

# Отчёт по лабораторной работе №3.

Mathematics Typing

---

Коне Сирики

08 Октября 2025

Российский университет дружбы народов, Москва, Россия

Объединённый институт ядерных исследований, Дубна, Россия

## Информация

---

- Коне Сирики
- Студент физмат
- профессор кафедры прикладной информатики и теории вероятностей
- Российский университет дружбы народов
- [konesirisil@yandex.ru](mailto:konesirisil@yandex.ru)
- <https://github.com/skone19>



Целью данной лабораторной работы является ознакомление с основами набора математических выражений в LaTeX.

The purpose of this lab work is to learn how to typeset mathematical formulas and equations using LaTeX math mode and related packages.

1. Study inline and display math modes.
2. Use the `amsmath` package to align and format equations.
3. Apply different math fonts.
4. Use `mathtools` for advanced formatting.
5. Try bold math and Unicode math.
6. Perform the exercises with examples.

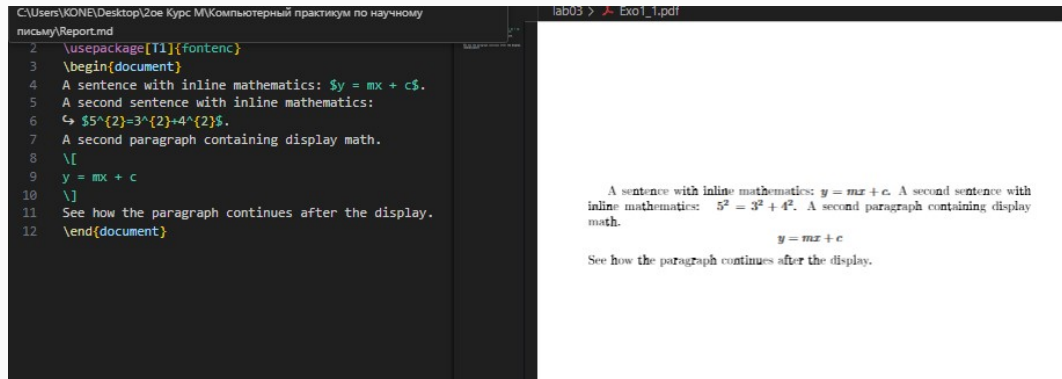
## Теоретическое введение

---

## 3.1 Математический режим / Math mode

В LaTeX существует два математических режима: **inline** и **display**.

In LaTeX there are two main math modes: inline (within text) and display (centered block).



The screenshot displays a LaTeX editor with two panels. The left panel shows the source code for a document named 'Report.md'. The code includes package loading, document initialization, and several paragraphs of text interspersed with mathematical expressions using inline and display math modes. The right panel shows the rendered PDF output, 'Exo1\_1.pdf', which visually demonstrates the effect of the `inline` and `display` math modes on the text.

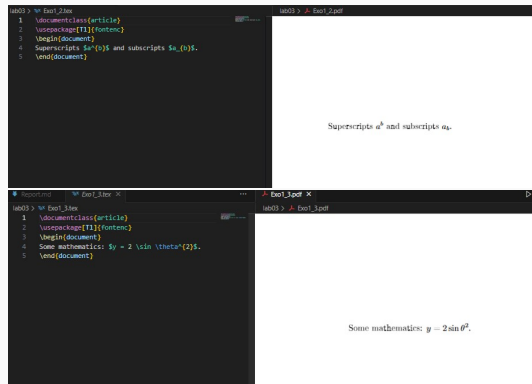
```
2 \usepackage[T1]{fontenc}
3 \begin{document}
4 A sentence with inline mathematics:  $y = mx + c$ .
5 A second sentence with inline mathematics:
6  $5^2=3^2+4^2$ .
7 A second paragraph containing display math.
8 \[
9 y = mx + c
10 \]
11 See how the paragraph continues after the display.
12 \end{document}
```

A sentence with inline mathematics:  $y = mx + c$ . A second sentence with inline mathematics:  $5^2 = 3^2 + 4^2$ . A second paragraph containing display math.

$$y = mx + c$$

See how the paragraph continues after the display.

## 3.1.1 Inline math mode and mathematical notation



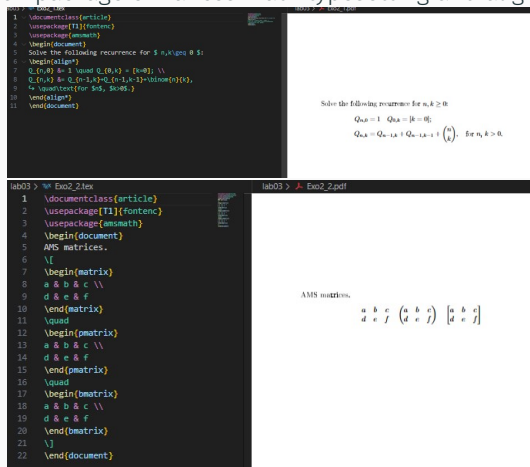


## 3.1.2 Display mathematics

<pre>lab03 &gt; % Ex01_4.tex 1 \documentclass{article} 2 \usepackage[T1]{fontenc} 3 \begin{document} 4 A paragraph about a larger equation 5 \[ 6 \int_{-\infty}^{+\infty} e^{-x^2} \, dx 7 \] 8 \end{document}</pre>	<pre>lab03 &gt; % Ex01_4.pdf</pre> <p>A paragraph about a larger equation</p> $\int_{-\infty}^{+\infty} e^{-x^2} dx$
<pre>lab03 &gt; % Ex01_5.tex 1 \documentclass{article} 2 \usepackage[T1]{fontenc} 3 \newcommand{\diff}{\mathop{}\!\mathrm{d}} % For italic 4 % \newcommand{\diff}{\mathop{}\!\mathrm{d}} % For upright 5 \begin{document} 6 A paragraph about a larger equation 7 \[ 8 \int_{-\infty}^{+\infty} e^{-x^2} \diff x 9 \] 10 \end{document}</pre>	<pre>lab03 &gt; % Ex01_5.pdf</pre> <p>A paragraph about a larger equation</p> $\int_{-\infty}^{+\infty} e^{-x^2} dx$
<pre>lab03 &gt; % Ex01_6.tex 1 \documentclass{article} 2 \usepackage[T1]{fontenc} 3 \begin{document} 4 A paragraph about a larger equation 5 \begin{equation} 6 \int_{-\infty}^{+\infty} e^{-x^2} \, dx 7 \end{equation} 8 \end{document}</pre>	<pre>lab03 &gt; % Ex01_6.pdf</pre> <p>A paragraph about a larger equation</p> $\int_{-\infty}^{+\infty} e^{-x^2} dx \quad (1)$

## 3.2 Пакет amsmath / The amsmath package

Пакет `amsmath` расширяет стандартные возможности для набора формул и выравнивания уравнений. The `amsmath` package enhances math typesetting and alignment.

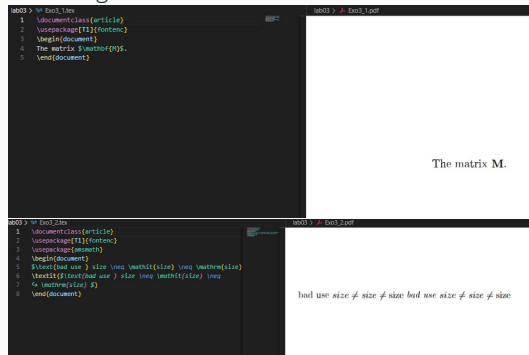


The top screenshot shows a LaTeX document using the `amsmath` package to solve a recurrence relation. The source code on the left defines a document class, loads packages, and uses `\begin{align*}` to display the recurrence relation and its solution. The rendered output on the right shows the text "Solve the following recurrence for  $n, k \geq 0$ :" followed by the recurrence relation  $Q_{n,k} = 1$  for  $k=0$  and  $Q_{n,k} = Q_{n-1,k} + Q_{n-1,k-1}$  for  $k > 0$ , with the solution  $Q_{n,k} = Q_{n-1,k} + Q_{n-1,k-1} + \binom{n}{k}$ .

The bottom screenshot shows a LaTeX document using the `amsmath` package to display matrices. The source code on the left defines a document class, loads packages, and uses `\begin{matrix}`, `\begin{pmatrix}`, and `\begin{bmatrix}` to display matrices. The rendered output on the right shows the text "AMS matrices," followed by three matrices:  $\begin{matrix} a & b & c \\ d & e & f \end{matrix}$ ,  $\begin{pmatrix} a & b & c \\ d & e & f \end{pmatrix}$ , and  $\begin{bmatrix} a & b & c \\ d & e & f \end{bmatrix}$ .

### 3.3 Шрифты в математическом режиме / Fonts in math mode

В математике разные шрифты обозначают разные типы объектов. Different font commands give different styles and meanings.



## 3.4 Дополнительные выравнивания / Further amsmath alignments

Environments like `gather` and `multline` are used for multi-line equations.

lab03 >  Exo4\_1.tex

```
1 \documentclass[a4paper]{article}
2 \usepackage[T1]{fontenc}
3 \usepackage{amsmath}
4 \begin{document}
5 \begin{gather}
6 P(x)=ax^5+bx^4+cx^3+dx^2+ex+f\\
7 x^2+x=10
8 \end{gather}
9 Multline
10 \begin{multline*}
11 (a+b+c+d)x^5+(b+c+d+e)x^4 \\
12 +(c+d+e+f)x^3+(d+e+f+a)x^2+(e+f+a+b)x \\
13 +(f+a+b+c)
14 \end{multline*}
15 \end{document}
```

lab03 >  Exo4\_1.pdf

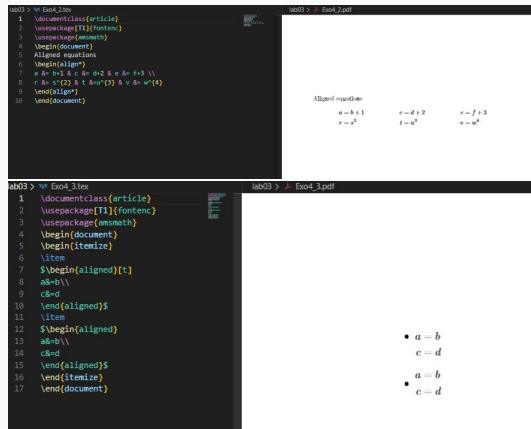
$$P(x) = ax^5 + bx^4 + cx^3 + dx^2 + ex + f \quad (1)$$

$$x^2 + x = 10 \quad (2)$$

Multline

$$\begin{aligned} & (a + b + c + d)x^5 + (b + c + d + e)x^4 \\ & + (c + d + e + f)x^3 + (d + e + f + a)x^2 + (e + f + a + b)x \\ & + (f + a + b + c) \end{aligned}$$

## 3.4.1 Columns in math alignments



The top screenshot shows a LaTeX document (Exo4\_2.tex) using the `\begin{aligned}` environment to align three equations. The code is as follows:

```
1 \documentclass{article}
2 \usepackage[T1]{fontenc}
3 \usepackage{amsmath}
4 \begin{document}
5 \begin{aligned}
6 &a \& b+1 \& c \& d+2 \& e \& f+3 \\
7 &r \& s^2 \& t \& u^3 \& v \& w^4 \\
8 \end{aligned}
9 \end{document}
```

The rendered output (Exo4\_2.pdf) shows the text "Aligned equations" followed by three columns of equations:

$$\begin{array}{lll} a = b + 1 & c = d + 2 & e = f + 3 \\ r = s^2 & t = u^3 & v = w^4 \end{array}$$

The bottom screenshot shows a LaTeX document (Exo4\_3.tex) using the `\begin{aligned}` environment within an `\item` to align two equations. The code is as follows:

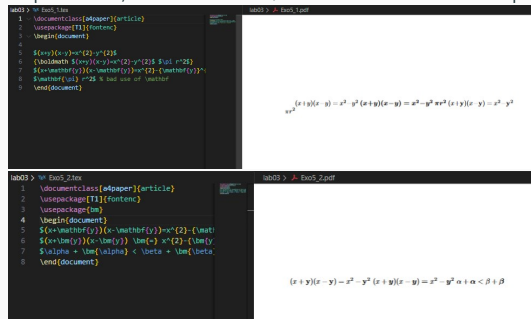
```
1 \documentclass{article}
2 \usepackage[T1]{fontenc}
3 \usepackage{amsmath}
4 \begin{document}
5 \begin{itemize}
6 \item
7 \begin{aligned}[t]
8 a&=b\\
9 c&=d
10 \end{aligned}
11 \item
12 \begin{aligned}
13 a&=b\\
14 c&=d
15 \end{aligned}
16 \end{itemize}
17 \end{document}
```

The rendered output (Exo4\_3.pdf) shows a bulleted list with two items, each containing two aligned equations:

- $a = b$   
 $c = d$
- $a = b$   
 $c = d$

## 3.5 Жирный шрифт в формулах / Bold Math

To bold entire or partial equations, we can use `\boldmath` or the `bm` package.



## 3.6 Пакет Mathtools / Mathtools package

`mathtools` builds upon `amsmath` and provides extended features like column alignment in matrices.

lab03 > %\* Exo6\_1.tex

```
1 \documentclass[a4paper]{article}
2 \usepackage[T1]{fontenc}
3 \usepackage{mathtools}
4 \begin{document}
5 \[
6 \begin{pmatrix*}[r]
7 10&11\\
8 1&2\\
9 -5&-6
10 \end{pmatrix*}
11 \]
12 \end{document}
```

lab03 > Exo6\_1.pdf

$$[r] \begin{pmatrix} 10 & 11 \\ 1 & 2 \\ -5 & -6 \end{pmatrix}$$

## 3.7 Юникодная математика / Unicode Math

Using `unicode-math` with OpenType fonts allows modern mathematical typesetting.

lab03 > Exo6_2.tex	lab03 > Exo6_2.pdf
<pre>1 \documentclass[a4paper]{article} 2 3 \usepackage{unicode-math} 4 \setmainfont{TeX Gyre Pagella} 5 \setmathfont{TeX Gyre Pagella Math} 6 \begin{document} 7 One two three 8 \[ 9 \log \alpha + \log \beta = \log(\alpha\beta) 10 \] 11 Unicode Math Alphanumerics 12 \[A + \symfrac{A}{A} + \symbf{A} + \symcal{A} + \symscr{A} + 13 \symbb{A}\] 14 \end{document}</pre>	<p>TeX Gyre Pagella TeX Gyre Pagella Math One two three</p> $\log \alpha + \log \beta = \log(\alpha\beta)$ <p>Unicode Math Alphanumerics</p> $A + A + A + A + A + A$



## Выполнение лабораторной работы

---

# 1. Переключение между режимами / Switching between math modes

```
lab03 > %* Exo3_8_1.tex > ...
1 \documentclass{article}
2 \usepackage[T1]{fontenc}
3 \usepackage{amsmath}
4
5 \begin{document}
6
7 \section*{Inline vs Display Mode}
8
9 Inline mode:  $E = mc^2$ ,  $y = ax^2 + bx + c$ ,  $\sum_{i=1}^n i = \frac{n(n+1)}{2}$ 
10
11 Same formulas in display mode:
12 \[
13 E = mc^2
14 \]
15 \[
16 y = ax^2 + bx + c
17 \]
18 \[
19 \sum_{i=1}^n i = \frac{n(n+1)}{2}
20 \]
21
22 \end{document}
```

lab03 > Exo3\_8\_1.pdf

## Inline vs Display Mode

Inline mode:  $E = mc^2$ ,  $y = ax^2 + bx + c$ ,  $\sum_{i=1}^n i = \frac{n(n+1)}{2}$



Same formulas in display mode:

$$E = mc^2$$


$$y = ax^2 + bx + c$$

$$\sum_{i=1}^n i = \frac{n(n+1)}{2}$$

## 2. Греческие буквы / Greek letters

lab03 >  Exo3\_8\_2.tex >  Greek Letters

```
1 \documentclass{article}
2 \usepackage[T1]{fontenc}
3
4 \begin{document}
5
6 \section*{Greek Letters}
7
8 Lowercase:  $\alpha$ ,  $\beta$ ,  $\gamma$ ,  $\delta$ ,  $\epsilon$ ,  $\zeta$ ,  $\eta$ ,  $\theta$ ,  $\iota$ ,  $\kappa$ ,  $\lambda$ ,  $\mu$ ,  $\nu$ ,  $\xi$ ,  $\pi$ ,  $\rho$ ,  $\sigma$ ,  $\tau$ ,  $\upsilon$ ,  $\phi$ ,  $\chi$ ,  $\psi$ ,  $\omega$ 
9
10 Uppercase:  $\Gamma$ ,  $\Delta$ ,  $\Theta$ ,  $\Lambda$ ,  $\Xi$ ,  $\Pi$ ,  $\Sigma$ ,  $\Upsilon$ ,  $\Phi$ ,  $\Psi$ ,  $\Omega$ 
11
12 \end{document}
13
```



lab03 >  Exo3\_8\_2.pdf

### Greek Letters


Lowercase:  $\alpha$ ,  $\beta$ ,  $\gamma$ ,  $\delta$ ,  $\epsilon$ ,  $\zeta$ ,  $\eta$ ,  $\theta$ ,  $\iota$ ,  $\kappa$ ,  $\lambda$ ,  $\mu$ ,  $\nu$ ,  $\xi$ ,  $\pi$ ,  $\rho$ ,  $\sigma$ ,  $\tau$ ,  $\upsilon$ ,  $\phi$ ,  $\chi$ ,  $\psi$ ,  $\omega$

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

### 3. Комбинирование шрифтов / Combining fonts

lab03 >  Exo3\_8\_3.tex >  Font Commands in Math Mode

```
1 \documentclass{article}
2 \usepackage[T1]{fontenc}
3 \usepackage{amsmath}
4
5 \begin{document}
6
7 \section*{Font Commands in Math Mode}
8
9 Normal font:  $\text{abcABC123}$ 
10
11 Roman:  $\mathrm{abcABC123}$ 
12
13 Text italic:  $\mathit{abcABC123}$ 
14
15 Bold:  $\mathbf{abcABC123}$ 
16
17 Sans serif:  $\mathsf{abcABC123}$ 
18
19 Typewriter:  $\mathtt{abcABC123}$ 
20
21 \section*{Nesting Commands}
22
23 Nesting test:  $\mathbf{\mathit{\text{text}}}$ 
24
25 Combination:  $\mathbf{x} + \mathit{y} = \mathsf{z}$ 
26
27 \end{document}
28
```

lab03 >  Exo3\_8\_3.pdf

#### Font Commands in Math Mode

Normal font:  $\text{abcABC123}$

Roman:  $\mathrm{abcABC123}$

Text italic:  $\mathit{abcABC123}$

Bold:  $\mathbf{abcABC123}$

Sans serif:  $\mathsf{abcABC123}$

Typewriter:  $\mathtt{abcABC123}$

#### Nesting Commands

Nesting test:  $\mathbf{\mathit{\text{text}}}$

Combination:  $\mathbf{x} + \mathit{y} = \mathsf{z}$

## 4. Параметры класса документа для уравнений / Equation alignment

The image displays three examples of LaTeX document classes and their rendered output for different equation alignment settings.

**Example 1: Left-Aligned Equations**

Code (Enl3\_8\_4.tex):

```
1 \documentclass[11pt]{article}
2 \usepackage[T1]{fontenc}
3 \usepackage{amsmath}
4
5 \begin{document}
6
7 \section*{Left-Aligned Equations}
8
9 Simple equation:
10 
$$E = mc^2$$

11
12
13 Complex equations:
14 
$$\int_{-\infty}^{\infty} e^{-x^2} dx = \sqrt{\pi}$$

15
16
17
18 Numbered equation:
19 
$$a^2 + b^2 = c^2$$

20
21 \end{document}
```

Rendered output (Enl3\_8\_4.pdf):

Left-Aligned Equations

Simple equation:

$$E = mc^2$$

Complex equation:

$$\int_{-\infty}^{\infty} e^{-x^2} dx = \sqrt{\pi}$$

Numbered equation:

$$a^2 + b^2 = c^2$$

**Example 2: Left-Side Equation Numbers**

Code (Enl3\_8\_5.tex):

```
1 \documentclass[11pt]{article}
2 \usepackage[T1]{fontenc}
3 \usepackage{amsmath}
4
5 \begin{document}
6
7 \section*{Left-Side Equation Numbers}
8
9 Left-numbered equation:
10 
$$e^{ix} + 1 = 0$$

11
12
13
14 Another equation:
15 
$$F = G \frac{m_1 m_2}{r^2}$$

16
17 \end{document}
```

Rendered output (Enl3\_8\_5.pdf):

Left-Side Equation Numbers

Left numbered equation:

$$(1) \quad e^{ix} + 1 = 0$$

Another equation:

$$(2) \quad F = G \frac{m_1 m_2}{r^2}$$

**Example 3: Left-Aligned Equations with Left-Side Numbers**

Code (Enl3\_8\_6.tex):

```
1 \documentclass[11pt]{article}
2 \usepackage[T1]{fontenc}
3 \usepackage{amsmath}
4
5 \begin{document}
6
7 \section*{Left-Aligned Equations with Left-Side Numbers}
8
9 
$$\frac{\partial^2 \psi}{\partial x^2} + \frac{\partial^2 \psi}{\partial y^2} = -c^2 \frac{\partial \psi}{\partial x}$$

10
11
12
13 
$$\nabla \cdot \mathbf{u} = \frac{\rho}{\rho_0}$$

14
15 \end{document}
```

Rendered output (Enl3\_8\_6.pdf):

Left-Aligned Equations with Left-Side Numbers

$$(1) \quad \frac{\partial^2 \psi}{\partial x^2} + \frac{\partial^2 \psi}{\partial y^2} = -c^2 \frac{\partial \psi}{\partial x}$$
$$(2) \quad \nabla \cdot \mathbf{u} = \frac{\rho}{\rho_0}$$

## 5. Расширенное использование amsmath / Using Mathtools

```
%* Exo3_8_7.tex x
lab03 > %* Exo3_8_7.tex > ...
1 \documentclass{article}
2 \usepackage[T1]{fontenc}
3 \usepackage{amsmath}
4
5 \begin{document}
6
7 \section*{Advanced amsmath Environments}
8
9 Multiple alignment:
10 \begin{align*}
11 x &= y + z & a &= b + c \\
12 x^2 &= y^2 + 2yz + z^2 & a^2 &= b^2 + 2bc + c^2
13 \end{align*}
14
15 Equation gathering:
16 \begin{gather*}
17 e^{i\theta} = \cos\theta + i\sin\theta \\
18 \cos^2\theta + \sin^2\theta = 1 \\
19 \tan\theta = \frac{\sin\theta}{\cos\theta}
20 \end{gather*}
21
22 Multiline equation:
23 \begin{multline*}
24 p(x) = 3x^6 + 14x^5y + 590x^4y^2 + 19x^3y^3 \\
25 - 12x^2y^4 - 12xy^5 + 2y^6 - a^3b^3
26 \end{multline*}
27
28 \end{document}
```

### Advanced amsmath Environments

Multiple alignment:

$$\begin{array}{rcl} x & = & y + z \\ x^2 & = & y^2 + 2yz + z^2 \end{array} \qquad \begin{array}{rcl} a & = & b + c \\ a^2 & = & b^2 + 2bc + c^2 \end{array}$$

Equation gathering:

$$\begin{aligned} e^{i\theta} &= \cos \theta + i \sin \theta \\ \cos^2 \theta + \sin^2 \theta &= 1 \\ \tan \theta &= \frac{\sin \theta}{\cos \theta} \end{aligned}$$

Multiline equation:

$$\begin{aligned} p(x) &= 3x^6 + 14x^5y + 590x^4y^2 + 19x^3y^3 \\ &\quad - 12x^2y^4 - 12xy^5 + 2y^6 - a^3b^3 \end{aligned}$$

## 6. Математика выделена жирным шрифтом с bm / Math in bold with bm

```
Exo3_8.tex x
lab03 > Exo3_8.tex > ...
8 \section*{Bold Mathematics}
9
10 With \verb|\boldmath|:
11 {\boldmath
12 \[
13 \nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}
14 \]}
15 }
16
17 With \verb|\bm|:
18 \[
19 \bm{\nabla} \times \bm{E} = -\frac{\partial \bm{B}}{\partial t}
20 \]
21
22 Mixed bold and normal:
23 \[
24 \bm{F} = q(\bm{E} + \bm{v} \times \bm{B})
25 \]
26
27 \end{document}
```

### Bold Mathematics

With `\boldmath`:

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

With `\bm`:

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

Mixed bold and normal:

$$\bm{F} = q(\bm{E} + \bm{v} \times \bm{B})$$

## Выводы

---



В ходе лабораторной работы №3 я изучил основы набора математических выражений в LaTeX, познакомился с пакетами `amsmath`, `mathtools`, `bm`, и `unicode-math`. В результате я научился выравнивать уравнения, изменять математические шрифты, делать символы жирными и работать с многострочными выражениями.

As a result, the goal of the lab was achieved: mastering math mode in LaTeX and using key math packages for professional-quality typesetting.

## Список литературы

---

Спасибо за внимание

---