



## Functions

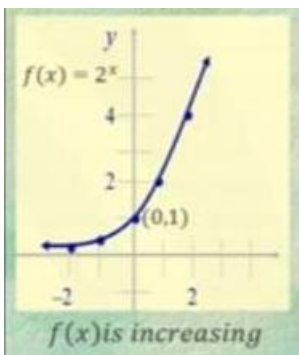
### 1.1 exponential functions

Definition: the exponential functions with base  $a$  can be written as

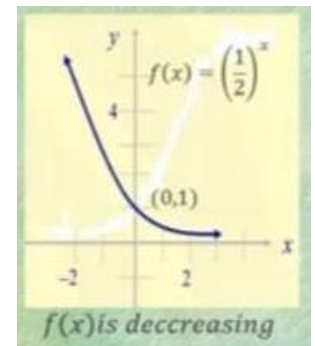
$$f(x) = a^x \text{ Such that } a > 0, a \neq 0$$

First: graphically

$$a > 1$$



$$0 < a < 1$$



**Remark:** the exponential function with base “e” is

$$f(x) = e^x$$

Where “e” is mathematical constant  $\approx 2.7183$



Second: algebraically

The properties of the exponential functions are :

1. If  $a > 0 \leftrightarrow a^x > 0$ .
2.  $a^x \cdot a^y = a^{x+y}$ .
3.  $a^x / a^y = a^{x-y}$ .
4.  $(a^x)^y = a^{x \cdot y}$ .
5.  $(a \cdot b)^x = a^x \cdot b^x$ .
6.  $a^{\frac{x}{y}} = \sqrt[y]{a^x} = (\sqrt[y]{a})^x$ .
7.  $a^{-x} = 1/a^x$  and  $a^x = 1/a^{-x}$ .
8.  $a^x = a^y \leftrightarrow x = y$ .
9.  $a^0 = 1$ ,  
 $a^\infty = \infty$ ,  $a^{-\infty} = 0$ , where  $a > 1$ .  
 $a^\infty = 0$ ,  $a^{-\infty} = \infty$ , where  $a < 1$ .

The graph of the exponential function  $y = a^x$  is :

**Examples :** solve 1)  $4^{x-3} = 8$     2)  $\left(\frac{4}{5}\right)^{6x+1} = \frac{5}{4}$     3)  $4^{2x+7} = 8^{x+2}$     4)  $5^3 = (x+2)^3$

5)  $x^2 e^x - 5x e^x = 0$

**Solution**

1)  $4^{x-3} = 8$

$$2^{2(x-3)} = 2^3$$

$$2(x-3) = 3$$

$$2x - 6 = 3$$

$$2x = 9$$

$$\mathbf{X = \frac{9}{2}}$$



$$2) \left(\frac{4}{5}\right)^{6x+1} = \frac{5}{4}$$

$$\left(\frac{4}{5}\right)^{6x+1} = \left(\frac{4}{5}\right)^{-1}$$

$$6x+1 = -1$$

$$6x = -2$$

$$X = \frac{-2}{6} = \frac{-1}{3}$$

$$3) 4^{2x+7} = 8^{x+2}$$

$$2^{2(2x+7)} = 2^{3(x+2)}$$

$$2(2x+7) = 3(x+2)$$

$$4x+14 = 3x+6$$

$$4x - 3x = 6 - 14$$

$$X = -8$$

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

$$5 = (x+2)$$

$$X = 5 - 2$$

$$X = 3$$



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$$5) x^2e^x - 5xe^x = 0$$

$$xe^x(x-5) = 0$$

$$x = 0$$

$$\text{or } x - 5 = 0$$

$$x = 5$$

(Note  $e^x \neq 0$ )