Math Formulas: Higher-order Derivatives

Definitions and properties

Second derivative

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

Higher-Order derivative

2. $$f^{(n)} = \left(f^{(n-1)}\right)'$$

3. $$(f \pm g)^{(n)} = f^{(n)} \pm g^{(n)}$$

Leibniz's Formulas

4. $$(f \cdot g)'' = f'' \cdot g + 2 \cdot f' \cdot g' + f \cdot g''$$

5. $$(f \cdot g)''' = f''' \cdot g + 3 \cdot f'' \cdot g' + 3 \cdot f' \cdot g'' + f \cdot g'''$$

6. $$(f \cdot g)^{(n)} = f^{(n)} \cdot g + n \cdot f^{(n-1)} \cdot g' + \frac{n(n-1)}{1 \cdot 2} \cdot f^{(n-2)} \cdot g'' + \cdots + f \cdot g^{(n)}$$

Important Formulas

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

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

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

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

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

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

13. $$(a^{m\,x})^{(n)} = m^n\, a^{m \cdot x} \ln^n a$$

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

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