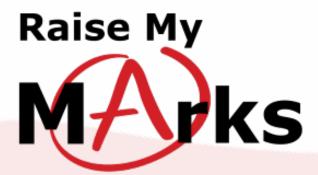
Higher Order Derivatives



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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 second derivative of the following functions,

a)
$$f(x) = 8x^4 + \frac{1}{3}x^2 + 9x - 5$$
 f) $f(x) = e^{x^2 + 1}$

f)
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b)
$$f(x) = 2x^5 - 7x^3 + 9x^2$$
 g) $f(x) = \frac{1+x^2}{x^2+2x-1}$

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

c)
$$f(x) = \sin 5x$$

h)
$$Q(v) = \frac{2}{(6+2v=+v^2)^4}$$

$$d) f(x) = \tan 3x$$

i)
$$y = e^{-5x} + 8\ln(2x^4)$$

e)
$$f(x) = \ln(9x + 2)$$

$$j) y = 4\sqrt[5]{x^3}$$

$$k) y = \frac{1}{8x^2} - \sqrt{x}$$