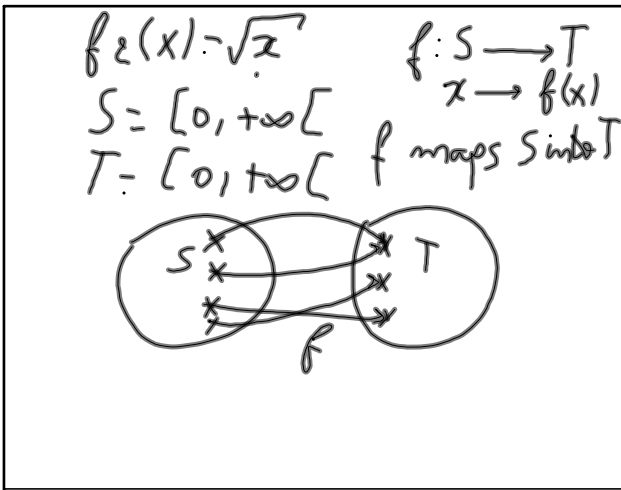


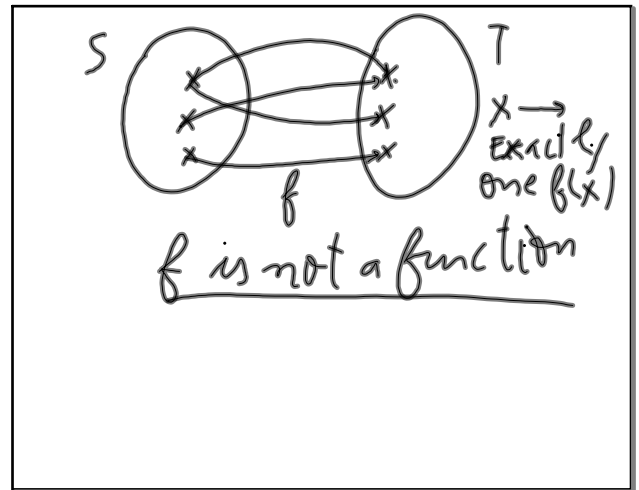
م 25-01:01 نابعش

$S$ : domain of  $f$   
 $T$ : codomain (image) of  $f$ .  
Example  $0^2 = 0$   
 $f_1(x) = x^2$   $(-3)^2 = 9$   
 $S = ]-\infty, +\infty[ = \mathbb{R}$   
 $T = \mathbb{R}^+ \cup \{0\}$

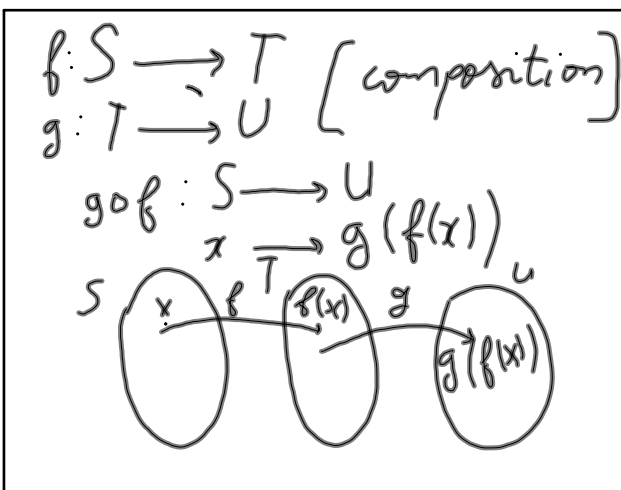
م 25-01:17 نابعش



م 25-01:21 نابعش



م 25-01:26 نابعش



م 25-01:29 نابعش

Example  
 $f(x) = x^3 + 2x, x \in \mathbb{R}$   
 $g(y) = y^7, y \in \mathbb{R}$   
 $- g \circ f = g(f(x)) = (x^3 + 2x)^7$   
 $- f \circ g = f(g(y)) = (y^7)^3 + 2y^7$

م 25-01:32 نابعش

$f, g, h$   
 $(h \circ g) \circ f = h \circ (g \circ f)$   
Example  
 $f(x) = x^4$   
 $g(y) = \sqrt{y^2 + 1}$   
 $h(z) = z^2 + 7z$

م 25-01:39 ناب عش

$f(x) = x^4, g(y) = \sqrt{y^2 + 1},$   
 $h(z) = z^2 + 7z$   
 $h \circ (g \circ f) = h(g(f(x)))$   
 $h(\sqrt{x^8 + 1})$   
 $h(\sqrt{x^8 + 1})$   
 $h \circ (g \circ f) = x^8 + 1 + 7z = x^8 + 7z$

م 25-01:48 ناب عش

$(h \circ g) \circ f =$   
 $h(g(y)) = (\sqrt{y^2 + 1})^2 + 7z$   
 $= y^2 + 7z$   
 $(y^2 + 7z) \circ f =$  /  $y = f(x)$   
 $(x^4)^2 + 7z = x^8 + 7z$

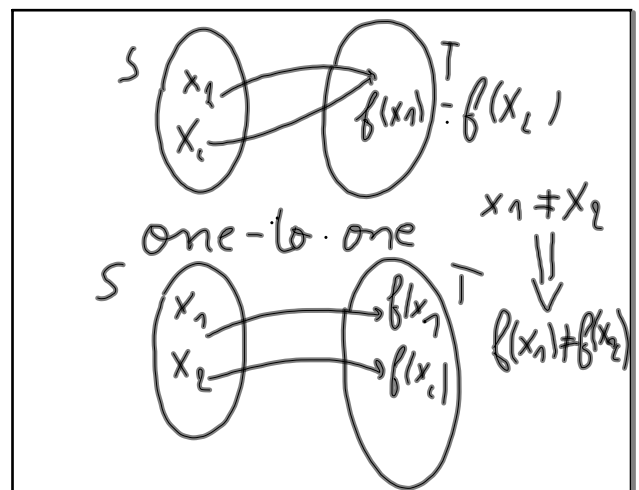
م 25-01:52 ناب عش

$f_1(x), f_2(x)$   
 $f_1(x) + f_2(x) \neq f_2(x) + f_1(x)$   
 $f_1(x) f_2(x) \neq f_2(x) f_1(x)$   
 $\forall x. \exists$  exactly one  $f(x)$

م 25-01:59 ناب عش

A function  $f: S \rightarrow T$  is called one-to-one if distinct elements in  $S$  have distinct images in  $T$  under  $f$

م 25-02:05 ناب عش



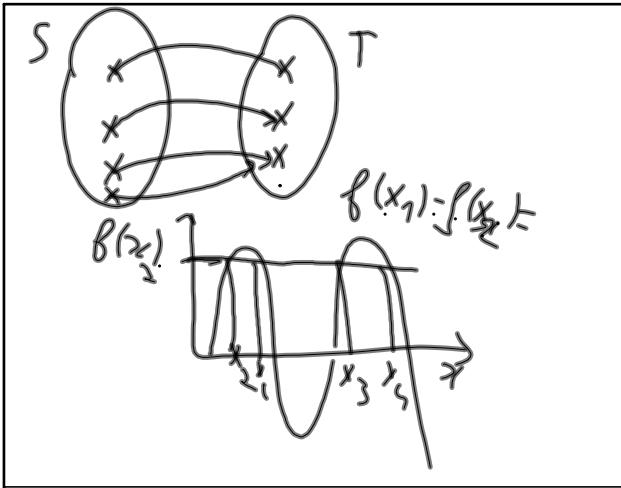
م 25-02:08 ناب عش

if  $x_1, x_2 \in S$  and  $x_1 \neq x_2$   
 then  $f(x_1) \neq f(x_2)$   
 if  $x_1, x_2 \in S$  and  $f(x_1) = f(x_2)$   
 then  $x_1 = x_2$

م 25-02:11 ناب عش

onto  
 $f: S \rightarrow T$   
 $f$  maps onto  $T$   
 for each  $y \in T$ , there is  
 at least one  $x \in S$

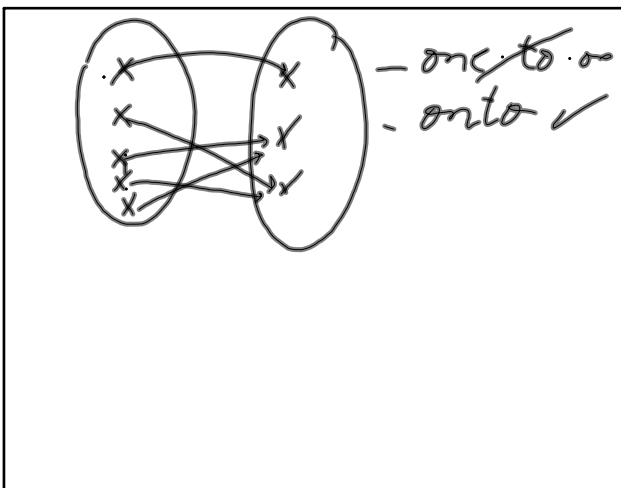
م 25-02:13 ناب عش



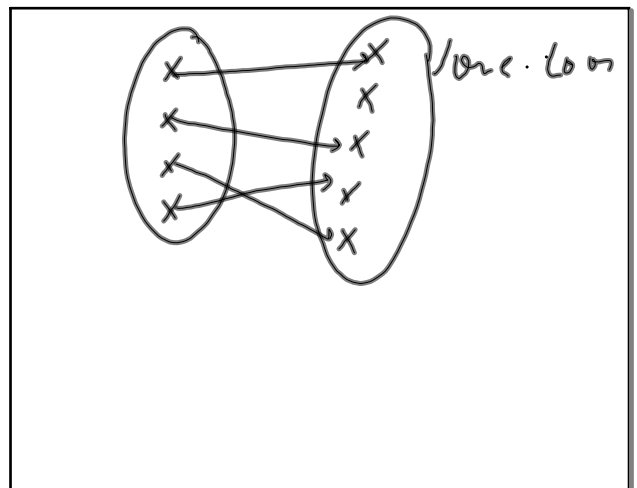
م 25-02:14 ناب عش

A function  $f: S \rightarrow T$   
 is called  
 [one-to-one correspondence  
 } for each  $y \in T$ , there  
 is exactly one  $x \in S$   
 } one-to-one  
 } onto

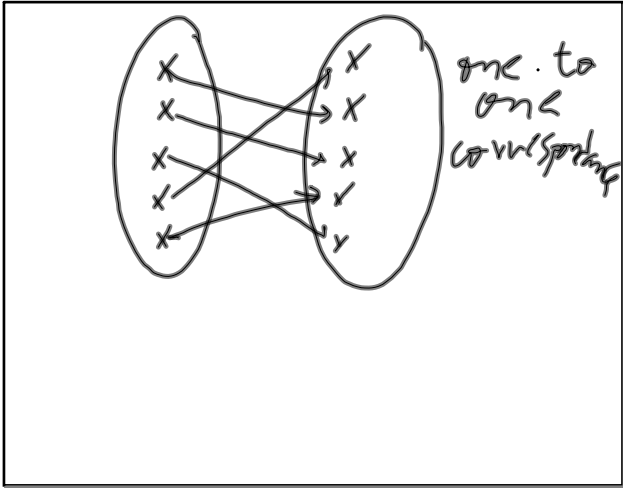
م 25-02:20 ناب عش



م 25-02:23 ناب عش



م 25-02:26 ناب عش



م 25-02:27 ناب عش

$$f: \mathbb{R} \rightarrow \mathbb{R}$$

$$x \rightarrow f(x) = 3x - 5$$

one-to-one ✓

$$x_1 \neq x_2 \Rightarrow f(x_1) \neq f(x_2)$$

$$x_1 \neq x_2 \Rightarrow 3x_1 \neq 3x_2 \Rightarrow 3x_1 - 5 \neq 3x_2 - 5 \Rightarrow f(x_1) \neq f(x_2)$$

م 25-02:28 ناب عش

$$f(x) = 3x - 5 = y \quad x \in \mathbb{R}$$

$$3x - 5 = y \quad y \in \mathbb{R}$$

$$3x = y + 5$$

$$x = \frac{y+5}{3}$$

onto / 3

م 25-02:35 ناب عش

$$f: \mathbb{R} \rightarrow \mathbb{R}$$

$$x \rightarrow 3x + 5$$

$$y = 3x + 5$$

$$x = \frac{y-5}{3}$$

م 25-02:40 ناب عش

$$f: \mathbb{R} \setminus \{0\} \rightarrow \mathbb{R}$$

$$x \rightarrow \frac{1}{x}$$

$$x_1, x_2 \in \mathbb{R} \setminus \{0\}$$

$$x_1 \neq x_2 \Rightarrow \frac{1}{x_1} \neq \frac{1}{x_2} \Rightarrow f(x_1) \neq f(x_2)$$

one to one

م 25-02:43 ناب عش

onto

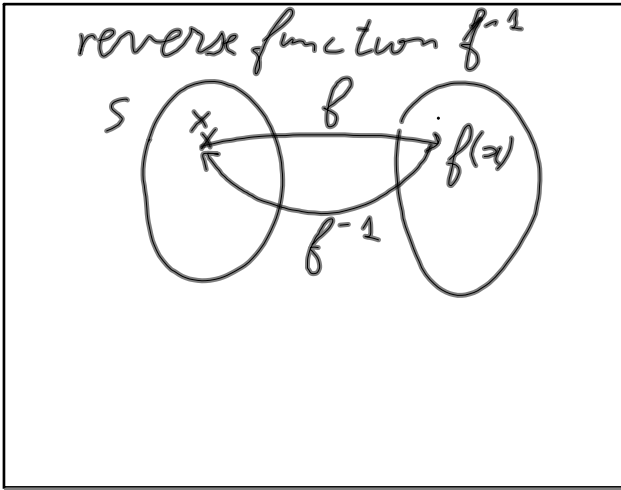
$$\mathbb{R} \setminus \{0\} \rightarrow \mathbb{R}$$

$$\frac{1}{x} = y \Rightarrow x = \frac{1}{y}$$

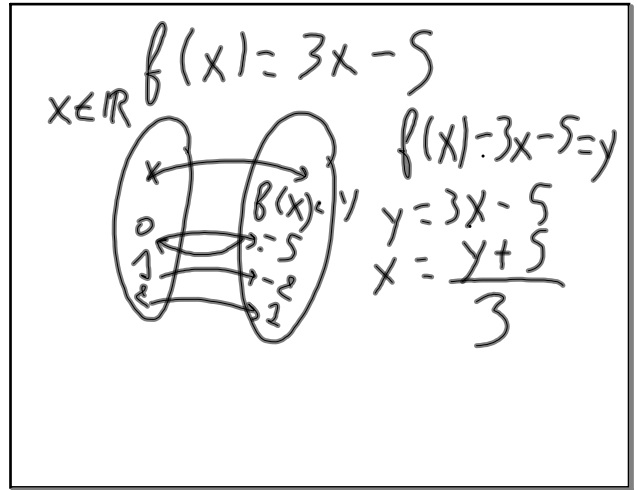
f is not onto

$\exists 0 \in \mathbb{R}$  and  $\frac{1}{0}$  does not exist.

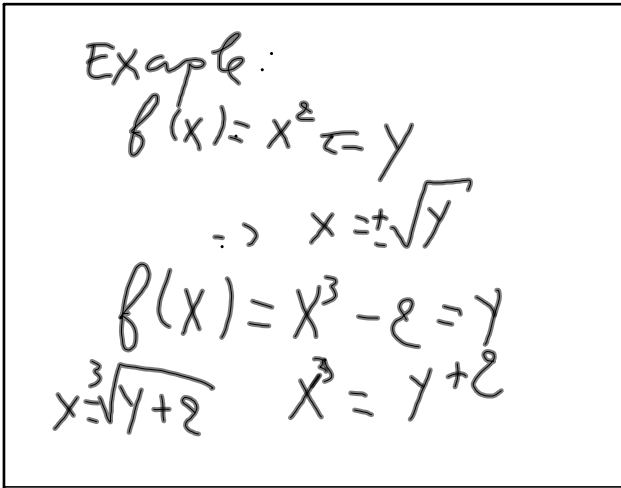
م 25-02:46 ناب عش



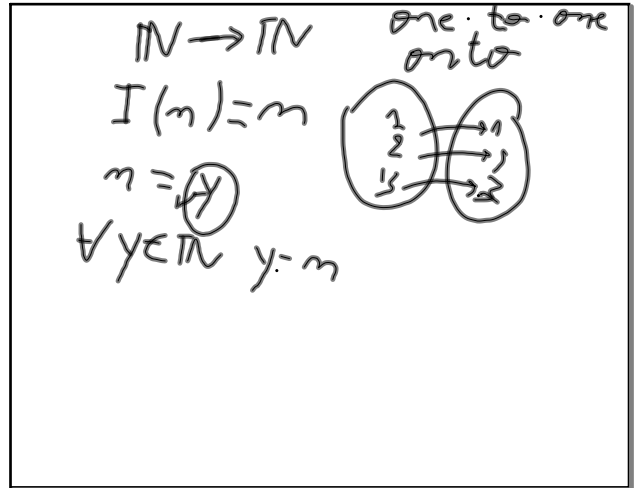
م 25-02:48 ناب عش



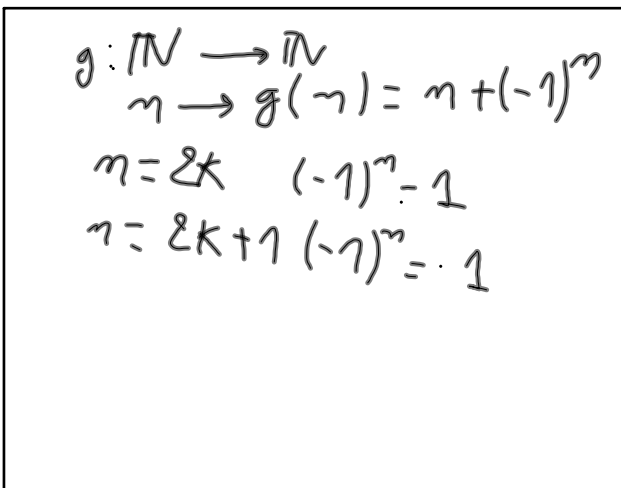
م 25-02:50 ناب عش



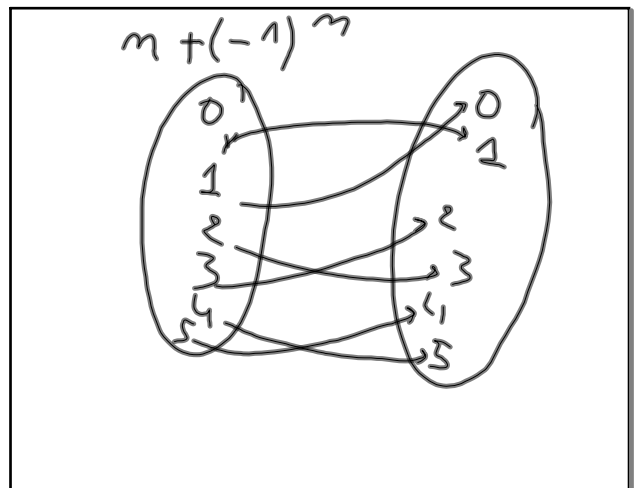
م 25-02:55 ناب عش



م 25-03:01 ناب عش



م 25-03:06 ناب عش

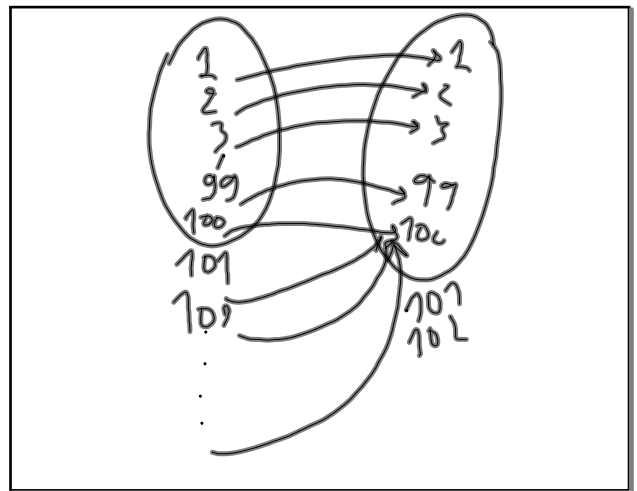


م 25-03:10 ناب عش

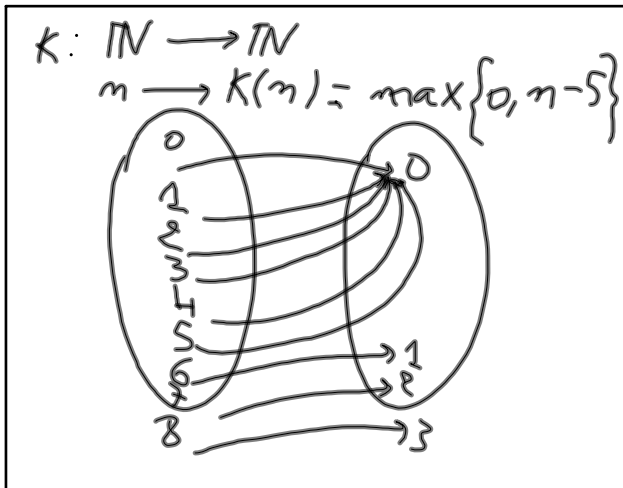
$$h(n) = \min(n, 100)$$

$n < 100 \quad h(n) = n$   
 $n \geq 100 \quad h(n) = 100$   
 $h: \mathbb{N} \rightarrow \mathbb{N}$

م 25-03:13 ناب عش



م 25-03:16 ناب عش



م 25-02:53 ناب عش