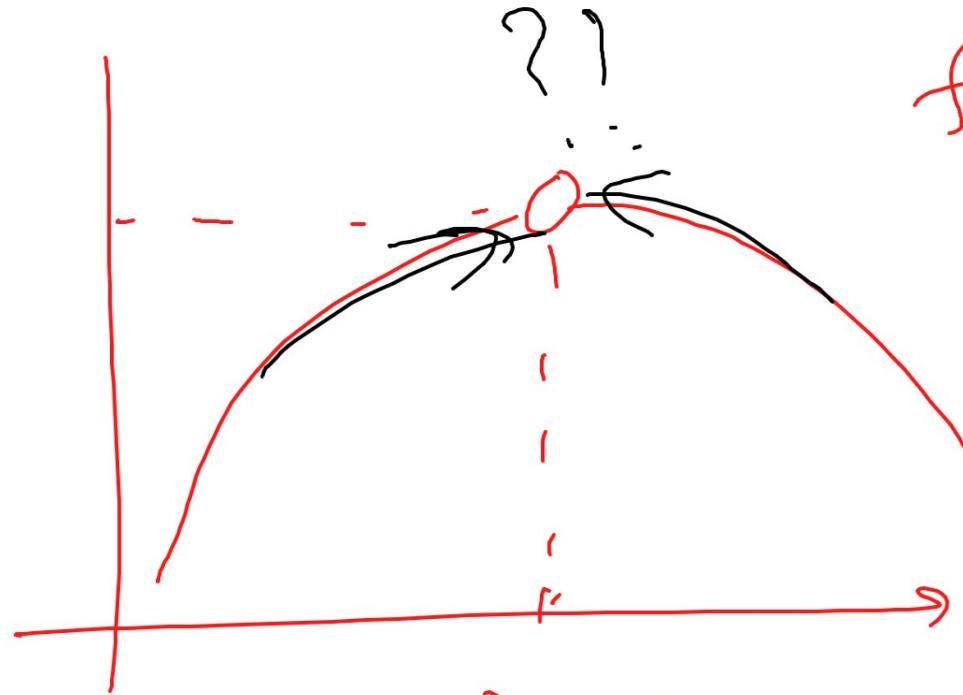


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$$f(x) = \begin{cases} x^2 & x \leq 0 \\ \frac{3x}{2} & x > 0 \end{cases}$$

LHD = 0 RHD = $\frac{3}{2}$





$$x = 2$$

Removable

$$f(a) = \boxed{\quad}$$

$$x \neq 2$$

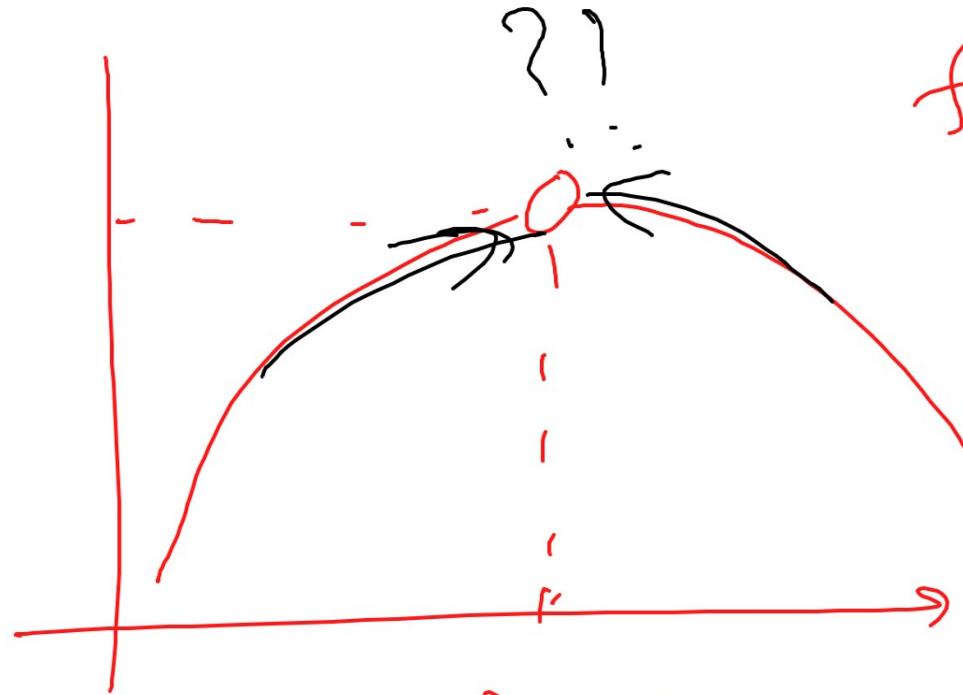
$$f(2) = ?$$

$$\text{LHL} = \text{RHL}$$

↓

limit exists

$$\text{LHL} = \text{RHL} = f(2)$$



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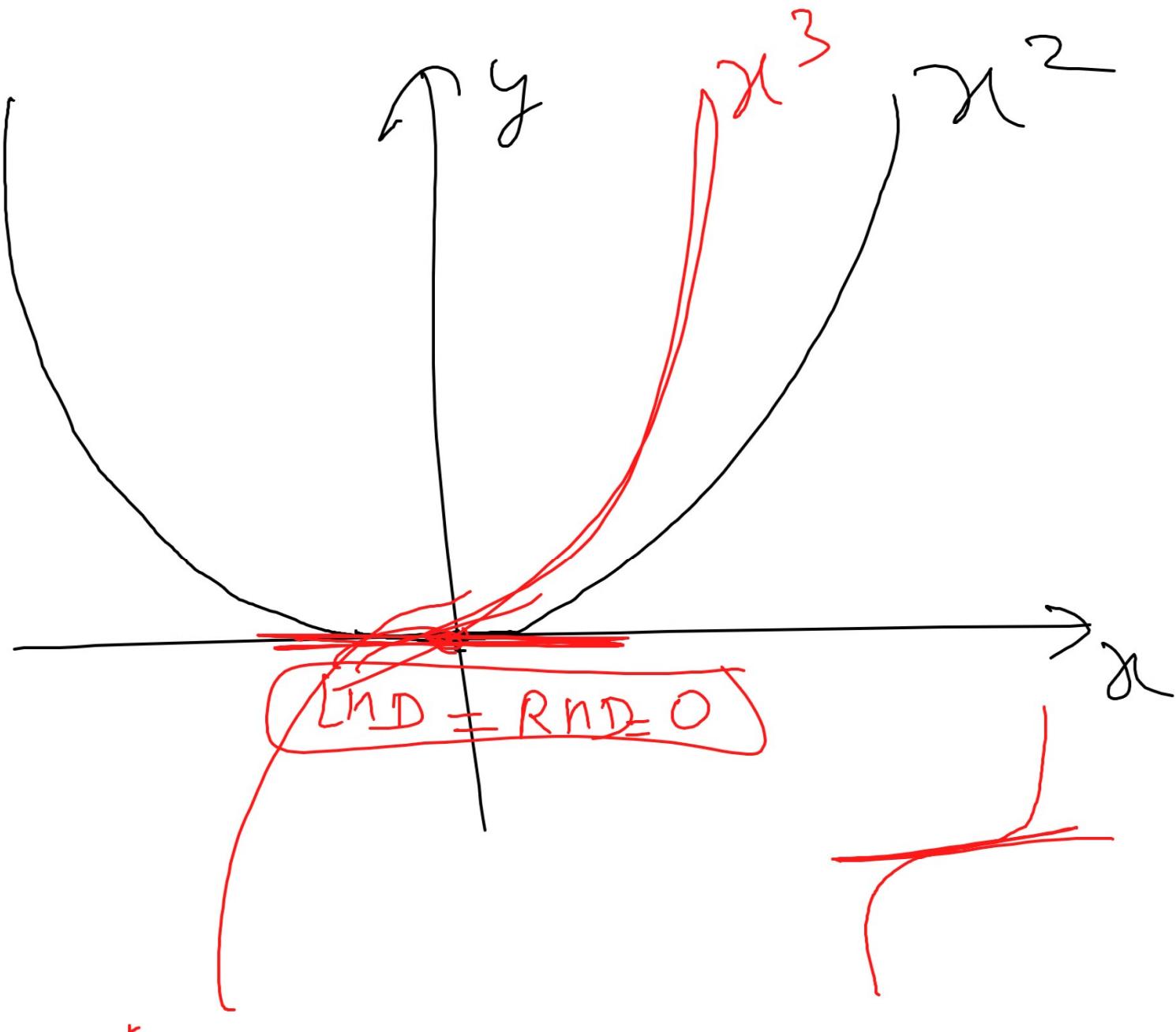
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$$\text{LHL} = \text{RHL}$$

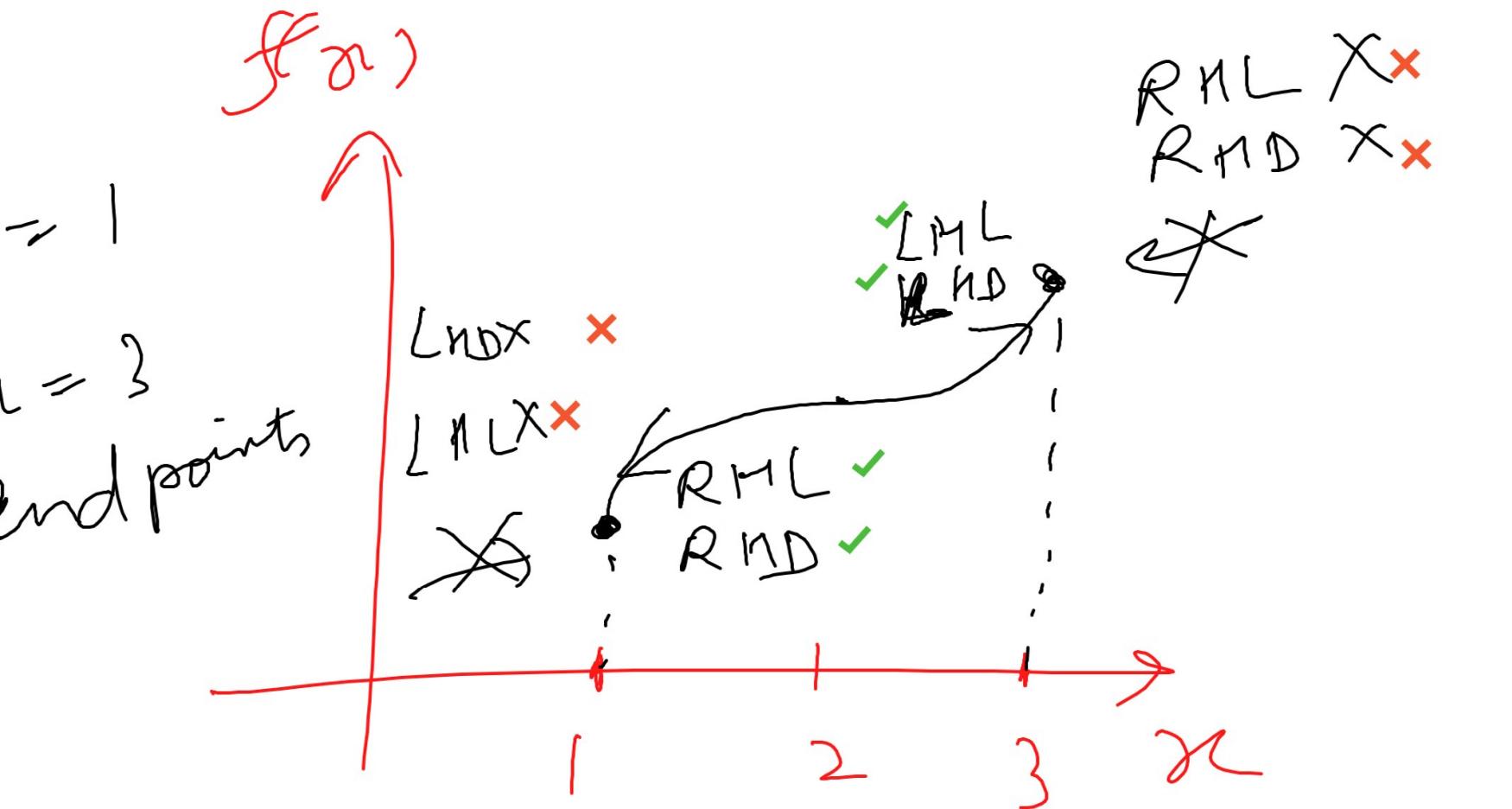
↓

limit exists

$$\text{LHL} = \text{RHL} = f(2)$$



$$\begin{aligned}
 & f(x) \\
 & \frac{df}{dx} \\
 & \frac{df}{dy} \\
 & f_y \\
 & \frac{df}{dx_y}
 \end{aligned}$$



$f(x)$ is defined $1 \leq x \leq 3$



Let $f(x)$ be defined in an open interval about $x=a$

BUT Not defined at $x=a$

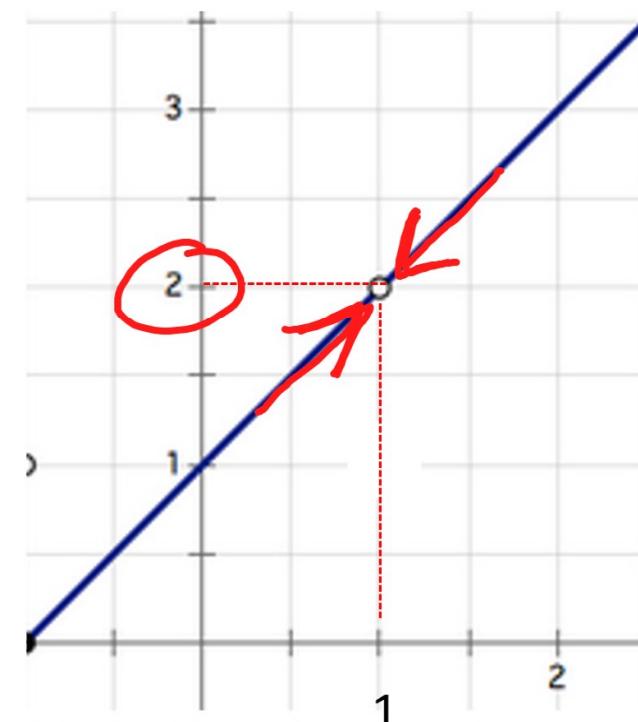
Then, if for all x close to ' a ', $f(x)$ will get an arbitrarily value close to a unique number

$$\text{let } f(x) = \frac{x^2-1}{x-1}$$

$f(1)$ is undefined

$$f(x) = \frac{(x-1)(x+1)}{(x-1)} = x + 1$$

$$\lim_{x \rightarrow 1} f(x) = 2$$



LHL = RHL

limits equal

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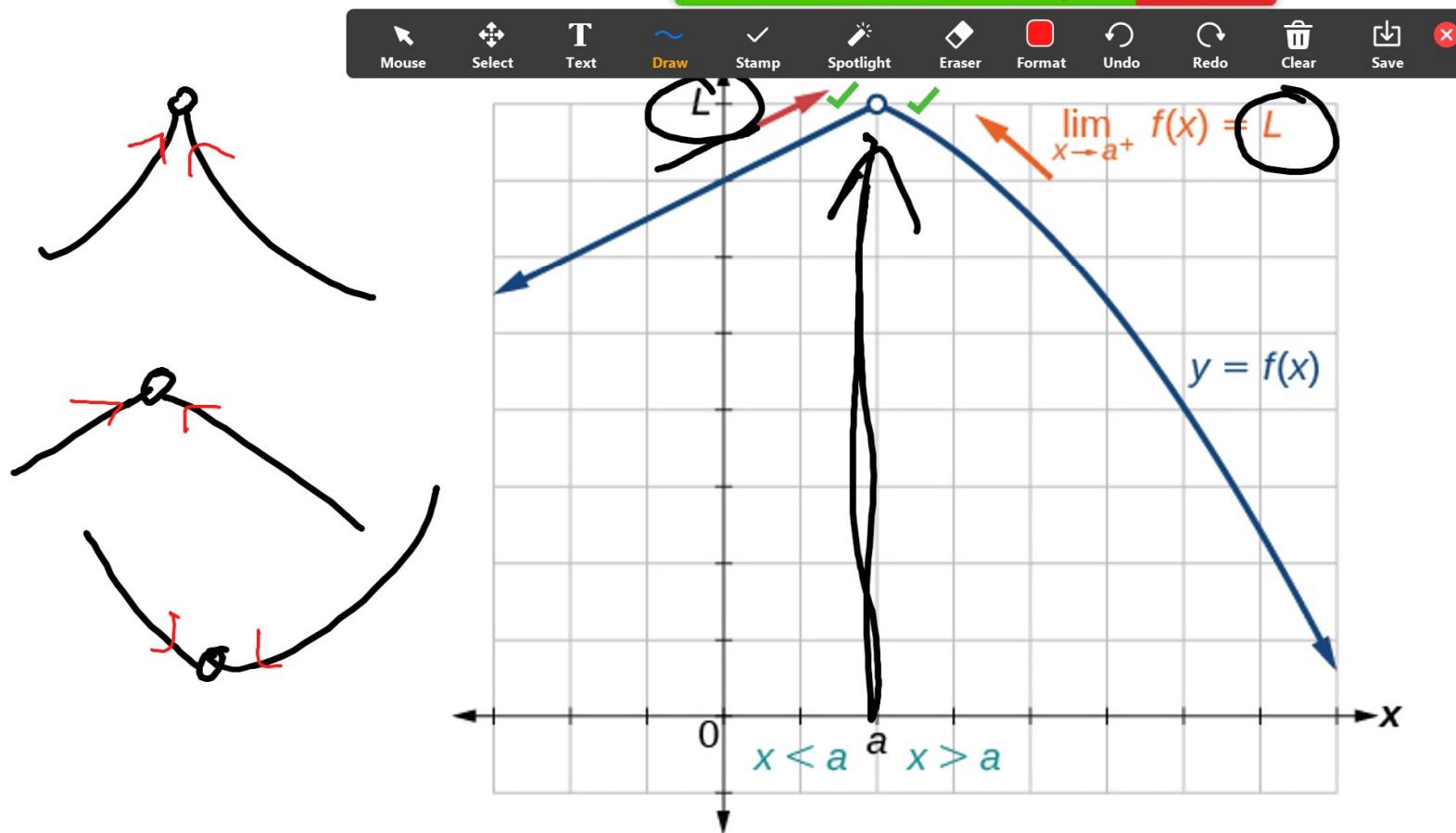
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Viraj Rao



LIMIT: LHL and RHL



Left hand limit (L.H.L) = $\lim_{x \rightarrow a^-} f(x)$

Put $x = a - h$

$$L.H.L = \lim_{h \rightarrow 0^+} f(a - h) = L$$

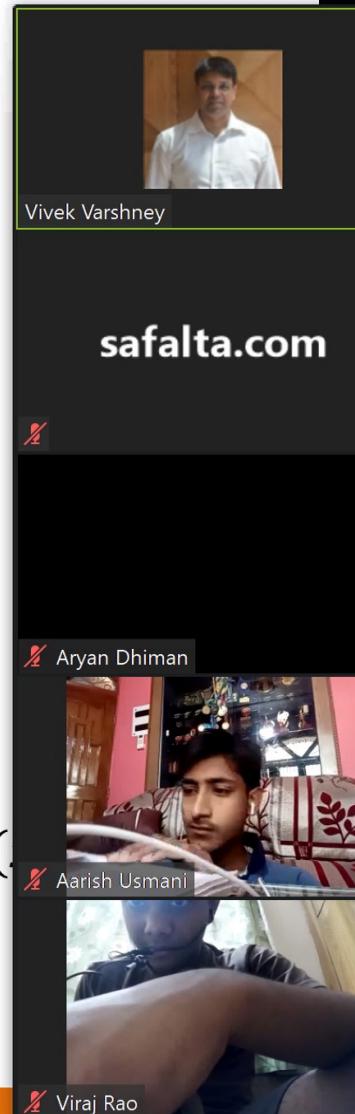
Right hand limit (R.H.L) = $\lim_{x \rightarrow a^+} f(x)$

Put $x = a + h$

$$R.H.L = \lim_{h \rightarrow 0^+} f(a + h) = L$$

Limit exists if and only if $L.H.L = R.H.L$

Therefore, you will have to check both the limits (LHL and RHL)



Theorems of Limit: Limit Application to Fraction



Limit can be applied to both Numerator and Denominator

$$\lim_{x \rightarrow a} \frac{f(x)}{g(x)} = \frac{\lim_{x \rightarrow a} f(x)}{\lim_{x \rightarrow a} g(x)}$$

Denominator should be a Non zero limit

ex:

$$\lim_{x \rightarrow 0} \frac{(1 + \sin x)}{(2 \cos^2 x)}$$

$\lim_{x \rightarrow 0} 1 + \sin x$ ✓

$\lim_{x \rightarrow 0} 2 \cos^2 x$ ✓

$= \frac{1}{2}$

$2(\cos^2 0) = 2(1^2)$

Note here → Cos 0 is not zero;

Therefore we could apply Limit like this.



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$$= \frac{\lim_{x \rightarrow 0} 1 + \sin x}{\lim_{x \rightarrow 0} 2 \cos^2 x}$$

$$= \frac{1}{2}$$

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$$\begin{aligned} &= \frac{\lim_{x \rightarrow 0} 1 + \sin x}{\lim_{x \rightarrow 0} 2 \cos^2 x} \\ &= \frac{1}{2} \end{aligned}$$

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