Mathematics Cheat Sheet

Algebra

Quadratic Formula:

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Binomial Theorem:

$$(a+b)^n = \sum_{k=0}^{n} \binom{n}{k} a^{n-k} b^k$$

Logarithm Laws:

$$\log(xy) = \log x + \log y$$
$$\log(x/y) = \log x - \log y$$
$$\log(x^n) = n \log x$$

Trigonometry

Basic Identities:

$$\sin^2\theta + \cos^2\theta = 1$$
$$1 + \tan^2\theta = \sec^2\theta$$
$$1 + \cot^2\theta = \csc^2\theta$$

Angle Sum:

$$\sin(\alpha \pm \beta) = \sin\alpha\cos\beta \pm \cos\alpha\sin\beta$$
$$\cos(\alpha \pm \beta) = \cos\alpha\cos\beta \mp \sin\alpha\sin\beta$$

Double Angle:

$$\sin(2\theta) = 2\sin\theta\cos\theta$$
$$\cos(2\theta) = \cos^2\theta - \sin^2\theta$$

Calculus

Derivatives:

$$\frac{d}{dx}x^n = nx^{n-1}$$
$$\frac{d}{dx}e^x = e^x$$
$$\frac{d}{dx}\ln x = \frac{1}{x}$$
$$\frac{d}{dx}\sin x = \cos x$$
$$\frac{d}{dx}\cos x = -\sin x$$

Product Rule:

$$(fg)' = f'g + fg'$$

Quotient Rule:

$$\left(\frac{f}{g}\right)' = \frac{f'g - fg'}{g^2}$$

Chain Rule:

$$\frac{d}{dx}f(g(x)) = f'(g(x)) \cdot g'(x)$$

Integration:

$$\int x^n dx = \frac{x^{n+1}}{n+1} + C$$
$$\int e^x dx = e^x + C$$
$$\int \frac{1}{x} dx = \ln|x| + C$$
$$\int \sin x dx = -\cos x + C$$
$$\int \cos x dx = \sin x + C$$

Integration by Parts:

$$\int u\,dv = uv - \int v\,du$$

Series

Geometric Series:

$$\sum_{n=0}^{\infty} ar^n = \frac{a}{1-r}, \quad |r| < 1$$

Taylor Series:

$$f(x) = \sum_{n=0}^{\infty} \frac{f^{(n)}(a)}{n!}(x-a)^n$$

Common Series:

$$e^x = \sum_{n=0}^{\infty} \frac{x^n}{n!}$$
$$\sin x = \sum_{n=0}^{\infty} \frac{(-1)^n x^{2n+1}}{(2n+1)!}$$
$$\cos x = \sum_{n=0}^{\infty} \frac{(-1)^n x^{2n}}{(2n)!}$$

Linear Algebra

Matrix Multiplication:
$(AB)_{ij} = \sum_k A_{ik}B_{kj}$
Determinant (2×2):

$$\det\begin{pmatrix} a & b \\ c & d \end{pmatrix} = ad - bc$$

Inverse (2×2):

$$A^{-1} = \frac{1}{\det A}\begin{pmatrix} d & -b \\ -c & a \end{pmatrix}$$

Probability

Conditional Probability:

$$P(A|B) = \frac{P(A \cap B)}{P(B)}$$

Bayes' Theorem:

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)}$$

Expected Value:

$$E[X] = \sum_i x_i P(X = x_i)$$