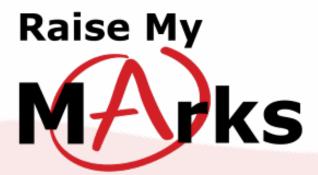
## Higher Order Derivatives



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## **Higher Order Derivatives**

So far we have considered taking a derivative of a function, implicitly or explicitly, once only. This is the first derivative we have been considering. When we take the derivative of the first derivative, we have a second derivative; the derivative of the second derivative is the third derivative; and so on. Notation-wise we have the following:

Function	f(x) = y
1st derivative	$f'(x) = \frac{dy}{dx}$
2nd derivative	$f''(x) = \frac{d^2y}{dx^2}$
3rd derivative	$f'''(x) = \frac{d^3y}{dx^3}$

Let's consider an example.

## Example

Find the second derivative of  $f(x) = \frac{x}{1+x}$ .

Solution: We need to use the quotient rule.

$$f'(x) = \frac{1+x-x}{(1+x)^2} = \frac{1}{(1+x)^2}$$
$$f''(x) = (1+x)^{-2}$$

Now we can use the power rule.

$$f''(x) = -2(1+x)^{-3}$$

Let's fid the third derivative of the function above.

$$f'''(x) = (-2)(-3)(1+x)^{-4} = 6(1+x)^{-4}$$

## Exercises

Find the third and fourth derivate of the following functions,

a) 
$$y = \ln x$$

$$b) f(x) = x^4 e^x$$

c) 
$$y = \sin^3(2x)$$

d) 
$$y = 7x^{10}$$

e) 
$$y = \frac{1}{x}$$