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Differentiate the following functions with respect to x:

1. Sin (3x + 5)

Solution:

Given Sin (3x + 5)

Let y = sin (3x + 5)

On differentiating y with respect to x, we get

$$\frac{dy}{dx} = \frac{d}{dx}[\sin(3x + 5)]$$

We know $\frac{d}{dx}(\sin x) = \cos x$

$$\Rightarrow \frac{dy}{dx} = \cos(3x + 5)\frac{d}{dx}(3x + 5)$$ [Using chain rule]

$$\Rightarrow \frac{dy}{dx} = \cos(3x + 5)\left[\frac{d}{dx}(3x) + \frac{d}{dx}(5)\right]$$

$$\Rightarrow \frac{dy}{dx} = \cos(3x + 5)\left[3\frac{d}{dx}(x) + \frac{d}{dx}(5)\right]$$

However, $\frac{d}{dx}(x) = 1$ and derivative of a constant is 0.

$$\Rightarrow \frac{dy}{dx} = \cos(3x + 5)\,[3 \times 1 + 0]$$

$$\therefore \frac{dy}{dx} = 3\cos(3x + 5)$$

Thus, $\frac{d}{dx}[\sin(3x + 5)] = 3\cos(3x + 5)$

2. $\tan^2 x$

Solution:

Given $\tan^2 x$

Let $y = \tan^2 x$

On differentiating y with respect to x, we get

$$\frac{dy}{dx} = \frac{d}{dx}(\tan^2 x)$$

We know $\frac{d}{dx}(x^n) = nx^{n-1}$

$\Rightarrow \frac{dy}{dx} = 2\tan^{2-1} x \frac{d}{dx}(\tan x)$ [Using chain rule]

$$\Rightarrow \frac{dy}{dx} = 2\tan x \frac{d}{dx}(\tan x)$$

However, $\frac{d}{dx}(\tan x) = \sec^2 x$

$$\Rightarrow \frac{dy}{dx} = 2\tan x (\sec^2 x)$$

$$\therefore \frac{dy}{dx} = 2\tan x \sec^2 x$$

Thus, $\frac{d}{dx}(\tan^2 x) = 2\tan x \sec^2 x$

3. tan (x° + 45°)

Solution:

Let y = tan (x° + 45°)

First, we will convert the angle from degrees to radians.

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We have $1^\circ = \left(\frac{\pi}{180}\right)^c \Rightarrow (x+45)^\circ = \left[\frac{(x+45)\pi}{180}\right]^c$

$$\Rightarrow y = \tan\left[\frac{(x+45)\pi}{180}\right]$$

On differentiating y with respect to x, we get

$$\frac{dy}{dx} = \frac{d}{dx}\left\{\tan\left[\frac{(x+45)\pi}{180}\right]\right\}$$

We know $\frac{d}{dx}(\tan x) = \sec^2 x$

$\Rightarrow \frac{dy}{dx} = \sec^2\left[\frac{(x+45)\pi}{180}\right]\frac{d}{dx}\left[\frac{(x+45)\pi}{180}\right]$ [Using chain rule]

$$\Rightarrow \frac{dy}{dx} = \sec^2(x^\circ + 45^\circ)\frac{\pi}{180}\frac{d}{dx}(x+45)$$

$$\Rightarrow \frac{dy}{dx} = \frac{\pi}{180}\sec^2(x^\circ + 45^\circ)\left[\frac{d}{dx}(x) + \frac{d}{dx}(45)\right]$$

However, $\frac{d}{dx}(x) = 1$ and derivative of a constant is 0.

$$\Rightarrow \frac{dy}{dx} = \frac{\pi}{180}\sec^2(x^\circ + 45^\circ)\,[1+0]$$

$$\therefore \frac{dy}{dx} = \frac{\pi}{180}\sec^2(x^\circ + 45^\circ)$$

Thus, $\frac{d}{dx}[\tan(x^\circ + 45^\circ)] = \frac{\pi}{180}\sec^2(x^\circ + 45^\circ)$