Differential Calculations

- To perform differential calculations, first display the Option Menu, and then input the values shown in the formula below.

OPTN F2 (CALC) ▷
F1 (d/dx) f(x) , a , Δx)

Δx: Increase/decrease of x
a: Point for which you want to determine the derivative

$$d/dx\,(f(x), a, \Delta x) \Rightarrow \frac{d}{dx} f(a)$$

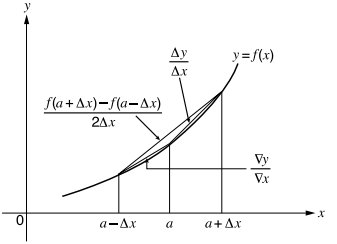
The differentiation for this type of calculation is defined as:

$$f'(a) = \lim_{\Delta x \to 0} \frac{f(a+\Delta x) - f(a)}{\Delta x}$$

In this definition, *infinitesimal* is replaced by a *sufficiently small* Δx, with the value in the neighborhood of $f'(a)$ calculated as:

$$f'(a) \fallingdotseq \frac{f(a+\Delta x) - f(a)}{\Delta x}$$

In order to provide the best precision possible, this unit employs central difference to perform differential calculations. The following illustrates central difference.



The slopes of point a and point $a + \Delta x$, and of point a and point $a - \Delta x$ in function $y = f(x)$ are as follows:

$$\frac{f(a+\Delta x) - f(a)}{\Delta x} = \frac{\Delta y}{\Delta x}, \quad \frac{f(a) - f(a-\Delta x)}{\Delta x} = \frac{\nabla y}{\nabla x}$$

In the above, $\Delta y/\Delta x$ is called the forward difference, while $\nabla y/\nabla x$ is the backward difference.To calculate derivatives, the unit takes the average between the value of $\Delta y/\Delta x$ and $\nabla y/\nabla x$, thereby providing higher precision for derivatives.

This average, which is called the *central difference*, is expressed as:

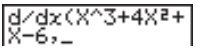
$$f'(a) = \frac{1}{2}\left(\frac{f(a+\Delta x)-f(a)}{\Delta x} + \frac{f(a)-f(a-\Delta x)}{\Delta x}\right)$$
$$= \frac{f(a+\Delta x)-f(a-\Delta x)}{2\Delta x}$$

●To perform a differential calculation

Example **To determine the derivative at point $x = 3$ for the function $y = x^3 + 4x^2 + x - 6$, when the increase/decrease of x is defined as $\Delta x = 1\text{E}-5$**

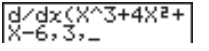
Input the function $f(x)$.

[AC] [OPTN] [F2] (CALC) [▷] [F1] (d/dx)
[X,T] [^] [3] [+] [4] [X,T] [x^2]
[+] [X,T] [−] [6] [▸]



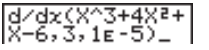
Input point $x = a$ for which you want to determine the derivative.

[3] [▸]

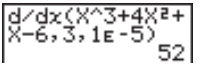


Input Δx, which is the increase/decrease of x.

[1] [EXP] [(−)] [5] [)]



[EXE]



- In the function $f(x)$, only X can be used as a variable in expressions. Other variables (A through Z) are treated as constants, and the value currently assigned to that variable is applied during the calculation.
- Input of Δx and the closing parenthesis can be omitted. If you omit Δx, the calculator automatically uses a value for Δx that is appropriate for the value of $x = a$, which you specified as the point for which you wanted to determine the derivative.
- Discontinuous points or sections with drastic fluctuation can adversely affect precision or even cause an error.
- Note that you cannot use differential calculation inside of a differential calculation term.

- Pressing AC during calculation of a differential (while the cursor is not shown on the display) interrupts the calculation.
- Always perform trigonometric differentials using radians (Rad Mode) as the angle unit.