VIDYA BHAWAN BALIKA VIDYA PITH

शक्तिउत्थानआश्रमलखीसरायबिहार

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Derivative

The rate of change of a quantity y with respect to another quantity x is called the derivative or differential coefficient of y with respect to x .

Differentiation of a Function

Let f(x) is a function differentiable in an interval [a, b]. That is, at every point of the interval, the derivative of the function exists finitely and is unique. Hence, we may define a new function g: [a, b] → R, such that, ∀ x ∈ [a, b], g(x) = f'(x). This new function is said to be differentiation (differential coefficient) of the function f(x) with respect to x and it is denoted by df(x) / d(x) or Df(x) or f'(x).

$$f'(x) = \frac{d}{dx} f(x) = \lim_{\delta x \to 0} \frac{f(x + \delta x) - f(x)}{\delta x}$$

Standard Differentiations

1. $d / d(x) (x^n) = nx^{n-1}$, $x \in R$, $n \in R$
2. $d / d(x) (k) = 0$, where k is constant.
3. $d / d(x) (e^x) = e^x$
4. $d / d(x) (a^x) = a^x \log e$ $a > 0$, $a \neq 1$

5. $\frac{d}{dx}(\log_e x) = \frac{1}{x}, x > 0$

6. $\frac{d}{dx}(\log_a x) = \frac{1}{x}(\log_a e) = \frac{1}{x \log_e a}$

7. $\frac{d}{dx}(\sin x) = \cos x$

8. $\frac{d}{dx}(\cos x) = -\sin x$

9. $\frac{d}{dx}(\tan x) = \sec^2 x, x \neq (2n+1)\frac{\pi}{2}, n \in I$

10. $\frac{d}{dx}(\cot x) = -\operatorname{cosec}^2 x, x \neq n\pi, n \in I$

11. $\frac{d}{dx}(\sec x) = \sec x \tan x, x \neq (2n+1)\frac{\pi}{2}, n \in I$

12. $\frac{d}{dx}(\operatorname{cosec} x) = -\operatorname{cosec} x \cot x, x \neq n\pi, n \in I$

13. $\frac{d}{dx}(\sin^{-1} x) = \frac{1}{\sqrt{1-x^2}}, -1 < x < 1$

14. $\frac{d}{dx}(\cos^{-1} x) = -\frac{1}{\sqrt{1-x^2}}, -1 < x < 1$

15. $\frac{d}{dx}(\tan^{-1} x) = \frac{1}{1+x^2}$

16. $\frac{d}{dx}(\cot^{-1} x) = -\frac{1}{1+x^2}$

17. $\frac{d}{dx}(\sec^{-1} x) = \frac{1}{|x|\sqrt{x^2-1}}, |x| > 1$

18. $\frac{d}{dx}(\operatorname{cosec}^{-1} x) = -\frac{1}{|x|\sqrt{x^2-1}}, |x| > 1$

19. $\frac{d}{dx}(\sinh x) = \cosh x$

20. $\frac{d}{dx}(\cosh x) = \sinh x$

21. $\frac{d}{dx}(\tanh x) = \operatorname{sech}^2 x$