

8.5 Higher Order Derivatives

Functions: f, y, u, v

Independent variable: x

Natural number: n

811. Second derivative

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

812. Higher-Order derivative

$$f^{(n)} = \frac{d^n y}{dx^n} = y^{(n)} = (f^{(n-1)})'$$

$$813. (u + v)^{(n)} = u^{(n)} + v^{(n)}$$

$$814. (u - v)^{(n)} = u^{(n)} - v^{(n)}$$

815. Leibnitz's Formulas

$$(uv)'' = u''v + 2u'v' + uv''$$

$$(uv)''' = u'''v + 3u''v' + 3u'v'' + uv'''$$

$$(uv)^{(n)} = u^{(n)}v + nu^{(n-1)}v' + \frac{n(n-1)}{1 \cdot 2} u^{(n-2)}v'' + \dots + uv^{(n)}$$

$$816. (x^m)^{(n)} = \frac{m!}{(m-n)!} x^{m-n}$$

$$817. (x^n)^{(n)} = n!$$

$$818. (\log_a x)^{(n)} = \frac{(-1)^{n-1} (n-1)!}{x^n \ln a}$$

$$819. (\ln x)^{(n)} = \frac{(-1)^{n-1} (n-1)!}{x^n}$$

$$820. (a^x)^{(n)} = a^x \ln^n a$$

$$821. (e^x)^{(n)} = e^x$$

$$822. (a^{mx})^{(n)} = m^n a^{mx} \ln^n a$$

$$823. (\sin x)^{(n)} = \sin\left(x + \frac{n\pi}{2}\right)$$

$$824. (\cos x)^{(n)} = \cos\left(x + \frac{n\pi}{2}\right)$$