

<https://GitHub.Com/Nazgand/NazgandMathBook>

Notation

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1 Substitution

This works similarly to Mathematica's Replace function. Example:

$$\frac{\partial}{\partial 3} 3^2 \neq \frac{\partial}{\partial x} x^2 \Big|_{x \rightarrow 3} = 2x \Big|_{x \rightarrow 3} = 6 \quad (1.1)$$

<https://reference.wolfram.com/language/ref/Replace.html>

2 Logic

And: Given statements A and B . The statement $A \wedge B$ means that both statements A and B are true.

Or: Given statements A and B . The statement $A \vee B$ means that at least 1 of the statements A or B is true.

Implies: The statement $A \Rightarrow B$ is a conditional statement stating that if A is true, then B is true.

$A \Leftrightarrow B$ means $[(A \Rightarrow B) \wedge (B \Rightarrow A)]$.

Brackets: Normally, logic is read from left to right, yet sometimes brackets are used to change the order or add clarification.
Example: $A \vee [B \wedge C]$.

Exists: $\exists a$ means that some a exists. $[\exists a, P(a)] \iff \{\} \neq \{a \mid P(a)\}$.

https://en.wikipedia.org/wiki/List_of_logic_symbols

Kronecker delta function:

$$\delta(0) = 1 \wedge [x \neq 0 \Rightarrow \delta(x) = 0] \quad (2.1)$$

https://en.wikipedia.org/wiki/Kronecker_delta

3 Order and Equality

Equals: $a = b$ means that a is equal to b .

[https://en.wikipedia.org/wiki/Equality_\(mathematics\)](https://en.wikipedia.org/wiki/Equality_(mathematics))

Greater than: $a > b$ means that a is greater than b . $a \geq b$ means that a is greater than or equal to b .

Less than: $a < b$ means that a is less than b . $a \leq b$ means that a is less than or equal to b .

[https://en.wikipedia.org/wiki/Inequality_\(mathematics\)](https://en.wikipedia.org/wiki/Inequality_(mathematics))

4 Sets

Sets: Sets either have an element or they do not have the element; no element is listed more than 1 time. Example sets are: $\{1, 2, 3\}, \{1, \{1, a, b\}\}$.

Element of: \in means "is an element of". Examples: $1 \in \{1, 2, 3\}$ and $\{1, a, b\} \in \{1, \{1, a, b\}\}$.

Subset: \subseteq means "is a subset of". Examples: $\{1, 2, 3\} \subseteq \{1, 2, 3\}$ and $\{3\} \subseteq \{1, 2, 3\}$ and $\{\} \subseteq \{1, 2, 3\}$.

Union: $A \cup B$ is the minimal set which contains all elements either A or B contain.

Intersection: $A \cap B$ is the set which contains all elements both A and B contain.

[https://en.wikipedia.org/wiki/Set_\(mathematics\)](https://en.wikipedia.org/wiki/Set_(mathematics))

Set builder notation:

The set of all things a which satisfy the constraining statement $P(a)$:

$$\{a \mid P(a)\} \quad (4.1)$$

The set of all things a in the set A which satisfy the statement $P(a)$:

$$\{a \in A \mid P(a)\} \quad (4.2)$$

https://en.wikipedia.org/wiki/Set-builder_notation

Integers:

$$0 \in \mathbb{Z} \wedge [a \in \mathbb{Z} \Leftrightarrow (a + 1) \in \mathbb{Z}] \quad (4.3)$$

$$\mathbb{Z}_{>0} = \{n \in \mathbb{Z} \mid n > 0\} \quad (4.4)$$

$$\mathbb{Z}_{\geq 0} = \{n \in \mathbb{Z} \mid n \geq 0\} \quad (4.5)$$

<https://en.wikipedia.org/wiki/Integer>

https://en.wikipedia.org/wiki/Natural_number#Notation

Rational numbers:

$$\mathbb{Q} = \left\{ \frac{a}{b} \mid a \in \mathbb{Z} \wedge b \in \mathbb{Z}_{>0} \right\} \quad (4.6)$$

$$\mathbb{Q}^+ = \{q \in \mathbb{Q} \mid q > 0\} \quad (4.7)$$

$$\mathbb{Q}^{\geq 0} = \{q \in \mathbb{Q} \mid q \geq 0\} \quad (4.8)$$

https://en.wikipedia.org/wiki/Rational_number

Real numbers:

$$\mathbb{R}^{\geq 0} = \{\inf A \mid A \subseteq \mathbb{Q}^+ \wedge A \neq \{\}\} \quad (4.9)$$

$$\mathbb{R} = \{a - b \mid \{a, b\} \subseteq \mathbb{R}^{\geq 0}\} \quad (4.10)$$

$$\mathbb{R}^+ = \{a \in \mathbb{R}^{\geq 0} \mid a > 0\} \quad (4.11)$$

https://en.wikipedia.org/wiki/Real_number

5 Sigma summation

$$\sum_{k \in \{\}} f(k) = 0 \quad (5.1)$$

$$\sum_{k \in \{a\}} f(k) = f(a) \quad (5.2)$$

$$\sum_{k \in (S_1 \cup S_2)} f(k) = \left(\sum_{k \in S_1} f(k) \right) + \left(\sum_{k \in S_2} f(k) \right) - \left(\sum_{k \in (S_1 \cap S_2)} f(k) \right) \quad (5.3)$$

Shorthand

$$\sum_{k=a}^{a-1} f(k) = 0 \quad (5.4)$$

$$\sum_{k=a}^{b+1} f(k) = \left(\sum_{k=a}^b f(k) \right) + f(b+1) = f(a) + \sum_{k=a+1}^{b+1} f(k) \quad (5.5)$$

6 Calculus

A limit $\lim_{a \rightarrow b} f(a)$ is the value usually approaching $f(b)$

n th derivative, not to be confused with $f^n(x)$:

$$f^{(n)}(x) = \frac{\partial^n}{\partial x^n} f(x) \quad (6.1)$$

[https://en.wikipedia.org/wiki/Derivative#Leibniz's_notation](https://en.wikipedia.org/wiki/Derivative#Leibniz%27s_notation)

Integrals can be thought as the area under a curve. The integral from a to b of function $f(x)$ with respect to x is:

$$\int_a^b f(x) \, dx \quad (6.2)$$

Laplace transform:

$$\mathcal{L}\{f(t)\}(s) = \int_0^\infty f(t)e^{-st} \, dt \quad (6.3)$$

Laplace transform inverse:

$$\mathcal{L}^{-1}\{\mathcal{L}\{f(t)\}(s)\}(t) = f(t) \quad (6.4)$$

https://en.wikipedia.org/wiki/Laplace_transform#Formal_definition

Modular arithmetic function, Mod : $(\mathbb{C}, \mathbb{C}) \rightarrow \mathbb{C}$

$$0 \leq \operatorname{Re} \left(\frac{\operatorname{Mod}(a, b)}{b} \right) < 1 \wedge \operatorname{Mod}(a, b) = \operatorname{Mod}(a + b, b) \quad (6.5)$$