# BASIC MATH FORMULAS

## SETS

**Universal Set** $(U)$ is the set of all elements under consideration in the context we are studying.

RELATIONS

**Subset:** A set A is a *subset of a set* B, if and only if every element of the set A is contained in the set B. It is denoted by $A \subset B \iff (\forall x):(x \in A \Rightarrow x \in B)$.

**Set Equality:** A set A is *equal* to a set B, if and only if every element from A is also in B, and every element in B is also in A. It is denoted by $A = B \iff (\forall x):(x \in A \Leftrightarrow x \in B)$.

**Set Inequality**: Two sets A and B are unequal if there is an element in A that is not in B or reverse.

**Disjoint sets:** Two sets A and B are disjoint if they do not have any shared elements; i.e., their intersection is the empty set.

OPERATIONS

**Intersection** of sets A and B are common elements to both. It is denoted by $A \cap B = \{x \in \mathrm{U} |\ x \in A\ i\ x \in B\}$.

**Union** of two sets A and B is the set of elements which are in A or in B or in both. It is denoted by $A \cup B = \{x \in \mathrm{U} | x \in A\ ili\ x \in B\}$.

**Difference** of sets A and B, denoted A\B, is the set consists of elements that are in A but not in B.

$A \backslash B = A \cap B^c = \{x \in \mathrm{U} | x \in A\ i\ x \notin \mathrm{B}\}$.

**Symmetric difference** of sets A i B is the set of elements which are in either of the sets but not in both. It is denoted by

$A \Delta B = A \backslash B \ \cup B \backslash A \ = \{x \in \mathrm{U} \mid x \in A \backslash B\ ili\ x \in B \backslash A\}$.

**Complement** of a set A contains the elements present in universal set but not in A: $A^c = \{x \ \in U \mid x \notin \mathrm{A}\}$.

PROPERTIES

*commutability*: $A \cap B = B \cap A, \quad A \cup B = B \cup A$

*associativity*: $(A \cup B) \cup C = A \cup (B \cup C)$,
$(A \cap B) C = A \cap (B \cap C)$

*idempotency*: $A \cup A = A, \quad A \cap A = A$

*distributivity*: $A \cap (B \cup C) = (A \cap B) \cup (A \cap C)$,
$A \cup (B \cap C) = (A \cup B) \cap (A \cup C)$

*involution*: $(A^c)^c = A$

**De Morgan**: $(A \cup B)^c = A^c \cap B^c, (A \cap B)^c = A^c \cup B^c$

## ALGEBARIC EXPRESSIONS

$(a \pm b)^2 = a^2 \pm 2ab + b^2$

$(a \pm b)^3 = a^3 \pm 3a^2 b + 3ab^2 + b^3$

$a^2 - b^2 = (a-b)(a+b)$

$a^3 \pm b^3 = (a \pm b)(a^2 \mp ab + b^2)$

$a^4 - b^4 = (a-b)(a+b)(a^2+b^2)$

$(a+b+c)^2 = a^2 + b^2 + c^2 + 2ab + 2ac + 2bc$

## EXPONENT RULES

$a^0 = 1, a \neq 0$

$a^m a^n = a^{m+n}$

$a^m : a^n = a^{m-n}, a \neq 0$

$(ab)^n = a^n b^n$

$\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}, b \neq 0$

$(a^m)^n = a^{mn}$

$a^{-n} = \frac{1}{a^n}, a \neq 0$

## ROOTS

$a^n = b \leftrightarrow a = \sqrt[n]{b}$

$\sqrt[n]{ab} = \sqrt[n]{a}\ \sqrt[n]{b}$

$\sqrt[n]{\frac{a}{b}} = \frac{\sqrt[n]{a}}{\sqrt[a]{b}}$

$\sqrt[n]{a^m} = \sqrt[np]{a^{mp}}$

$\sqrt[n]{\sqrt[m]{a}} = \sqrt[nm]{a} = a^{\frac{1}{nm}}$

$\sqrt[m]{a^n} = a^{\frac{n}{m}}$

## QUADRATIC EQUATION

$$ax^2 + bx + c = 0, \qquad a \neq 0$$

$$x_{1,2} = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$ax^2 + bx + c = a\,(x - x_1)\,(x - x_2)$$

## FACTORIALS AND BINOMIAL FORMULA

$$n! = 1 \cdot 2 \cdot 3 \cdot 4 \cdot \dots \cdot (n-2) \cdot (n-1) \cdot n \,, n \epsilon N \;;\quad 0! = 1$$

$$\binom{n}{k} = \frac{n!}{k!\,(n-k)!} = \frac{n(n-1)(n-2)\dots(n-(k-1))}{k!} \,, k \leq n, \;\; n, k \;\epsilon\; N_0$$

$$\binom{n}{0} = 1 \,,\; \binom{n}{n} = 1 \,,\; \binom{n}{1} = \binom{n}{n-1} = n \,,\;\; \binom{n}{k} = \binom{n}{n-k}$$

$$(\boldsymbol{a}+\boldsymbol{b})^{\boldsymbol{n}} = \binom{n}{0} a^n b^0 + \binom{n}{1} a^{n-1} b^1 + \binom{n}{2} a^{n-2} b^2 + \cdots \binom{n}{k} a^{n-k} b^k + \cdots$$

$$+ \binom{n}{n-1} a^1 b^{n-1} + \binom{n}{n} a^0 b^n = \sum_{\boldsymbol{k=0}}^{\boldsymbol{n}} \binom{\boldsymbol{n}}{\boldsymbol{k}} \boldsymbol{a}^{\boldsymbol{k}} \boldsymbol{b}^{\boldsymbol{n-k}} \;\;, n \epsilon\; N$$

## TRIGONOMETRY TABLE

| | $0$ | $\frac{\pi}{6}$ | $\frac{\pi}{4}$ | $\frac{\pi}{3}$ | $\frac{\pi}{2}$ | $\pi$ | $\frac{3\pi}{2}$ | $2\pi$ |
|---|---|---|---|---|---|---|---|---|
| | *0* | *30°* | *45°* | *60°* | *90°* | *180°* | *270°* | *360°* |
| ***sin*** | 0 | $\frac{1}{2}$ | $\frac{\sqrt{2}}{2}$ | $\frac{\sqrt{3}}{2}$ | 1 | 0 | -1 | 0 |
| ***cos*** | 1 | $\frac{\sqrt{3}}{2}$ | $\frac{\sqrt{2}}{2}$ | $\frac{1}{2}$ | 0 | -1 | 0 | 1 |
| ***tg*** | 0 | $\frac{\sqrt{3}}{3}$ | 1 | $\sqrt{3}$ | ±∞ | 0 | ±∞ | 0 |
| ***ctg*** | ±∞ | $\sqrt{3}$ | 1 | $\frac{\sqrt{3}}{3}$ | 0 | ±∞ | 0 | ±∞ |

## COMPLEX NUMBERS

$z = x + yi \,,\; x, y \;\in \boldsymbol{R}\,,\quad |z| = \sqrt{x^2+y^2}$ is the ***absolute*** *value (or modulus or magnitude) of a complex number* $z = x + yi$

### CONJUGATE

$z = x + yi$

$\bar{z} = x - yi$

$\overline{z_1 + z_2} = \bar{z}_1 + \bar{z}_2$

$\overline{z_1 \cdot z_2} = \bar{z}_1 \cdot \bar{z}_2$

$\overline{\left(\frac{z_1}{z_2}\right)} = \frac{\bar{z}_1}{\bar{z}_2}$

### POWERS OF THE IMAGINAR UNIT

$i = \sqrt{-1}$

$i^2 = -1$

$i^3 = -i$

$i^4 = 1$

$i^{4k} = 1$

$i^{4k+1} = i$

$i^{4k+2} = -1$

$i^{4k+3} = -i \;\; k \in N_0$

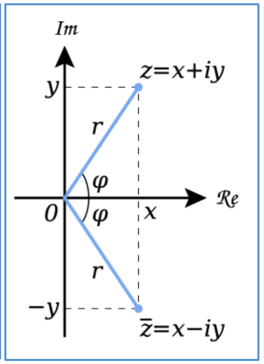
### TRIGONOMETRIC FORM

$z = x + yi = r\,(\cos\varphi + i\;\sin\varphi)$

$r = |z| = \sqrt{x^2+y^2}$

$Arg\; z = \varphi$

$\mathrm{tg}\varphi = \frac{y}{x}, \varphi \in [0, 2\pi >$




### OPERATIONS

$(a + b \cdot i) \pm (c + d \cdot i)$
$= (a \pm c) + (b \pm d) \cdot i$

$(a + b \cdot i)\,(c + d \cdot i)$
$= (ac - bd)\,(ad + bc)\,i$

$\frac{a + b\,i}{c + d\,i} = \frac{ac + bd + (bc - ad)\,i}{c^2 + d^2}$

$$z_1 \cdot z_2 = r_1 r_2 \left( \cos(\varphi_1 + \varphi_2) + \mathrm{i}\sin(\varphi_1 + \varphi_2) \right)$$

$$\frac{z_1}{z_2} = \frac{r_1}{r_2} \left(\cos(\varphi_1 - \varphi_2) + \mathrm{i}\sin(\varphi_1 - \varphi_2)\right)$$

$$z^n = r^n \left( \cos(n\varphi) + \mathrm{i}\sin(n\varphi) \right)$$

$$\sqrt[n]{z} = \sqrt[n]{r} \left( cos\frac{\varphi + 2k\pi}{n} + i\; sin\frac{\varphi + 2k\pi}{n} \right), k = 0, 1, \dots, n-1.$$