Factoring Formulas

$$\mathbf{a^2} - \mathbf{b^2} = (a-b)(a+b)$$

$$(\mathbf{a} + \mathbf{b})^\mathbf{2} = a^2 + 2ab + b^2$$

$$(\mathbf{a} - \mathbf{b})^\mathbf{2} = a^2 - 2ab + b^2$$

$$\mathbf{a^3} - \mathbf{b^3} = (a-b)(a^2 + ab + b^2)$$

$$\mathbf{a^3} + \mathbf{b^3} = (a+b)(a^2 - ab + b^2)$$

$$(\mathbf{a} + \mathbf{b})^\mathbf{3} = a^3 + 3a^2b + 3ab^2 + b^3$$

$$(\mathbf{a} - \mathbf{b})^\mathbf{3} = a^3 - 3a^2b + 3ab^2 - b^3$$

Radicals

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

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

$$\sqrt[n]{a^n} = |a| \qquad \sqrt[m]{\sqrt[n]{a}} = \sqrt[m \cdot n]{a}$$

Exponents

$$a^n \cdot a^m = a^{n+m} \qquad \frac{a^n}{a^m} = a^{n-m}$$

$$(a \cdot b)^n = a^n \cdot b^n \qquad \left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}$$

$$(a^n)^m = a^{n \cdot m} \qquad \left(\frac{a}{b}\right)^{-n} = \left(\frac{b}{a}\right)^n$$

Quadratic Formula

$$\mathbf{a}x^2 + \mathbf{b}x + \mathbf{c} \qquad \text{for} \quad a \neq 0$$

$$\Delta = b^2 - 4ac$$

$$x_{1,2} = \frac{-b \pm \sqrt{\Delta}}{2a}$$

$$p = \frac{-b}{2a} \quad , \quad q = \frac{-\Delta}{4a}$$

$$a(x-p)^2 + q \qquad \text{(vertex form)}$$

$$a(x-x_1)(x-x_2) \qquad \text{(factored form)}$$

Logarithms

$$a^c = x \Leftrightarrow \log_a x = c \qquad for \qquad a \in R^+_{\setminus\{0\}}, x \in R^+$$

$$\log_a a = 1 \qquad \log_a 1 = 0$$

$$\ln x = \log_e x \qquad \log x = \log_{10} x$$

$$\log_a b \cdot \log_b c = \log_a c \qquad \log_a b = \frac{1}{\log_b a}$$

$$\log_a(x \cdot y) = \log_a x + \log_a y$$

$$\log_a\left(\frac{x}{y}\right) = \log_a x - \log_a y$$

Binomial Coefficient

$$\binom{n}{k} = \frac{n!}{k!(n-k)!}$$

Matrices

$$A_{m \times n} = \begin{bmatrix} a_{1,1} & a_{1,2} & \cdots & a_{1,n} \\ a_{2,1} & a_{2,2} & \cdots & a_{2,n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{m,1} & a_{m,2} & \cdots & a_{m,n} \end{bmatrix}$$

$$A_{ij} = (-1)^{i+j} M_{ij} \qquad \text{(Cofactor expansion of element } a_{ij})$$

Minor M_{ij} is the determinant of submatrix (of rank $n-1$), cut down from A by removing i row and j column.

$$A^{-1} = \frac{1}{\det A} \cdot [A_{ij}]^T \qquad \text{where} \qquad A^{-1} \cdot A = A \cdot A^{-1} = \mathbf{I}$$

$$\det A = \sum_{j=1}^{n} a_{ij} A_{ij} \qquad \text{(Laplace expansion)}$$

$$\det A = \det A^T$$

$$\det(A \cdot B) = \det A \cdot \det B$$

$$\det(A^{-1}) = (\det A)^{-1}$$

$$\det(k \cdot A) = k^n \cdot \det A \qquad k \in R, n \text{ order of } A$$

Limits

$$\lim_{n \to \infty} \frac{1}{n} = 0 \qquad \lim_{n \to \infty} \frac{1}{\sqrt{n}} = 0$$

$$\lim_{n \to \infty} 2^n = \infty \qquad \lim_{n \to \infty} \left(\frac{1}{2}\right)^n = 0$$

$$\lim_{n \to \infty} n = \infty \qquad \lim_{n \to \infty} \left(1 + \frac{1}{n}\right)^n = e$$

$$\lim_{n \to \infty} \sqrt[n]{a} = 1 \qquad \lim_{n \to \infty} \frac{n}{0} = \infty$$

$$\lim_{x \to 0} \frac{\sin x}{x} = 1 \qquad \lim_{x \to 0} \left(1 + \frac{1}{x}\right)^x = 1$$

Indeterminate forms

$$\frac{0}{0}, \quad \frac{\infty}{\infty}, \quad \infty - \infty, \quad 0 \cdot \infty, \quad \infty^0, \quad 1^\infty, \quad 0^0$$

Derivatives

$$y = f\Big(g(x)\Big) \qquad y' = f'(g) \cdot g'$$

$$y = f(x) \cdot g(x) \qquad y' = f' \cdot g + f \cdot g'$$

$$y = \frac{f(x)}{g(x)} \qquad y' = \frac{f' \cdot g - f \cdot g'}{g^2}$$

$y = x^n \qquad y' = n \cdot x^{n-1} \qquad\qquad y = ax \qquad y' = a$

$y = a^x \qquad y' = a^x \cdot \ln a \qquad\qquad y = e^x \qquad y' = e^x$

$y = \log_a x \quad y' = \dfrac{1}{x \cdot \ln a} \qquad\qquad y = \ln x \quad y' = \dfrac{1}{x}$

$y = \sin x \quad y' = \cos x \qquad\qquad y = \cos x \quad y' = -\sin x$