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# Using TEX/LATEX typesetting system in preparation of scientific texts

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# About the speaker: Aleksei Tepljakov

- Currently employed at Tallinn University of Technology, Department of Computer Control;
- Main area of research: fractional calculus based modeling and control, fractional-order filters and signal processing;
- Working on the interdisciplinary project FOMCON ("Fractional-order Modeling and Control") and the corresponding MATLAB toolbox;
- PhD student; thesis topic in present form: "Fractional calculus based identification and control of complex dynamic systems";
- Further research interests: control of complex nonlinear systems, quantum mechanics in control.

# Talk overview

- Introduction: what is TEX (LATEX) and why use it, brief development history, applications in publishing;
- Brief introduction to the LATEX language;
- Software overview: TEX/LATEX implementations, editors, BibTEX bibliography management;
- Important considerations when working with LATEX;
- References for further reading.

# Intoduction: the name of the game

- TEX is a highly sophisticated typesetting program which allows to create professionally designed documents in digital format. The emphasis is on technical texts, thus it has a powerful engine for typesetting mathematics.
- LATEX is a document markup language and document preparation system built on top of the TEX engine. It facilitates the use of the typesetting platform and is based on the idea that the author of the text should focus on the content of the document, not the design.

Since it is not possible to cover the full scope of these systems (especially TEX) in a relatively short talk, the following presentation will be mostly devoted to LATEX.

# Why use TEX/LATEX?

- Professionally crafted layouts are available, based on years of typesetting experience, resulting in high-quality print documents following strict format rules;
- Outstanding typesetting quality of mathematical formulae;
- LATEX takes care of the logical structure of the document, complex structures (footnotes, references, table of contents, bibliographies and so on) can be generated easily;
- There exists an abundance of packages for LATEX, implementing numerous features and extending the basic typesetting capabilities of the system;
- TEX/LATEX are **free** and highly portable and run on almost any hardware platform and computer operating system.

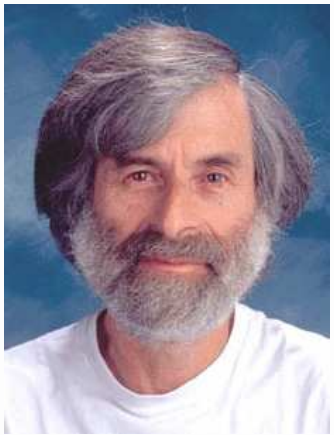
# History: TEX origins

On 30 of March, 1977, Donald Knuth was presented with galley proofs of the second volume of his book "The Art of Computer Programming". He was rather frustrated with the quality of the print: around that time digital typography was becoming increasingly popular. Knuth decided that his input to this field was in order. What became of that decision is the birth to one of the greatest computer-based typesetting tools: TEX.

Since then the TEX system has seen some changes. The fundamental version 3.0 was released in 1989. Further development is frozen and only bug fixes are provided. Current version of TEX is $3.1415926$ (the version number it is approaching $\pi$).

# History: LaTeX origins

The LaTeX system was originally written in the early 1980s by Leslie Lamport. Since then it has been continuously developed by the community. The version that we use today is LaTeX $2_\varepsilon$.



LaTeX is intended to provide a high-level language that uses the power of TeX. LaTeX essentially comprises a collection of TeX macros and a program to process LaTeX documents. Since the TeX formatting commands are low-level, it is usually much simpler for end-users to use LaTeX.

Consecutively, the main idea of LaTeX is the following: **authors should be able to focus on the content of what they are writing without being distracted by its visual presentation**.

# LaTeX applications in scientific publications

- Books (original development aim by Knuth);
- Other manuscripts (conference papers, journal articles, etc.)
  - All major technical conferences and journals provide specific TeX/LaTeX templates;
- Presentation slides (like those in front of you);
- Web-publications
  - Direct (X)HTML output (not very recommended);
  - Web-based LaTeX syntax-compatible libraries.

# Brief introduction to LaTeX: example source

```latex
\documentclass[12pt]{article}
\usepackage{amsmath}
\title{\LaTeX}
\date{}
\begin{document}
  \maketitle
  \LaTeX{} is a document preparation system for the \TeX{}
  typesetting program. This is a simple example of the \LaTeX{}
  language and the resulting document.
  % This is a comment; it will not be shown in the final output.
  \begin{align}
    E &= mc^2                                    \\
    m &= \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}}
  \end{align}
\end{document}
```

# Brief introduction to LaTeX: example result

LaTeX

LaTeX is a document preparation system for the TeX typesetting program.
This is a simple example of the LaTeX language and the resulting document.

$$E = mc^2 \tag{1}$$

$$m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{2}$$

# TEX/LATEX implementations

In order to use TEX/LATEX, one needs to install one of the available platform implementations. Among the popular ones are

- MikTEX (Windows): current version: 2.9, link: `http://miktex.org/`.
- TEX Live (Unix, Windows): current version: 2012, link `http://www.tug.org/texlive/`.
- MacTEX (MacOS): current version: 2012, link: `http://www.tug.org/mactex/`.

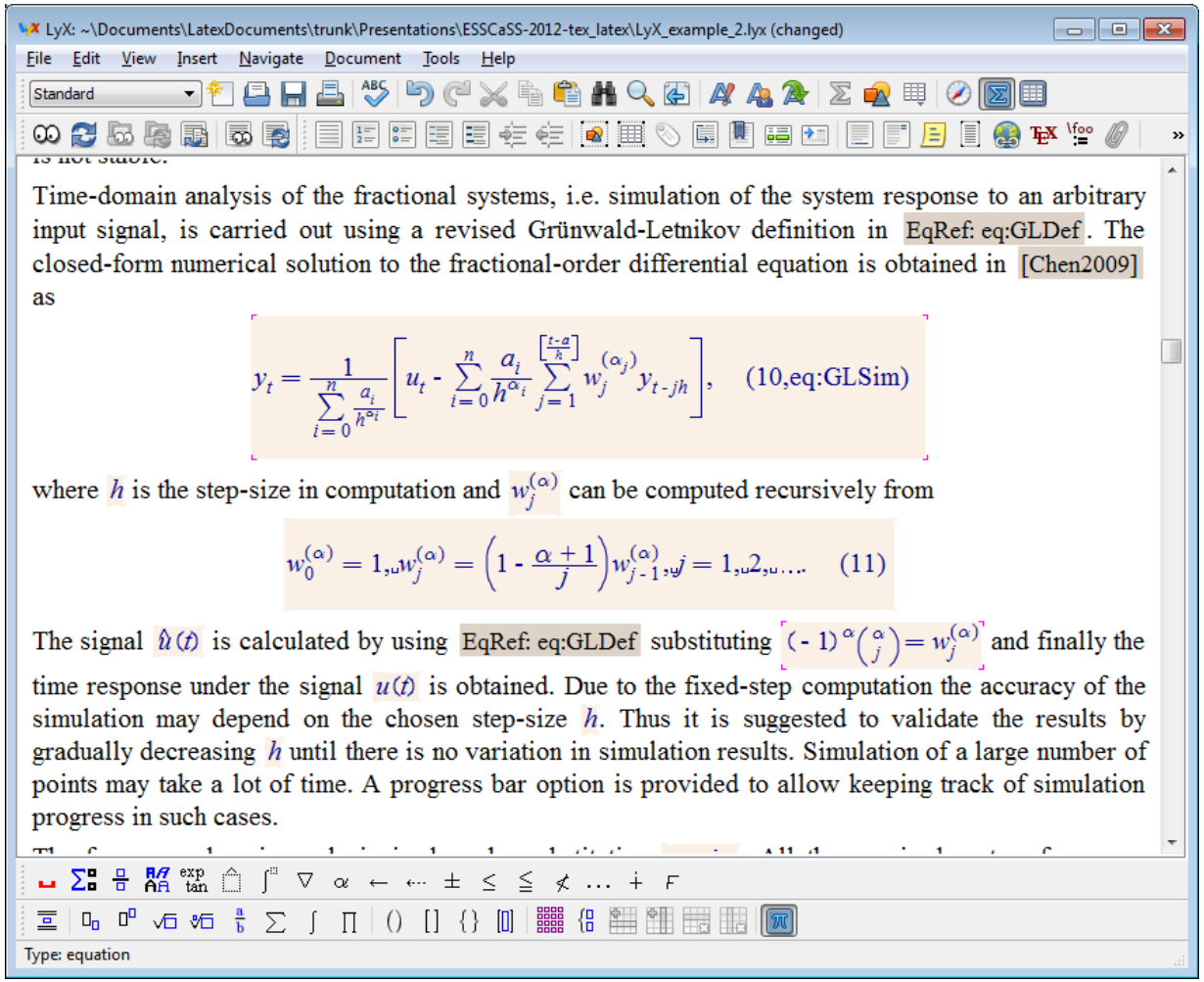
These contain the required binaries as well as a number of packages required to work with TEX/LATEX documents. Next, let us take a look at some of the available TEX/LATEX editors.

# TEX/LATEX editors

- LyX (`http://www.lyx.org/`): the WYSIWYM (What You See Is What You Mean) document processor. It provides a graphical interface similar to that of Microsoft Office Word and comes with a fully integrated equation editor.
- TEXlipse (`http://texlipse.sourceforge.net/`): the pure TEX/LATEX editor in the form of an Eclipse platform plugin. Has syntax highlighting, code completion and hinting and facilitates work with references.
- JabRef (`http://jabref.sourceforge.net/`): BibTEX bibliography editor.

All of these applications are cross-platform and should run equally well on Windows, Linux, and MacOS.

# LyX: example source



# LyX: example result

Time-domain analysis of the fractional systems, i.e. simulation of the system response to an arbitrary input signal, is carried out using a revised Grünwald-Letnikov definition in (3). The closed-form numerical solution to the fractional-order differential equation is obtained in [7] as

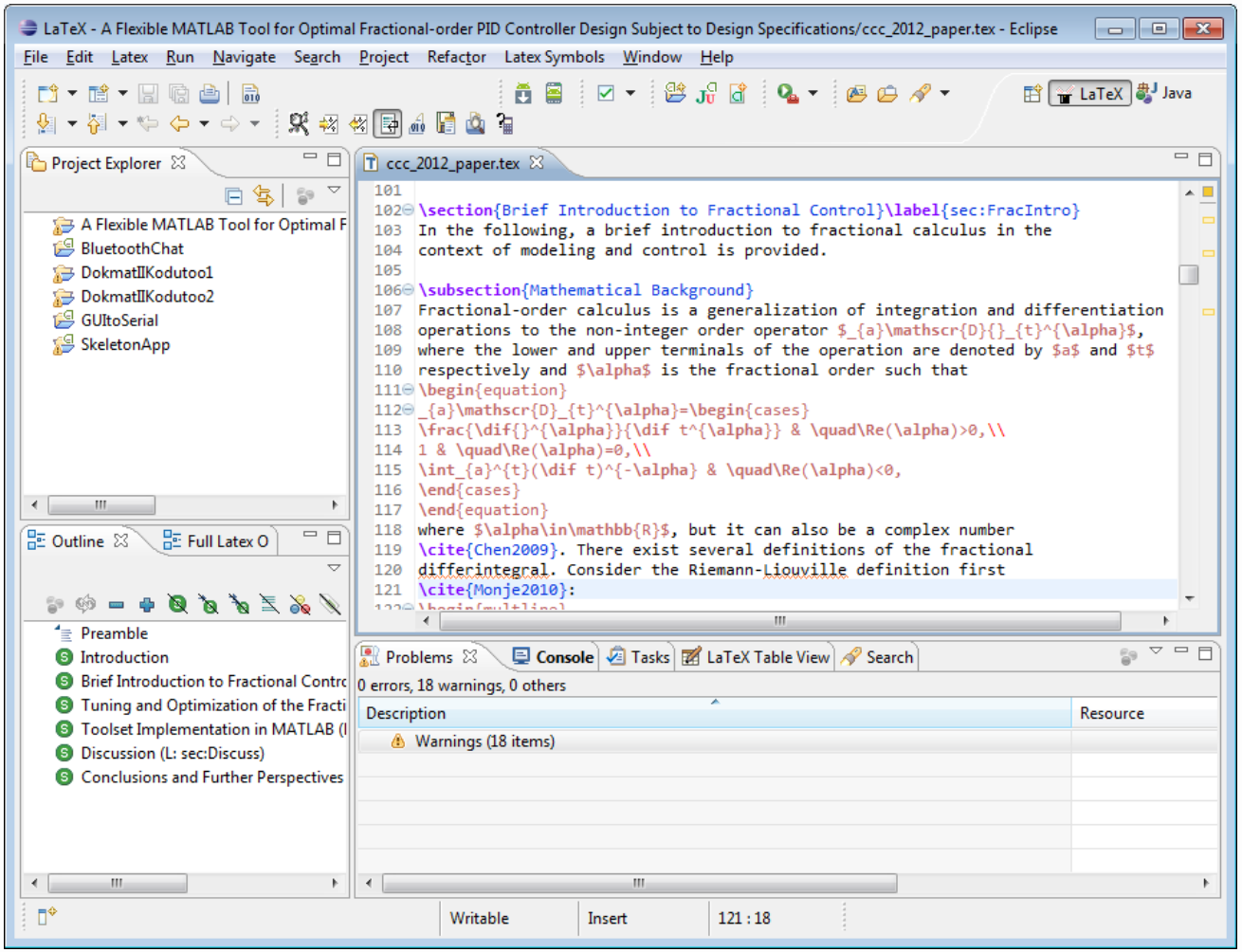
$$y_t = \frac{1}{\sum_{i=0}^{n} \frac{a_i}{h^{\alpha_i}}} \left[ u_t - \sum_{i=0}^{n} \frac{a_i}{h^{\alpha_i}} \sum_{j=1}^{\left[\frac{t-a}{h}\right]} w_j^{(\alpha_j)} y_{t-jh} \right], \tag{10}$$

where $h$ is the step-size in computation and $w_j^{(\alpha)}$ can be computed recursively from

$$w_0^{(\alpha)} = 1,\ w_j^{(\alpha)} = \left(1 - \frac{\alpha+1}{j}\right) w_{j-1}^{(\alpha)},\ j = 1,\ 2,\ \ldots. \tag{11}$$

The signal $\hat{u}(t)$ is calculated by using (3) substituting $(-1)^{\alpha}\binom{\alpha}{j} = w_j^{(\alpha)}$ and finally the time response under the signal $u(t)$ is obtained. Due to the fixed-step computation the accuracy of the simulation may depend on the chosen step-size $h$. Thus it is suggested to validate the results by gradually decreasing $h$ until there is no variation in simulation results. Simulation of a large number of points may take a lot of time. A progress bar option is provided to allow keeping track of simulation progress in such cases.

# TEXlipse: example source



# TEXlipse: example result

## 2 Brief Introduction to Fractional Control

In the following, a brief introduction to fractional calculus in the context of modeling and control is provided.

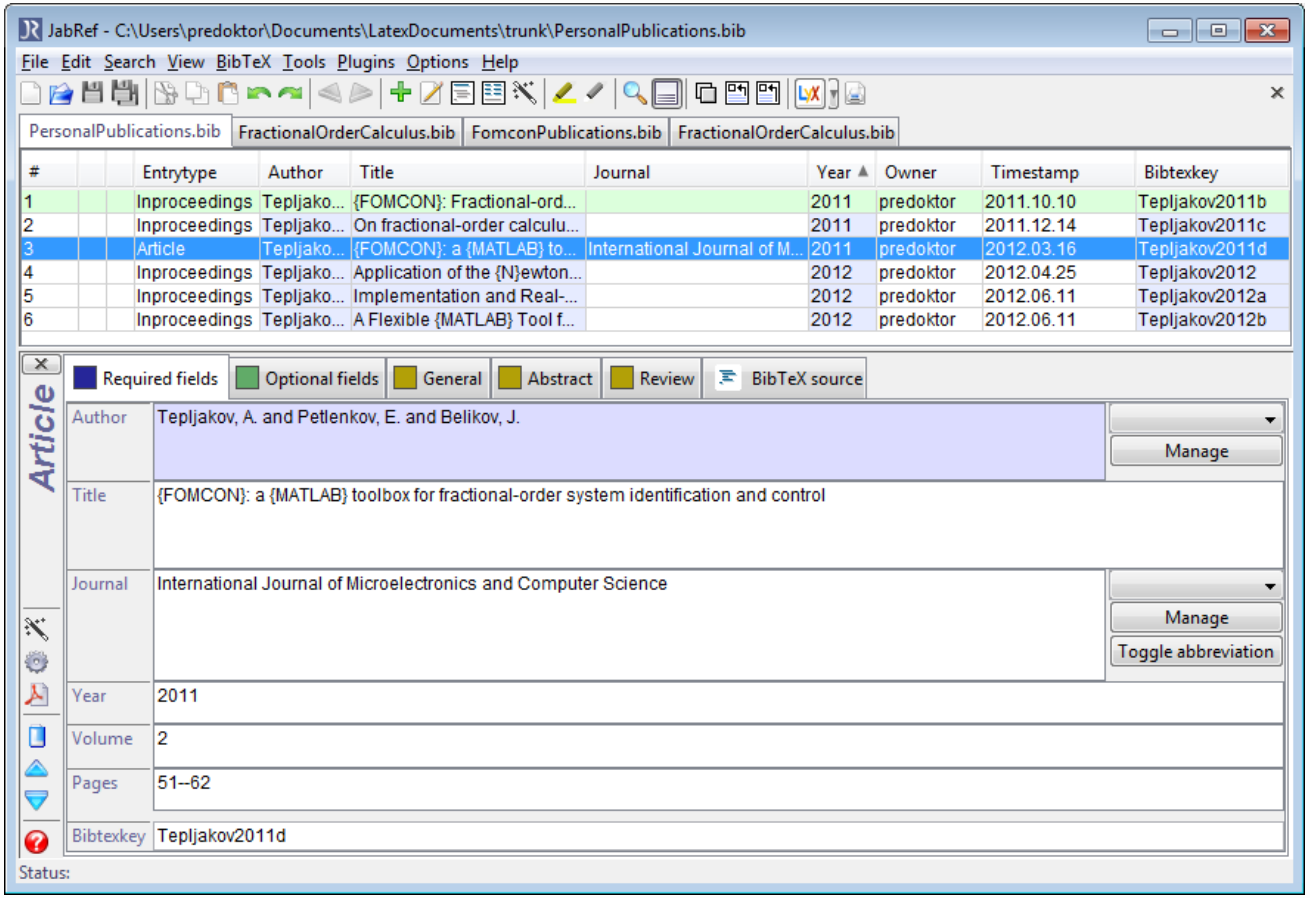
### 2.1 Mathematical Background

Fractional-order calculus is a generalization of integration and differentiation operations to the non-integer order operator ${}_a\mathscr{D}_t^\alpha$, where the lower and upper terminals of the operation are denoted by $a$ and $t$ respectively and $\alpha$ is the fractional order such that

$$ {}_a\mathscr{D}_t^\alpha = \begin{cases} \frac{\mathrm{d}^\alpha}{\mathrm{d}t^\alpha} & \Re(\alpha) > 0, \\ 1 & \Re(\alpha) = 0, \\ \int_a^t (\mathrm{d}t)^{-\alpha} & \Re(\alpha) < 0, \end{cases} \tag{1} $$

where $\alpha \in \mathbb{R}$, but it can also be a complex number [5]. There exist several definitions of the fractional differintegral. Consider the Riemann-Liouville definition first [6]:

# JabRef: BibTeX bibliography files



# BibTEX generated bibliography

**Publications**


[1] A. Tepljakov, E. Petlenkov, and J. Belikov, "Application of the Newton method to first-order implicit fractional transfer function approximation," in *Proc. 19th Int Mixed Design of Integrated Circuits and Systems (MIXDES) Conference*, A. Napieralski, Ed., 2012, pp. 473–477.

[2] A. Tepljakov, E. Petlenkov, and J. Belikov, "FOMCON: Fractional-order modeling and control toolbox for MATLAB," in *Proc. 18th Int Mixed Design of Integrated Circuits and Systems (MIXDES) Conference*, A. Napieralski, Ed., 2011, pp. 684–689.

[3] A. Tepljakov, E. Petlenkov, and J. Belikov, "Implementation and real-time simulation of a fractional-order controller using a MATLAB based prototyping platform," in *Proc. 13th Biennial Baltic Electronics Conference*, 2012, accepted for publication.

[4] A. Tepljakov, E. Petlenkov, and J. Belikov, "A flexible MATLAB tool for optimal fractional-order PID controller design subject to specifications," in *Proceedings of the 31st Chinese Control Conference*, W. Li and Q. Zhao, Eds., Hefei, Anhui, China, 2012, pp. 4698–4703.

[5] A. Tepljakov, E. Petlenkov, and J. Belikov, "On fractional-order calculus applications to industrial control problems," in *Proc. of the Fifth IKTDK Information and Communication technology Doctoral School Conf.* Tallinn, Estonia: Tallinn University of Technology, 2011, pp. 47–50.

[6] A. Tepljakov, E. Petlenkov, and J. Belikov, "FOMCON: a MATLAB toolbox for fractional-order system identification and control," *International Journal of Microelectronics and Computer Science*, vol. 2, no. 2, pp. 51–62, 2011.

# TEX/LATEX: important considerations

- Some problems with Unicode may arise (TEX/LATEX do not support it by default);
- The user is limited to a limited set of fonts compatible with the TEX typesetting system.

Solution: use XeTEX/XeLATEX to prepare documents in Unicode. LYX automatically does this for you in most cases. But pay attention to the chosen document language! Choose "English" for the bibliography section, or you will run into problems.

- With some TEX/LATEX format converters, manual image conversion needs to be done;
- Creation of new structure elements requires TEX proficiency.

# TEX/LATEX: further reading

- Donald Knuth, *The TEXbook*, 15th ed. Addison-Wesley, 1989: `http://www.ctan.org/tex-archive/systems/knuth/dist/tex/`;
- Tobias Oetiker, *A Not So Short Introduction To LATEX 2ε*: `http://www.ctan.org/tex-archive/info/lshort/`;
- The Comprehensive TEX Archive Network: `http://www.ctan.org/`;
- TEX Users Group: `http://www.tug.org/`.

> — You learn best by doing.

# Discussion

Thank you for listening!