# 1 Advanced Mathematical Document

This document tests all markdown features including special characters, equations, tables, and more.

## 1.1 Mathematical Equations

### 1 Inline Mathematics

The quadratic formula is $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ and Euler's identity is $e^{i\pi} + 1 = 0$.

The area of a circle: $A = \pi r^2$ where $r$ is the radius.

### 2 Block Equations

**Partial Differential Equation (Heat Equation):**

$$\frac{\partial u}{\partial t} = \alpha \frac{\partial^2 u}{\partial x^2}$$

**Navier-Stokes Equation:**

$$\rho \left( \frac{\partial \mathbf{v}}{\partial t} + \mathbf{v} \cdot \nabla \mathbf{v} \right) = -\nabla p + \mu \nabla^2 \mathbf{v} + \mathbf{f}$$

**Integral Example:**

$$\int_0^\infty e^{-x^2} \, dx = \frac{\sqrt{\pi}}{2}$$

**Double Integral:**

$$\iint_D f(x, y) \, dA = \int_a^b \int_c^d f(x, y) \, dy \, dx$$

**Matrix Example:**

$$\mathbf{A} = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix}$$

**Matrix Multiplication:**

$$\mathbf{C} = \mathbf{A} \times \mathbf{B} = \begin{pmatrix} c_{11} & c_{12} \\ c_{21} & c_{22} \end{pmatrix}$$

**Square Root and Fractions:**

$$\sqrt{x^2 + y^2} = \sqrt{\frac{a}{b} + \frac{c}{d}}$$

**Summation and Product:**

$$\sum_{i=1}^n i^2 = \frac{n(n+1)(2n+1)}{6} \quad \text{and} \quad \prod_{i=1}^n i = n!$$

**Limit Example:**

$$\lim_{x \to \infty} \frac{1}{x} = 0$$

**Taylor Series:**

$$f(x) = f(a) + f'(a)(x-a) + \frac{f''(a)}{2!}(x-a)^2 + \frac{f'''(a)}{3!}(x-a)^3 + \cdots$$

## 1.2 Special Characters & Symbols

### 1 Greek Letters

$\alpha$ (alpha), $\beta$ (beta), $\gamma$ (gamma), $\delta$ (delta), $\varepsilon$ (epsilon), $\zeta$ (zeta), $\eta$ (eta), $\theta$ (theta), $\lambda$ (lambda), $\mu$ (mu), $\pi$ (pi), $\sigma$ (sigma), $\tau$ (tau), $\varphi$ (phi), $\omega$ (omega)

Uppercase: $\Gamma$ (Gamma), $\Delta$ (Delta), $\Theta$ (Theta), $\Lambda$ (Lambda), $\Xi$ (Xi), $\Pi$ (Pi), $\Sigma$ (Sigma), $\Phi$ (Phi), $\Psi$ (Psi), $\Omega$ (Omega)

### 2 Mathematical Operators

$\pm \mp \times \div \cdot \sqrt{} \sqrt[3]{} \sqrt[4]{} \infty \propto \approx \neq \equiv \leq \geq \subset \supset \subseteq \supseteq \cap \cup \int \oint \partial \nabla \Delta \prod \sum$

### 3 Other Symbols

© ® ™ € £ ¥ ¢ § ¶ † ‡ • ‰ ′ ″ ‴ $\to \leftarrow \uparrow \downarrow \leftrightarrow \Rightarrow \Leftarrow \Leftrightarrow$

## 1.3 Complex Tables

### 1 Table 1: Special Characters in Cells

| Symbol | Name | LaTeX | Unicode |
|---|---|---|---|
| $\alpha$ | Alpha | `\alpha` | U+03B1 |
| $\beta$ | Beta | `\beta` | U+03B2 |
| $\int$ | Integral | `\int` | U+222B |
| $\sum$ | Sum | `\sum` | U+2211 |
| $\sqrt{}$ | Square Root | `\sqrt{}` | U+221A |
| $\infty$ | Infinity | `\infty` | U+221E |
| $\approx$ | Approximately | `\approx` | U+2248 |
| $\neq$ | Not Equal | `\neq` | U+2260 |

### 2 Table 2: Mathematical Constants

| Constant | Symbol | Approximate Value | Formula |
|---|---|---|---|
| Pi | $\pi$ | 3.14159265359 | $\pi = \frac{C}{d}$ |
| Euler's Number | e | 2.71828182846 | $e = \lim_{n \to \infty}(1 + \frac{1}{n})^n$ |
| Golden Ratio | $\varphi$ | 1.61803398875 | $\phi = \frac{1+\sqrt{5}}{2}$ |
| Planck's Constant | h | $6.62607015 \times 10^{-34}$ J·s | $E = h\nu$ |

### 3 Table 3: Programming Languages & Operators

| Language | Addition | Multiplication | Division | Modulo | Power |
|---|---|---|---|---|---|
| Python | `a + b` | `a * b` | `a / b` | `a % b` | `a ** b` |
| C++ | `a + b` | `a * b` | `a / b` | `a % b` | `pow(a, b)` |
| JavaScript | `a + b` | `a * b` | `a / b` | `a % b` | `a ** b` |
| Java | `a + b` | `a * b` | `a / b` | `a % b` | `Math.pow(a, b)` |

## 1.4 Code Blocks

### 1 Python Code with Special Characters

```python
import numpy as np
import matplotlib.pyplot as plt

# Calculate π using Monte Carlo method
def estimate_pi(n_samples=1000000):
    """Estimate π using random points in a square"""
    x = np.random.uniform(-1, 1, n_samples)
    y = np.random.uniform(-1, 1, n_samples)
    inside_circle = (x**2 + y**2) <= 1
    pi_estimate = 4 * np.sum(inside_circle) / n_samples
    return pi_estimate

# Test with special operators: +, -, *, /, %, **, //, &, |, ^, ~, <<, >>
result = (2 ** 3) * (10 // 3) + (15 % 4) - (100 / 7)
print(f"Result: {result:.4f}")

# Unicode in strings
symbols = "α β γ δ ε ζ η θ λ μ π σ τ φ ω"
operators = "± × ÷ √ ∞ ≈ ≠ ≤ ≥ ∫ ∑"
```

### 2 LaTeX Equation

```latex
\begin{equation}
\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}
\end{equation}

\begin{align}
\nabla \cdot \mathbf{E} &= \frac{\rho}{\epsilon_0} \\
\nabla \cdot \mathbf{B} &= 0 \\
\nabla \times \mathbf{E} &= -\frac{\partial \mathbf{B}}{\partial t} \\
\nabla \times \mathbf{B} &= \mu_0 \mathbf{J} + \mu_0 \epsilon_0 \frac{\part
ial \mathbf{E}}{\partial t}
\end{align}
```

## 1.5 Lists with Special Characters

### 1 Unordered List

- Item with $\alpha$ (alpha) and $\beta$ (beta)

- Mathematical operators: $\int \sum \prod \sqrt{}$

- Comparison: $\approx \neq \leq \geq \infty$

- Arrows: $\rightarrow \leftarrow \uparrow \downarrow \leftrightarrow$

- Symbols: © ® ™ € £ ¥

### 2 Ordered List

1. First: Calculate $\int_0^1 x^2 dx = \frac{1}{3}$

2. Second: Evaluate $\sum_{i=1}^{10} i = 55$

3. Third: Solve $\frac{dy}{dx} = 2x$ to get $y = x^2 + C$

4. Fourth: Matrix multiplication $\mathbf{A} \times \mathbf{B}$

5. Fifth: Compute $\lim_{x \to 0} \frac{\sin x}{x} = 1$

### 3 Nested Lists

- Top level with $\pi \approx 3.14159$
  - Nested with $e^{i\pi} + 1 = 0$
  - Another nested: $\sqrt{-1} = i$
- Another top: $\infty$ (infinity)
  - Sub-item: $\lim_{n \to \infty}$

## 1.6 Text Formatting Tests

**Bold text** with _italic text_ and `inline code` with special chars: α_β^γ

Regular text with **bold**, *italic*, and ***bold italic*** combined.

Text with special characters: @ # $ % ^ & * ( ) _ + = { } [ ] | \ : ; " ' < > , . ? /

Escaped characters test: \_underscore\_ \*asterisk\* \#hash\# \$dollar\$ \%percent\%

## 1.7 Links and References

Visit Python Official for documentation.

Check out NumPy for numerical computing.

Mathematical reference: Wolfram MathWorld

## 1.8 Advanced Equations Section

### 1 Schrödinger Equation

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

### 2 Maxwell's Equations

$$\nabla \cdot \mathbf{E} = \frac{\rho}{\epsilon_0}$$

$$\nabla \cdot \mathbf{B} = 0$$

$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$$

$$\nabla \times \mathbf{B} = \mu_0 \mathbf{J} + \mu_0 \epsilon_0 \frac{\partial \mathbf{E}}{\partial t}$$

### 3 Einstein Field Equations

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

### 4 Fourier Transform

$$\hat{f}(\xi) = \int_{-\infty}^{\infty} f(x)e^{-2\pi i x \xi}dx$$

## 1.9  Conclusion

This document contains:

- Multiple heading levels (# ## ### ####)
- Tables with special characters ($\alpha$ $\beta$ $\gamma$ $\pi$ $\sum$ $\int$)
- Mathematical equations (*inline* and $$block$$)
- Code blocks with various languages
- Lists (ordered, unordered, nested)
- Special symbols (©®™€£¥)
- Links and references
- Text formatting (**bold**, *italic*, `code`)
- Greek letters ($\alpha$ $\beta$ $\gamma$ $\delta$ $\varepsilon$ $\zeta$ $\eta$ $\theta$ $\lambda$ $\mu$ $\pi$ $\sigma$ $\tau$ $\varphi$ $\omega$ $\Gamma$ $\Delta$ $\Theta$ $\Lambda$ $\Xi$ $\Pi$ $\Sigma$ $\Phi$ $\Psi$ $\Omega$)
- Mathematical operators ($\pm$ $\times$ $\div$ $\sqrt{}$ $\infty$ $\approx$ $\neq$ $\leq$ $\geq$ $\int$ $\sum$ $\prod$ $\partial$ $\nabla$)
- Complex LaTeX equations with matrices, integrals, partial derivatives