<u>Find the second order differentiation</u>

The second derivative of a function f (x) is usually denoted f" (x). That is:

$$F'' = (f')'$$

The second derivative of a dependent variable y with respect to an independent variable x is written

$$\frac{d^2y}{dx^2}$$

This notation is derived from the following formula:

$$\frac{d^2y}{dx^2} = \frac{d}{dx}\left(\frac{dy}{dx}\right).$$

Example:
Find the second order derivatives of the function.

$$x^2 + 3x + 2$$

Solution:

Let $y = x^2 + 3x + 2$

Then,

$$\frac{dy}{dx} = \frac{d}{dx}(x^2) + \frac{d}{dx}(3x) + \frac{d}{dx}(2) = 2x + 3 + 0 = 2x + 3$$

$$\therefore \frac{d^2y}{dx^2} = \frac{d}{dx}(2x+3) = \frac{d}{dx}(2x) + \frac{d}{dx}(3) = 2 + 0 = 2$$

Example:
Find the second order derivatives of the function.
$e^{6x}\cos 3x$

Solution :

Let $y = e^{6x}\cos 3x$

Then,

$$\frac{dy}{dx} = \frac{d}{dx}(e^{6x}.\cos 3x) = \cos 3x.\frac{d}{dx}(e^{6x}) + e^{6x}.\frac{d}{dt}(\cos 3x)$$

$$= \cos 3x.e^{6x}.\frac{d}{dt}(6x) + e^{6x}.(-\sin 3x).\frac{d}{dx}(3x)$$

$$= 6e^{6x}\cos 3x - 3e^{6x}\sin 3x \qquad ....(1)$$

$$\therefore \frac{d^2y}{dx^2} = \frac{d}{dy}(6e^{6x}\cos 3x - 3e^{6x}\sin 3x) = 6.\frac{d}{dx}(e^{6x}\cos 3x) - 3.\frac{d}{dx}(e^{6x}\sin 3x)$$

$$= 6.[6e^{6x}\cos 3x - 3e^{6x}\sin 3x] - 3.\left[\sin 3x.\frac{d}{dx}(e^{6x}) + e^{6x}.\frac{d}{dx}(\sin 3x)\right] \quad [U\sin g(1)$$

$$= 36e^{6x}\cos 3x - 18e^{6x}\sin 3x - 3[\sin 3x.e^{6x}.6 + e^{6c}.\cos 3x.3]$$
$$= 36e^{6x}\cos 3x - 18e^{6x}\sin 3x - 18e^{6x}\sin 3x - 9e^{6x}\cos 3x$$

$$= 27e^{6x}\cos 3x - 36e^{6x}\sin 3x$$

$$= 9e^{6x}(3\cos 3x - 4\sin 3x)$$