Complex Equations Showcase for TeXSync Website

Developed with LaTeX and by TeXSync

April 29, 2025

Contents

1 Introduction

Welcome to **TeXSync**, the online LaTeX editor. Here we showcase the capability to render highly complex mathematical structures.

2 Calculus

2.1 Complex Differentiation

Let $f(z) = u(x, y) + iv(x, y)$, then the complex derivative is:

$$f'(z) = \lim_{\Delta z \to 0} \frac{f(z + \Delta z) - f(z)}{\Delta z}$$

The Cauchy-Riemann equations are:

$$\frac{\partial u}{\partial x} = \frac{\partial v}{\partial y}, \quad \frac{\partial u}{\partial y} = -\frac{\partial v}{\partial x}$$

2.2 Multivariable Integration

The volume under a surface $z = f(x, y)$ is:

$$V = \iint_D f(x, y)\, dx\, dy$$

Where D is the domain of integration.

2.3 Line Integrals

For a vector field $\vec{F}$, the line integral along curve C is:

$$\oint_C \vec{F} \cdot d\vec{r} = \oint_C (F_x\, dx + F_y\, dy + F_z\, dz)$$

3 Series and Summations

The infinite geometric series:

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

The Taylor series expansion for e^x is:

$$e^x = \sum_{n=0}^{\infty} \frac{x^n}{n!}$$

4 Linear Algebra and Matrices

A system of linear equations:

$$\begin{aligned} 2x + 3y - z &= 7 \\ 4x - y + 5z &= 3 \\ -6x + 2y + 3z &= 8 \end{aligned}$$

In matrix form:

$$\begin{bmatrix} 2 & 3 & -1 \\ 4 & -1 & 5 \\ -6 & 2 & 3 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 7 \\ 3 \\ 8 \end{bmatrix}$$

5 Tensor Calculus (Advanced)

The Riemann curvature tensor:

$$R^{\rho}_{\sigma\mu\nu} = \partial_{\mu}\Gamma^{\rho}_{\nu\sigma} - \partial_{\nu}\Gamma^{\rho}_{\mu\sigma} + \Gamma^{\rho}_{\mu\lambda}\Gamma^{\lambda}_{\nu\sigma} - \Gamma^{\rho}_{\nu\lambda}\Gamma^{\lambda}_{\mu\sigma}$$

Einstein field equations:

$$R_{\mu\nu} - \frac{1}{2}Rg_{\mu\nu} + \Lambda g_{\mu\nu} = \frac{8\pi G}{c^4}T_{\mu\nu}$$

6 Physics: Quantum Mechanics

The time-dependent Schrödinger equation:

$$i\hbar\frac{\partial}{\partial t}\Psi(\mathbf{r},t) = \left(-\frac{\hbar^2}{2m}\nabla^2 + V(\mathbf{r},t)\right)\Psi(\mathbf{r},t)$$