

### 2.3 : Introducing Techniques of differentiation

the process of finding  
the derivatives

(\*) Some general Rules:

$$\textcircled{1} [f(x) + g(x)]' = f'(x) + g'(x)$$

$$\textcircled{2} [f(x) - g(x)]' = f'(x) - g'(x)$$

note:  $[f(x) \cdot g(x)]' \neq f'(x) \cdot g'(x)$   
(not equal to)

$$\left[ \frac{f(x)}{g(x)} \right]' \neq \frac{f'(x)}{g'(x)}$$

$$(3) \quad [k \cdot f(x)]' = k \cdot f'(x)$$

④ (Power Rule)  $\left[ x^n \right]' = n \cdot x^{n-1}$

Example :

(1)  $f(x) = x^4$

$$\Rightarrow f'(x) = 4 \cdot x^{4-1} = 4 \cdot x^3$$

$$\textcircled{2} \quad f(x) = x^{2024}$$

$$\Rightarrow f'(x) = 2024 \cdot x^{2023}$$

$$\textcircled{2} \quad f(x) = x^2 + x^3 + x^4 - x^5$$

$$f'(x) = (x^2 + x^3 + x^4 - x^5)'$$

$$= (x^2)' + (x^3)' + (x^4)' - (x^5)'$$

$$= 2x' + 3x^2 + 4x^3 - 5x^4$$

$$= 2x + 3x^2 + 4x^3 - 5x^4$$

$$[ \text{note: } x' = x ; x^0 = 1 ]$$

$$\textcircled{3} \quad f(x) = x - x^{-1} + x^{1/2}$$

$$f'(x) = [x - x^{-1} + x^{1/2}]'$$

$$= (x^1)' - (x^{-1})' + (x^{1/2})'$$

$$= 1 \cdot x^0 - (-1) \cdot x^{-1-1} + \frac{1}{2} x^{1/2-1}$$

$$= 1 + x^{-2} + \frac{1}{2} x^{-1/2}$$

$$(4) \quad f(x) = 7 \cdot x^{10}$$

$$\begin{aligned} f'(x) &= (7x^{10})' = 7 \cdot (x^{10})' \\ &= 7 \cdot 10 \cdot x^9 \\ &= 70x^9 \end{aligned}$$

$$(5) \quad f(x) = \sqrt{x} = x^{1/2}$$

$$\begin{aligned} \Rightarrow f'(x) &= \frac{1}{2} x^{1/2-1} \\ &= \frac{1}{2} x^{-1/2} \end{aligned}$$

$$(6) \quad f(x) = 7 \cdot \sqrt[5]{x}$$

$$\begin{aligned} \Rightarrow f'(x) &= [7 \cdot x^{1/5}]' \\ &= 7 \cdot \frac{1}{5} \cdot x^{1/5-1} \\ &= \frac{7}{5} x^{-4/5} \end{aligned}$$

$$(7) \quad f(x) = \frac{1}{x^1} + \frac{1}{x^{2024}}$$

$$f(x) = x^{-1} + x^{-2024}$$

$$f'(x) = -1 \cdot x^{-1-1} + (-2024) \cdot x^{-2024-1}$$

$$= -x^{-2} - 2024 x^{-2025}$$

Note:  $\sqrt[k]{x} = x^{1/k}$

$$\sqrt[k]{x^h} = x^{h/k}$$

$$\frac{1}{x^k} = x^{-k}$$

Some basic Rules (cont.)

$$(5) \quad (x)' = 1$$

$$(6) \quad (c)' = 0$$

[ Example:  $(20)' = 0$  ;  $(2024)' = 0$  ]

Pracice Problems : Find  $f'(x)$

$$(1) \quad f(x) = x^{20}$$

$$(2) \quad f(x) = 3x^{10}$$

$$(3) \quad f(x) = 4x^2 - 5x^3 + 6x^9$$

$$(4) \quad f(x) = 6\sqrt{x} + \frac{1}{x}$$

$$(5) \quad f(x) = \frac{7}{x} + 20$$

$$(6) \quad f(x) = \frac{9}{x^2} + \frac{1}{x}$$

$$(7) \quad f(x) = 20x + \frac{7}{x^3} + \frac{2}{\sqrt{x}} + 3$$

$$(8) \quad f(x) = \frac{2x^3}{3} + \frac{x^5}{7} - \frac{2}{\sqrt[3]{x}} + \frac{5}{6\sqrt{x}} + 1$$

$$(9) \quad f(x) = \frac{1}{\sqrt{x^3}} + \frac{2}{x^3} + \frac{\sqrt[3]{x}}{4} + 1$$

$$(10) \quad f(x) = \sqrt[9]{x^2} + \frac{4}{\sqrt[6]{x^{31}}} + 2$$