Отчёта по лабораторной работе №3

Mathematics Typing

ДРАММЕХ МАРИАМА Л

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1 Цель работы

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.

2 Задание

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.

3 Теоретическое введение

3.1 3.1 Математический режим / Math mode

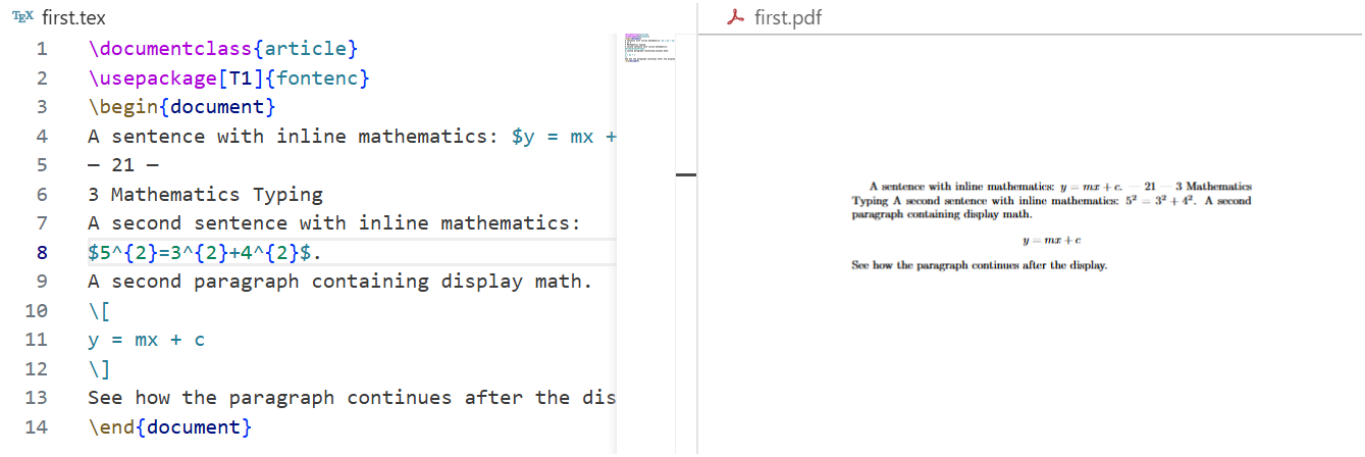
В LaTeX существует два математических режима: **inline** и **display**.
In LaTeX there are two main math modes: inline (within text) and display (centered block).

documentclass{article}
\usepackage[T1]{fontenc}
\begin{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.
\end{document}

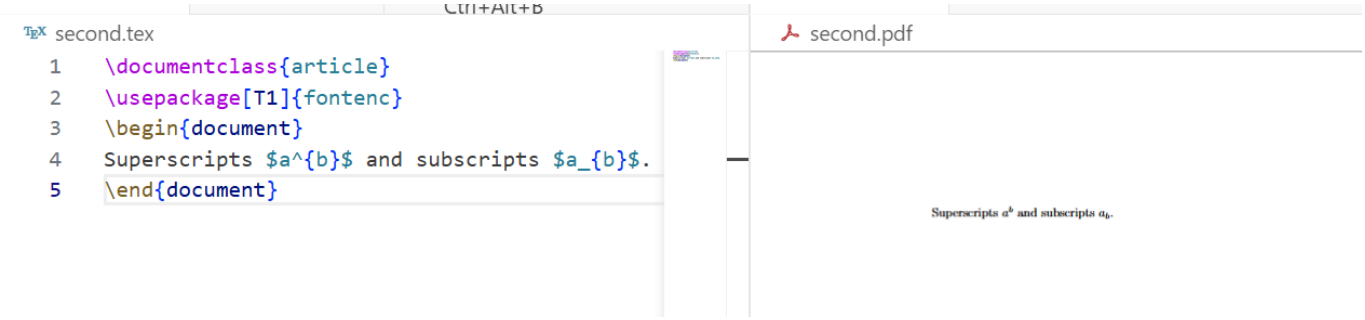
(рис.**¿fig:001?**)



3.1.1 3.1.1 Inline math mode and mathematical notation

\documentclass{article}
\usepackage[T1]{fontenc}
\begin{document}
Superscripts a^{b} and subscripts a_{b}.
\end{document}

(см. Рис. **¿fig:002?**)



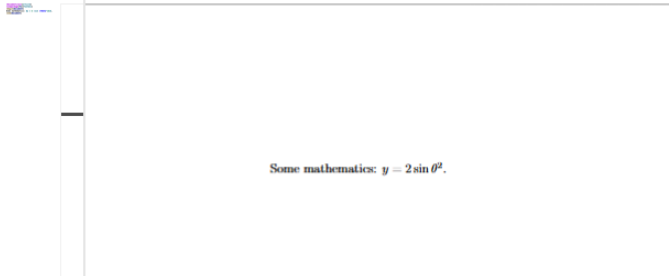
\documentclass{article}
\usepackage[T1]{fontenc}
\begin{document}
Some mathematics: $y = 2 \sin \theta^{2}$.
\end{document}

(см. Рис. **¿fig:003?**)

third.tex

```
\documentclass{article}
\usepackage[T1]{fontenc}
\begin{document}
Some mathematics: $y = 2 \sin \theta^{2}$.
\end{document}
```

third.pdf



3.1.2 3.1.2 Display mathematics

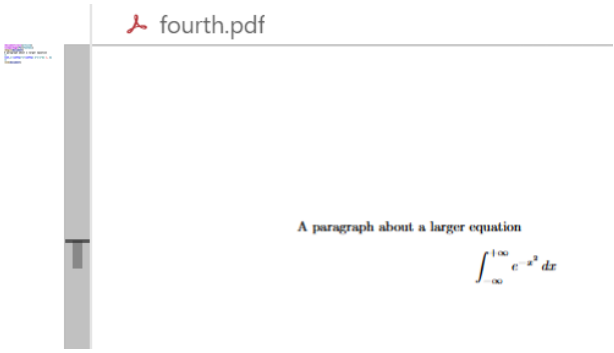
\documentclass{article}
\usepackage[T1]{fontenc}
\begin{document}
A paragraph about a larger equation
\[
\int_{-\infty}^{+\infty} e^{-x^2} \, dx
\]
\end{document}

(см. Рис. **¿fig:004?**)

fourth.tex

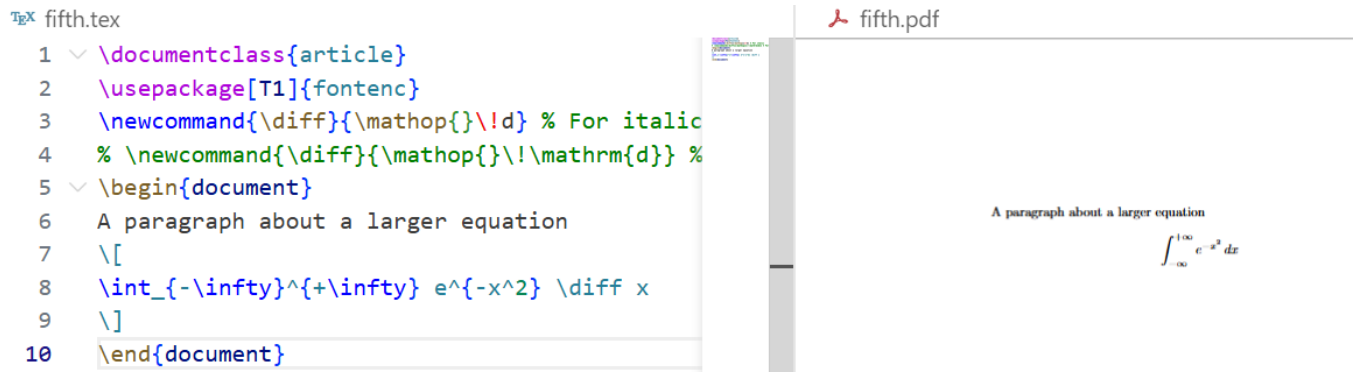
```
\documentclass{article}
\usepackage[T1]{fontenc}
\begin{document}
A paragraph about a larger equation
\[
\int_{-\infty}^{+\infty} e^{-x^2} \, dx
\]
\end{document}
```

fourth.pdf



\documentclass{article}
\usepackage[T1]{fontenc}
\newcommand{\diff}{\mathop{}\!d} % For italic
% \newcommand{\diff}{\mathop{}\!\mathrm{d}} % For upright
\begin{document}
A paragraph about a larger equation
\[
\int_{-\infty}^{+\infty} e^{-x^2} \diff x
\]
\end{document}

(см. Рис. **¿fig:005?**)




```
\documentclass{article}
\usepackage[T1]{fontenc}
\begin{document}
A paragraph about a larger equation
\begin{equation}
\int_{-\infty}^{+\infty} e^{-x^2} \, dx
\end{equation}
\end{document}
```

(см. Рис. **¿fig:006?**)

3.2 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.

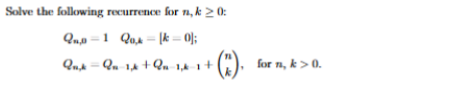
```
\documentclass{article}
\usepackage[T1]{fontenc}
\usepackage{amsmath}
\begin{document}
\begin{align*}
Q_{n,k} &= Q_{n-1,k} + Q_{n-1,k-1} + \binom{n}{k}, \\
&\quad \text{for } n,k>0.
\end{align*}
\end{document}
```

(см. Рис. **¿fig:007?**)

seventh.tex

```
\documentclass{article}
\usepackage[T1]{fontenc}
\usepackage{amsmath}
\begin{document}
Solve the following recurrence for $ n,k\geq
\begin{align*}
Q_{n,0} &= 1 \quad Q_{0,k} = [k=0]; \\
Q_{n,k} &= Q_{n-1,k}+Q_{n-1,k-1}+\binom{n}{k}
\quad\text{for $n$, $k>0$.}
\end{align*}
\end{document}
```

seventh.pdf

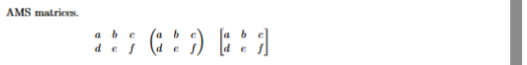


(см. Рис. **¿fig:008?**)

eighth.tex

```
\documentclass{article}
\usepackage[T1]{fontenc}
\usepackage{amsmath}
\begin{document}
AMS matrices.
\[
\begin{matrix}
a & b & c \\
d & e & f
\end{matrix}
\quad
\begin{pmatrix}
a & b & c \\
d & e & f
\end{pmatrix}
\quad
\begin{bmatrix}
a & b & c \\
d & e & f
\end{bmatrix}
\]
\end{document}
```

eighth.pdf



3.3 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.

\documentclass{article}
\usepackage{amsmath}
\begin{document}
$\mathrm{A}, \mathit{A}, \mathbf{A}, \mathsf{A}, \mathtt{A}, \mathbb{A}$
\end{document}

(см. Рис. **¿fig:009?**)

nineth.tex

```
\documentclass{article}
\usepackage[T1]{fontenc}
\begin{document}
The matrix $\mathbf{M}$.
\end{document}
```

nineth.pdf

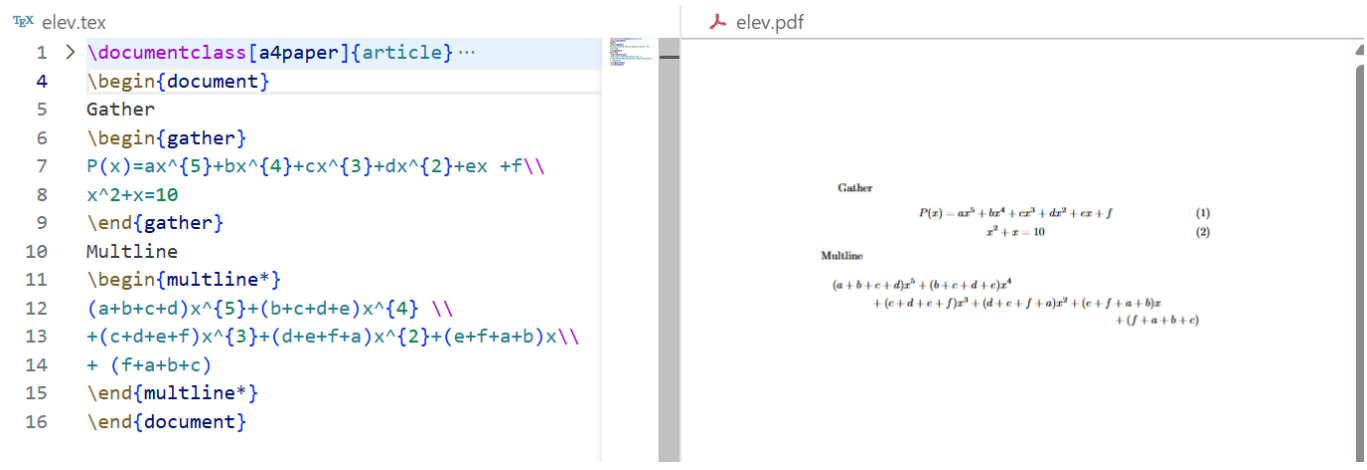
(см. Рис. **¿fig:010?**)

3.4 3.4 Дополнительные выравнивания / Further amsmath alignments

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

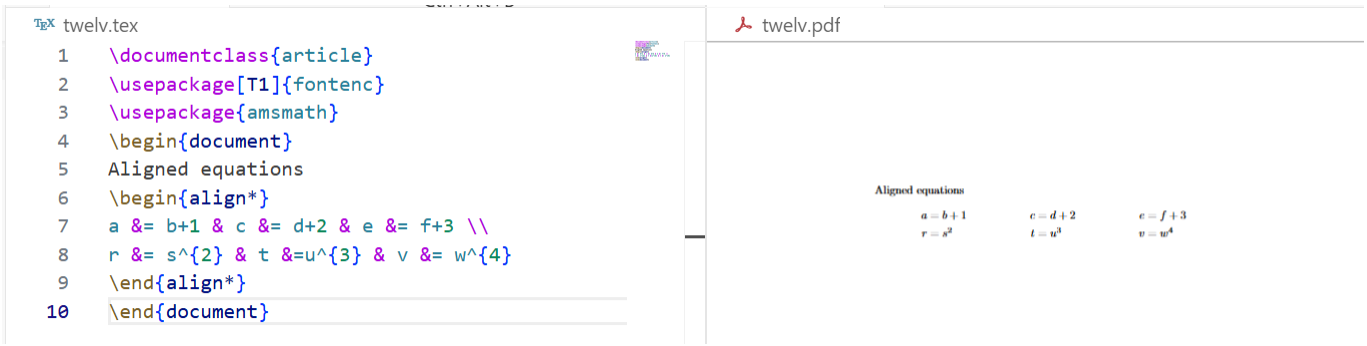
\documentclass{article}
\usepackage{amsmath}
\begin{document}
\begin{gather}
P(x)=ax^{5}+bx^{4}+cx^{3}+dx^{2}+ex+f\\
x^2+x=10
\end{gather}
\end{document}

(см. Рис. **¿fig:011?**)

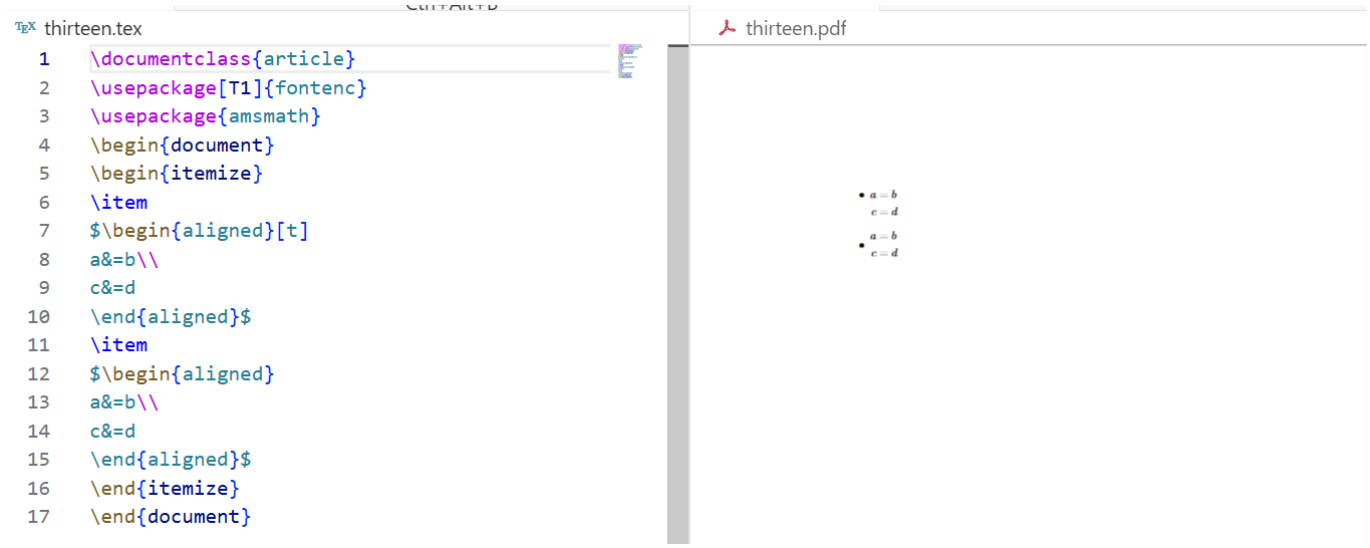


3.5 3.4.1 Columns in math alignments

(см. Рис. **¿fig:012?**)



(см. Рис. **¿fig:013?**)

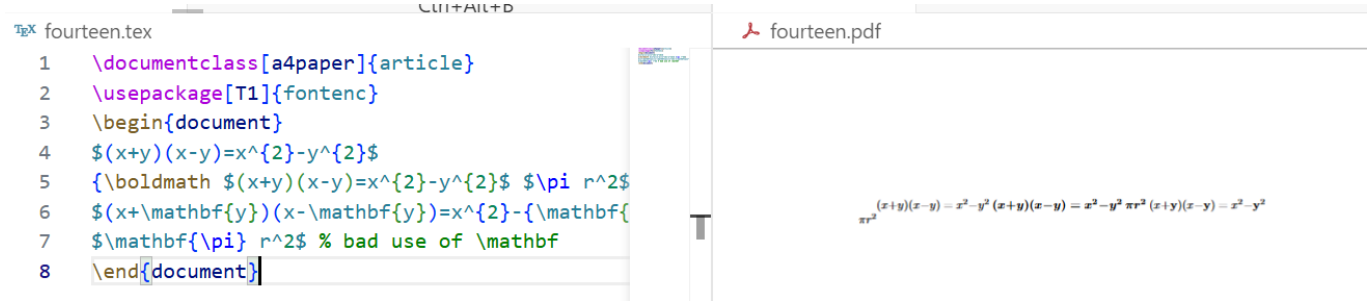


3.6 3.5 Жирный шрифт в формулах / Bold Math

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

\documentclass{article}
\usepackage{bm}
\begin{document}
$(x+\bm{y})(x-\bm{y}) = x^2 - \bm{y}^2$
\end{document}

(см. Рис. **¿fig:014?**)



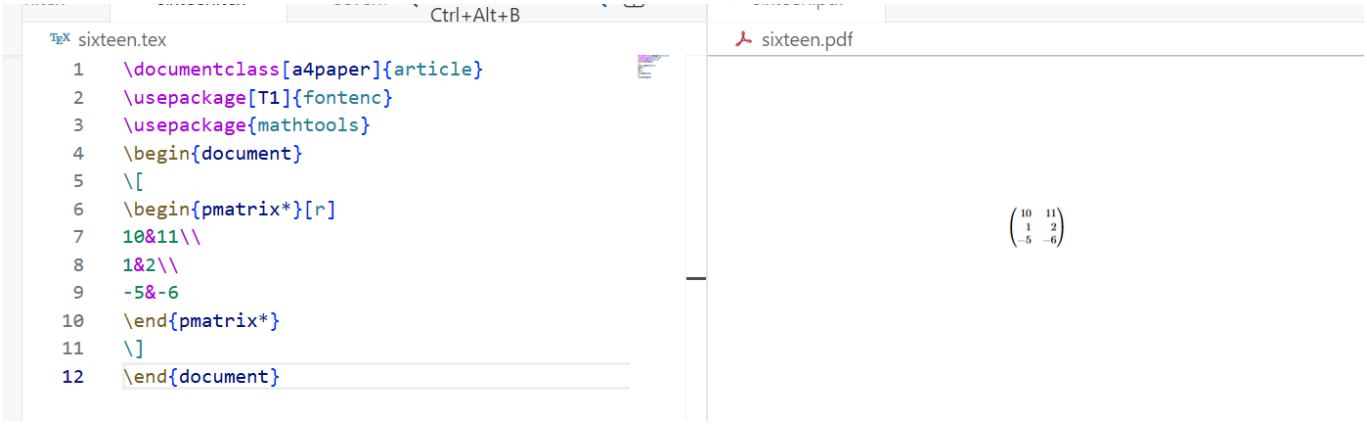
(см. Рис. **¿fig:015?**)

3.7 3.6 Пакет Mathtools / Mathtools package

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

```
\documentclass{article}
\usepackage{mathtools}
\begin{document}
\[
\begin{pmatrix*}[r]
10 & 11 \\
1 & 2 \\
-5 & -6
\end{pmatrix*}
\]
\end{document}
```

(см. Рис. **¿fig:016?**)



3.8 3.7 Юникодная математика / Unicode Math

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

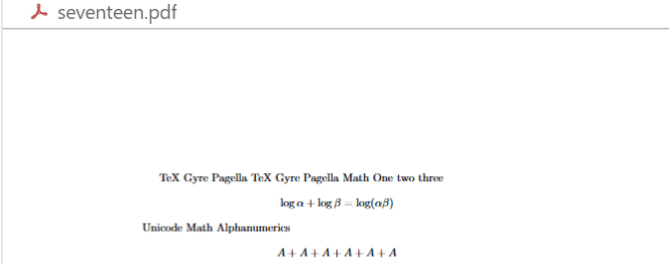
```
\documentclass{article}
\usepackage{unicode-math}
\setmainfont{TeX Gyre Pagella}
\setmathfont{TeX Gyre Pagella Math}
\begin{document}
\[
\log \alpha + \log \beta = \log(\alpha\beta)
\]
\end{document}
```

(см. Рис. **¿fig:017?**)

seventeen.tex

```tex
% !TEX lualatex
\documentclass[a4paper]{article}
\usepackage{unicode-math}
\setmainfont{TeX Gyre Pagella}
\setmathfont{TeX Gyre Pagella Math}
\begin{document}
One two three
\[
\log \alpha + \log \beta = \log(\alpha\beta)
\]
Unicode Math Alphanumerics
\[A + \symfrak{A}+\symbf{A}+ \symcal{A} + \sy
\end{document}
```

seventeen.pdf



4 Выполнение лабораторной работы

4.1 3.8 Упражнения / Exercises

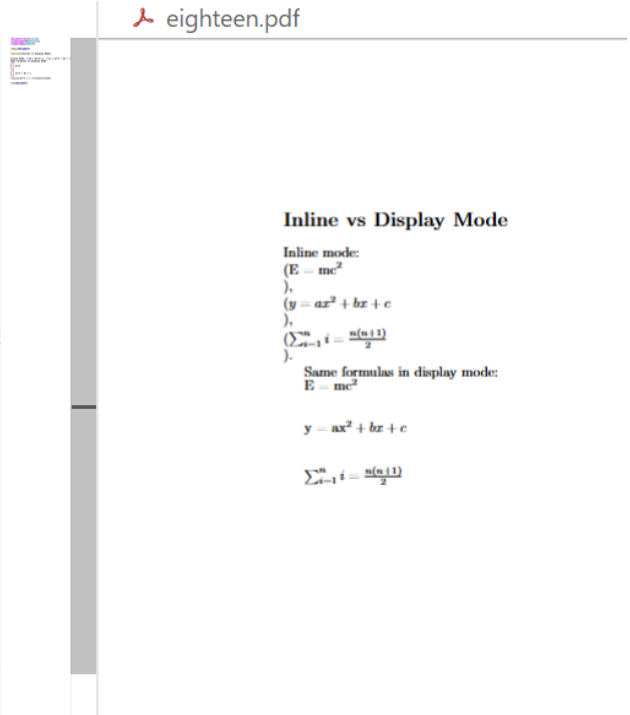
4.1.1 1. Переключение между режимами / Switching between math modes

(см. Рис. **¿fig:018?**)

eighteen.tex > Inline vs Display Mode

```tex
\documentclass{article}
\usepackage[T1]{fontenc}
\usepackage{amsmath}

\begin{document}

\section*{Inline vs Display Mode}

Inline mode: \\(E = mc^2\\), \\(y = ax^2 + bx
Same formulas in display mode:
\\[
E = mc^2
\\]
\\[
y = ax^2 + bx + c
\\]
\\[
\sum_{i=1}^n i = \frac{n(n+1)}{2}

\end{document}
```

eighteen.pdf



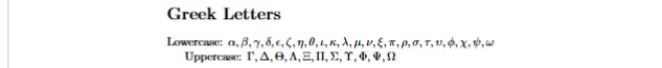
4.1.2 2. Греческие буквы / Greek letters

(см. Рис. **¿fig:019?**)

nineteen.tex > Greek Letters

```
\documentclass{article}
\usepackage[T1]{fontenc}

\begin{document}

\section*{Greek Letters}

Lowercase: $\alpha, \beta, \gamma, \delta, \e

Uppercase: $\Gamma, \Delta, \Theta, \Lambda,

\end{document}
```

nineteen.pdf



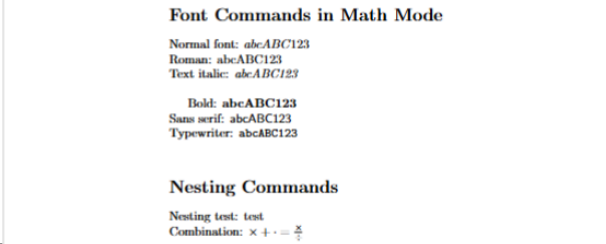
4.1.3 3. Комбинирование шрифтов / Combining fonts

(см. Рис. **¿fig:020?**)

twenty.tex

```
\documentclass{article}
\usepackage[T1]{fontenc}
\usepackage{amsmath,amssymb}  % Added amssymb
\usepackage{amsfonts}         % For \mathfrak

\begin{document}

\section*{Font Commands in Math Mode}

Normal font: $abcABC123$ \\
Roman: $\mathrm{abcABC123}$ \\
Text italic: $\mathit{abcABC123}$ \\

Bold: $\mathbf{abcABC123}$ \\
Sans serif: $\mathsf{abcABC123}$ \\
Typewriter: $\mathtt{abcABC123}$ \\

\section*{Nesting Commands}

Nesting test: $\mathit{\mathrm{test}}$ \\
Combination: $\times + \cdot = \frac{\times}{\div}$

\end{document}
```

twenty.pdf



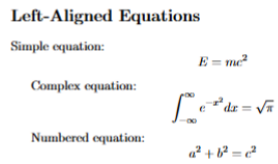
4.1.4 4. Параметры класса документа для уравнений / Equation alignment

(см. Рис. **¿fig:021?**)

twenty one.tex

```tex
\documentclass[11pt]{article}
\usepackage[T1]{fontenc}
\usepackage{amsmath}

\begin{document}

\section*{Left-Aligned Equations}

Simple equation:
\[ E = mc^2 \]

Complex equation:
\[ \int_{-\infty}^{\infty} e^{-x^2} dx = \sqr

Numbered equation:
\[ a^2 + b^2 = c^2 \]

\end{document}
```

twenty one.pdf



Left-Aligned Equations

Simple equation:

$$E = mc^2$$

Complex equation:

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

Numbered equation:

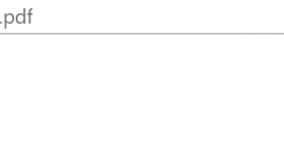
$$a^2 + b^2 = c^2$$

(см. Рис. **¿fig:022?**)

twen22.tex

```tex
\documentclass[leqno]{article}
\usepackage[T1]{fontenc}
\usepackage{amsmath}

\begin{document}

\section*{Left-Side Equation Numbers}

Left-numbered equation:
\begin{equation}
e^{i \pi} + 1 = 0
\end{equation}

Another equation:
\begin{equation}
F = G \frac{m_1 m_2}{r^2}
\end{equation}

\end{document}
```

twen22.pdf



Left-Side Equation Numbers

Left-numbered equation:

(1) $$e^{i\pi} + 1 = 0$$

Another equation:

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

(см. Рис. **¿fig:023?**)

twen23.tex

```
\documentclass[fleqn,leqno]{article}
\usepackage[T1]{fontenc}
\usepackage{amsmath}

\begin{document}

\textbf{Section* (Left-Aligned Equations with

\begin{equation}
    \frac{\partial^2 \varphi}{\partial t^2} =
\end{equation}

\begin{equation}
    \nabla \cdot \mathbf{E} = \frac{\rho}{\va
\end{equation}

\end{document}
```

twen23.pdf

Section* (Left-Aligned Equations with Left-Side Numbers)

(1) $\frac{\partial^2 \varphi}{\partial t^2} = c^2 \nabla^2 \varphi$

(2) $\nabla \cdot \mathbf{E} = \frac{\rho}{\varepsilon_0}$

4.1.5 5. Расширенное использование amsmath / Using Mathtools

(см. Рис. **¿fig:024?**)

twen23.tex | twen24.tex | Ctrl+Alt+B | twen24.pdf

twen24.tex

```
\begin{gather*}
e^{i\theta} = \cos\theta + i\sin\theta \\
\cos^2\theta + \sin^2\theta = 1 \\
\tan\theta = \frac{\sin\theta}{\cos\theta}
\end{gather*}

Multiline equation:
\begin{multline*}
p(x) = 3x^6 + 14x^5y + 590x^4y^2 + 19x^3y^3 \
- 12x^2y^4 - 12xy^5 + 2y^6 - a^3b^3
\end{multline*}

\end{document}
```

twen24.pdf

Advanced amsmath Environments

Multiple alignment:

$$x = y + z$$
$$x^2 = y^2 + 2yz + z^2$$

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

Equation gathering:

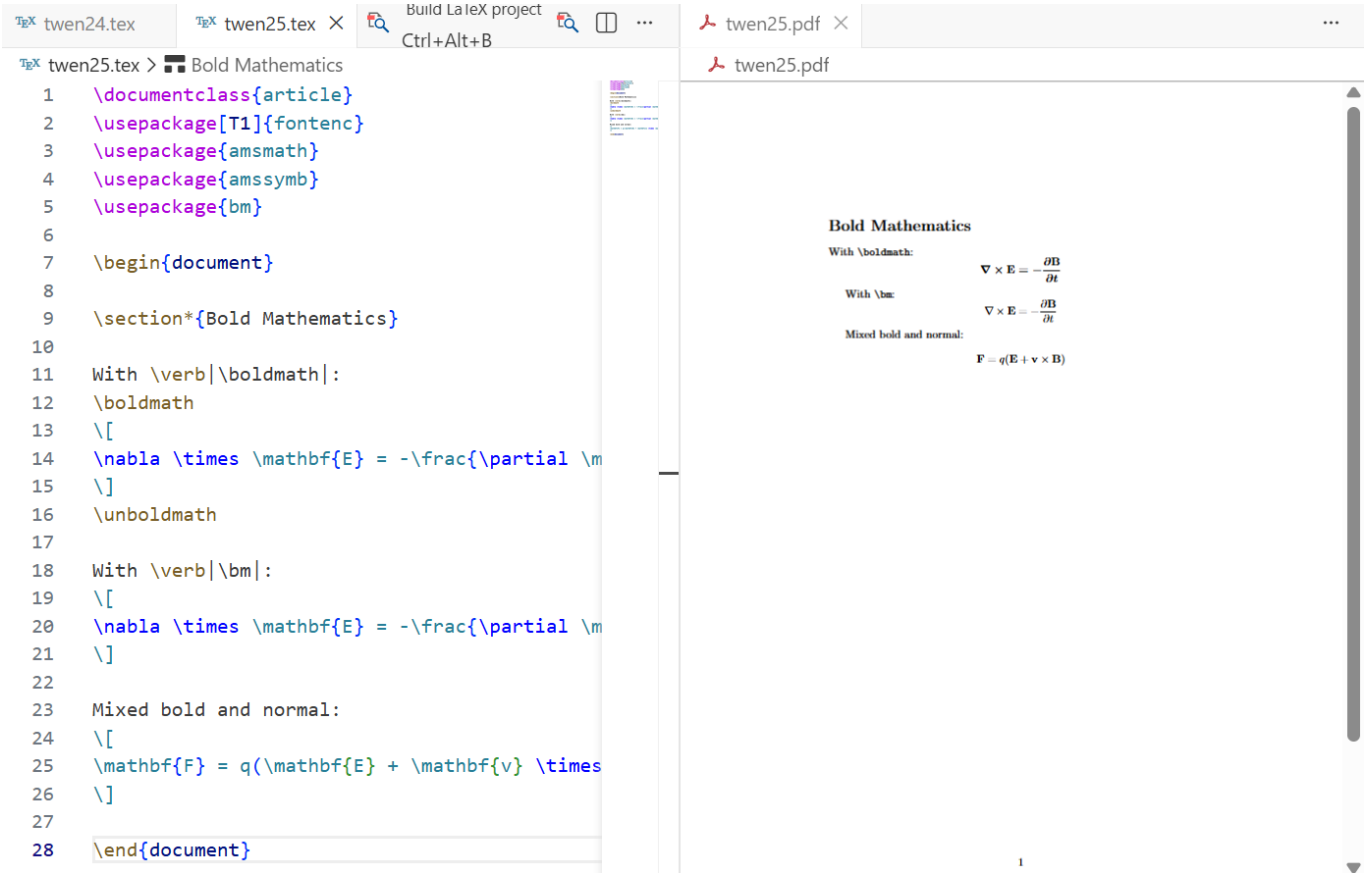
$$e^{i\theta} = \cos\theta + i\sin\theta$$
$$\cos^2\theta + \sin^2\theta = 1$$
$$\tan\theta = \frac{\sin\theta}{\cos\theta}$$

Multiline equation:

$$p(x) = 3x^6 + 14x^5y + 590x^4y^2 + 19x^3y^3 - 12x^2y^4 - 12xy^5 + 2y^6 - a^3b^3$$

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

(см. Рис. **¿fig:025?**)



5 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