

**Learning outcomes**

After completing this section, you will inshaAllah be able to

1. find higher order derivatives of
  - a. explicitly defined functions
  - b. implicitly defined functions

## Higher order derivatives: Introduction & Computations

- Given a function  $f(x)$ .
- Then its derivative  $f'(x)$  is again a function of  $x$
- So we can differentiate  $f'(x)$  further.
- This leads to the idea of higher order derivatives of  $f(x)$ .

- Given  $f(x)$ . Then

- $f'(x) = \frac{d}{dx}(f(x))$  1<sup>st</sup> derivative of  $f(x)$

- $f''(x) = \frac{d}{dx}(f'(x))$  2<sup>nd</sup> derivative of  $f(x)$

- $f'''(x) = \frac{d}{dx}(f''(x))$  3<sup>rd</sup> derivative of  $f(x)$

⋮

- $f^{(k)}(x) = \frac{d}{dx}(f^{(k-1)}(x))$  k<sup>th</sup> derivative of  $f(x)$

### Other notations

- $y', y'', \dots, y^{(k)}$
- $\frac{dy}{dx}, \frac{d^2y}{dx^2}, \frac{d^3y}{dx^3}, \dots$
- $D, D^2, D^3, \dots$

- We learn computations and concept with the help of examples.

See examples 1, 2, 3, 4, 5, 6, 7, 8, 9 done in class

See example 2 to learn how to find higher order derivatives for implicitly defined functions.