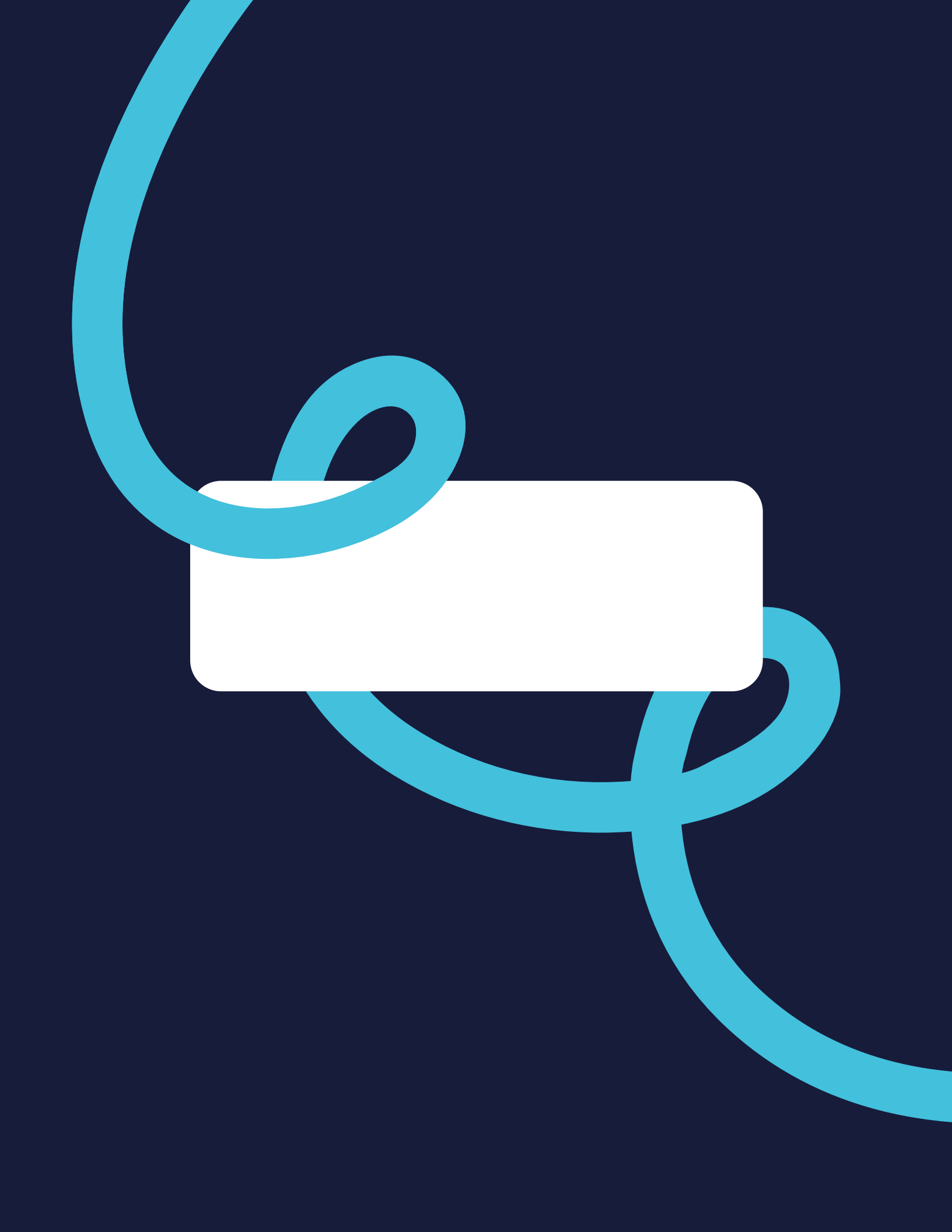
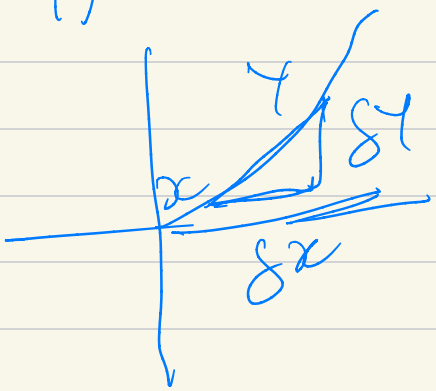


Differentiation -



$$\frac{dy}{dx} = \frac{f(x+\delta x) - f(x)}{\delta x}$$

1 - $y = x^3 \Rightarrow 3x^2$

$\sin x \Rightarrow \cos x \quad \cos x \Rightarrow -\sin x$

$\tan x \Rightarrow \sec^2 x \quad \cot x \Rightarrow \operatorname{cosec}^2 x$

$e^x \Rightarrow e^x \quad \ln x \Rightarrow 1/x$

2 - product Rule

$$f(x) = uv$$
$$= u'v + v'u$$

$y = x^2 \sin x$

$= 2x \sin x + x^2 \cos x$

3 - Chain Rule -

$y = \sin x^2 \Rightarrow u = x^2 \Rightarrow \frac{du}{dx} = 2x$

$y = \sin u \Rightarrow \frac{dy}{du} = \cos u \Rightarrow \cos x^2$

By Chain Rule

$$\frac{dy}{dx} = \frac{dy}{du} \times \frac{du}{dx} = \cos x^2 \times 2x \Rightarrow \boxed{2x \cos x^2}$$

Implicit function

$$y = a^x \Rightarrow \ln y = \ln a^x$$

$$\ln y = x \ln a \Rightarrow \frac{1}{y}\frac{dy}{dx} = \ln a$$

$$\frac{dy}{dx} = y \ln a \Rightarrow a^x \ln a$$

$$y = e^x \Rightarrow \ln y = \ln e^x$$

$$\ln y = x \ln e \Rightarrow \frac{1}{y}\frac{dy}{dx} = \ln e$$

$$\frac{dy}{dx} = y \ln e^e \Rightarrow \boxed{\frac{dy}{dx} = e^x \times 1}$$

$$\boxed{\ln e = 1}$$

$$y^2 + 2xy + x^2 = 0$$

$$2y\frac{dy}{dx} + 2y + 2x\frac{dy}{dx} + 2x = 0$$

$$\frac{dy}{dx}(2y + 2x) = -2(y+x)$$

$$\frac{dy}{dx} = \frac{-2(y+x)}{2(y+x)}$$

$$\boxed{\frac{dy}{dx} = 1}$$

Q →

$$y = \frac{fx}{gx} \Rightarrow \frac{f'(x)g(x) - g'(x)f(x)}{(gx)^2}$$

$$\boxed{y = \frac{x^2}{e^x} \Rightarrow \frac{2x e^x - e^x x^2}{(e^x)^2}}$$

⇒ L' Hospital Rule for limit

$\lim_{x \to a/\infty} = \frac{0}{0}$ or $\frac{\infty}{\infty}$ only

then use this Rule

$$\lim_{x \to 0} \frac{\sin x}{x} = \frac{\sin 0}{0} = \frac{0}{0}$$

gets undefined

then use LH Rule

$$\lim_{x \to 0} \frac{\sin x}{x} = \frac{\frac{\partial}{\partial x}\sin x}{\frac{\partial}{\partial x} x} = \frac{\cos x}{1} = \frac{\cos 0}{1} = \boxed{1}$$

even after y' its undefined then do differentiation again & again till not getting defined point