

## 4.1 Antiderivatives: Basic Concepts

A **Differential Equation** in  $x$  and  $y$  is an equation that involves,  $x$ ,  $y$ , and the derivative of  $y$ .

$$\text{eg: } dy/dx = 5x^4 - 6x^2$$

Definition, **Antiderivative**:

A function  $F$  is an **antiderivative** of  $f$  on an interval  $I$  if  $F'(x) = f(x)$  for all  $x$  in  $I$ .

## Antidifferentiation or Indefinite Integration

The **operation of finding all the solutions** to the differential equation,  $dy = f(x) dx$ , is called **antidifferentiation or indefinite integration** and is denoted by the integral sign  $\int$ . The solution when  $F'(x) = f(x)$  is:

$$y = \int f(x) dx = F(x) + c$$

↑  
integrand

↑  
variable  
of integration

↑  
constant  
of integration

$$y = \int f(x)dx = F(x) + c$$

integrand

variable  
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constant  
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**Note: Operators  $\int$  and  $dx$  are no longer present after the operation of integration is performed.**

The integral sign  $\int$  and  $dx$  indicate the operation of integration the same way that a plus sign indicates the operation of addition.

For the addition problem,  $3 + 2 = 5$ , the result no longer has the operator,  $+$  ; it contains only the result.

Likewise, for integration, the result no longer has either the integral sign  $\int$  or the  $dx$ . **To continue to write the  $\int$  or the  $dx$  after the operation of integration has been performed is, therefore, not correct.**

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Rules of:

Differentiation

$$\frac{d(c)}{dx} = 0$$

$$\frac{d(kx)}{dx} = k$$

$$\frac{d(x^n)}{dx} = nx^{n-1}$$

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

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

Integration

$$\int 0 dx = c$$

$$\int k dx = kx + c$$

$$\int x^n dx = \frac{x^{n+1}}{n+1} + c$$

$$\int \cos x dx = \sin x + c$$

$$\int \sin x dx = -\cos x + c$$

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