

# PREPARING A DISSERTATION FOR THE DEGREE OF *Candidate of Sciences*: A 10-MINUTE GUIDE

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October 5, 2024

## Preface

This brief guide is intended for *Skoltech* PhD students who are about to start writing their dissertation in the *Candidate of Sciences* format and are wondering where to start. It provides a collection of practical advices and common phrases used to write particular sections of a dissertation to help students interpret the structure and formatting rules set by the System of standards of the Russian Federation on information, librarianship and publishing, commonly referred as GOST R 7.0.11-2011.

Assuming you have made major scientific breakthroughs and published a couple of high-quality papers in prestigious journals, you are ready for the next step – organizing your material into the format, suitable for the dissertation in the *Candidate of Sciences* format. The amount of effort you will have to put into preparing your thesis will strongly depend if your papers are written in  $\text{\LaTeX}$  or MSWord.

For those of you, who wrote your papers in MSWord and is planning to stay in academia, my personal *biased* advise is to **learn**  $\text{\LaTeX}$  and make a commitment to **never again** write a paper in MSWord. The experience of rearranging the material from your papers into the dissertation format will be painful enough for you to realize that MSWord is not intended for scientific purposes and to switch to  $\text{\LaTeX}$ .

For those of you, who have written your papers in  $\text{\LaTeX}$  your life will be easy, because what you need to do is to download the Russian PhD  $\text{\LaTeX}$  Dissertation Template from GitHub: <https://github.com/AndreyAkinshin/Russian-Phd-LaTeX-Dissertation-Template> and follow the instructions provided there. All the formatting, citations, bibliography will be done by the  $\text{\LaTeX}$  template itself. There would be few places in `common/data.tex`, `common/newnames.tex`, `common/renames.tex`, `Dissertation/disstyles.tex` files in the template, where you will need to change names from Russian to English. In the future *Skoltech* is planning to distribute the *Skoltech*-specific  $\text{\LaTeX}$  form with all the modifications made.

## 1. How to write an introduction

Typically, the most confusing part of a dissertation in the *Candidate of Sciences* format is an introduction. To strictly follow the dissertation preparation guidelines, the introduction should consist of specific sections, each having its distinctive purpose. Many students are often confused about what needs to be written in each section and, as a result, some requirements may not be properly addressed, possibly inducing unnecessary complications at later stages of the defense. Below each required section, listed in the sequence it should appear in the dissertation, is briefly discussed. For better understanding of what needs to be covered in each section a few common phrases used to write each part are provided.

**The relevance of the research area. The degree of its development.** This section can be viewed as a brief literature review but with the main emphasis on the significance of the research area, recent progress, impact on science and/or industry, etc. The work conducted in the area ought to be discussed with the appropriate references, the issues that are already addressed need to be mentioned, the problems that are not addressed or partially addressed should be highlighted and the contemporary importance of the research direction needs to be clearly articulated. In this section one can discuss if the area has been abandoned in the past due to the lack of progress, lack of tools and why now it is the right time to resurrect the research. If the area is “hot” now with many scientists actively pursuing research, articulate how your research fits its main agenda.

**Goals and problems addressed.** There are two common mistakes that are often made. The first concerns the objectives of the dissertation. On many occasions I have seen the phrases like “The main objective of the dissertation is to **study** ...”. This is completely wrong! The *process* doing something abstract can not be the goal, the goal should be more concrete, e.g., to develop a theory, a model or a methodology, to demonstrate the applicability of a model, a theory or a methodology, etc.

The second mistake often comes from an incorrect interpretation of the Russian phrase “*цели и задачи*”. The correct interpretation of the phrase is “**goals and problems addressed**”. Other interpretations like “*goals and objectives*”, “*aims and goals*”, and “*goals and tasks*” are **incorrect**. The first two are incorrect because both words are synonyms, the last one is because a *task*, often technical, is usually assigned by someone (which should not be the case for the PhD research), while a *problem* is a challenge that is addressed in the dissertation. For this reason a common phrase, which can be used in the dissertation is “To achieve the goal of the dissertation, the following problems are addressed:”, usually followed by the list of the specific problems that are solved in the dissertation. This should not be confused with the “main results submitted for the defense,” discussed later. The problems are more specific, they could be of technical, theoretical, or experimental nature. The main results are more grandiose and usually require the solution of many problems to achieve them.

**Scientific novelty.** The common mistake often made by students in this section is listing the problems solved, instead of focusing on *novelty*. A problem could have been solved a long time ago, but in the dissertation the problem might be addressed using an alternative formulation or solved using a novel approach, developed by the student. Thus, this section

should focus on what is novel, e.g., the new model for unstudied behavior is developed, new regimes are described, the theory is generalized, etc. Basically in this section the candidate should describe not what was addressed, but only *novel* aspects that have been developed, discovered, etc. The common phrases for this section are:

- The thesis presents a fundamentally new (method, approach, etc.) ... with unique properties that distinguishes it from all known ...
- The dissertation also presents the novel (model, method, theory, approach etc.) developed by the author ...
- The author's groundbreaking results also include ...

**Theoretical and practical significance.** In this section the results of the dissertation that have theoretical and/or practical significance need to be mentioned. For example, if a new approach/theory sets the foundation for the research direction, mention how you envision this direction will develop and what impact it might have. If theory/method or results are applicable in other fields, list these fields and how they could be affected by the discovery. If the approach has the potential to expand, describe the directions of expansion/generalization that you envision. Make sure the significance is explained in plain terms, understandable to a general reader, especially if the results of the dissertation can affect other fields.

**Methodology and research methods.** This section should mainly focus on **tools** that are used to achieve the results and not on the achievements of the author of the dissertation. It should contain methods, theories, approaches, experimental procedures or facilities that the research is either based on or used to validate/verify the results.

**Main results submitted for the defense.** This section is of primary importance, because the main results, reported in this section, would need to be listed verbatim during the defense and the presentation for the dissertation defense should be built around this list. This section should be distinguished from the "*goals and problems solved*" section, where mainly small and technical problems, solved in the dissertation, are listed. The main results submitted for defense should be more grandiose in scope and should be easily assessable. For example, a theory or model is developed, a theorem is proved, a method is proposed, a new phenomenon is discovered, etc. Another important aspect that needs to be emphasized is that the results submitted for the defense should be unique. For example, for a group of PhD students working in the same lab and on the same scientific problem, the set of main results should be different from each other and clearly distinguishable. The items listed in this section should be the ones the author of the dissertation should be known for. Remember, the dissertation is the accumulation of research accomplishments, demonstrating substantial progress in the field. Note that the dissertation does not need to address all the open questions of the field, but it should consist of measurable significant research achievements, that are claimed by the author and are the subject of the defense.

**Personal contribution of the author.** In this section the author should clarify his/her contribution to each particular paper, the dissertation is based on, or chapter/section of the dissertation, especially if the paper has multiple authors or if the material of the paper/dissertation could be used in the dissertation by the other student. The research is always multifaceted, it

is common when many people make significant contributions to a scientific breakthrough, the author should substantiate the nature of the contribution and when applicable, emphasize that the contribution is **defining**. If the author describes his/her contributions incorrectly, that could be the sole reason for dismissal of the dissertation. Thus, the individual contributions should be described accurately, so the defense committee can decide if the contributions are sufficient to accept the dissertation for the defense.

**Validity of the obtained results.** One of the main confusion about this section is that many students describe only methods used to validate the results, e.g., comparison of the results of numerical simulation and experiment. Note that validation is more general concept, for example reproducibility of the results should also be addressed in this section as well. A typical section would contain the statement “The validity of the results of the dissertation is confirmed by the following.” Commonly used phrases for this section are:

- All developed methods are described in detail in ...
- The developed methods are implemented in ...
- The results ... are in agreement with published experimental and/or computational results obtained by ...

**Approbation.** This section could be a stand alone section or combined with the validity section. It should list the documents or public occurrences where the results of the dissertation are presented. Commonly used phrases for this section are:

- The main results on the topic of the dissertation resulted in [number] of publications [cite all publication here], [number] of which – in periodical scientific journals or publications indexed by Web of Science or Scopus [cite all publication here], [number] – in conference abstracts [XX-XX].
- The results of the dissertation were presented at the following international conferences: (list the conferences).

**Dissertation structure.** This section should contain the following statement: “The dissertation consists of an introduction, [number] chapters, and a conclusion. The dissertation is [number] pages long, including [number] figures, [number] algorithms, and [number] tables. The list of references contains [number] titles including [number] of publications by the author.

**Organization of the Dissertation.** Writing a small paragraph on dissertation structure alone without further elaboration on the organization of the dissertation is completely inadequate. The dissertation should contain the description how it is organized, i.e., the description what each chapter is all about. Basically, it can be viewed as a shorter version of the *dissertation abstract* without equations, figures, and illustrations, but with references to sections of the dissertation and bibliography. People reading this part should get an idea what the dissertation is all about and what the main results of each section are.

## 2. How to organize chapters

Ideally, each chapter of the dissertation should be based on at least one full-length peer-reviewed journal publication. As a result, students have a tendency to put the whole paper in the chapter with its own introduction and conclusion. This practice is highly discouraged. The dissertation should have only one introduction and one conclusion section. If an author wants to provide specific to the chapter background, which is not mentioned in the general introduction, it can be easily done by adding a section at the beginning of the chapter with either a descriptive title or without a title at all. The material used in the introduction of the corresponding article should be stripped out of the statements already mentioned in the general introduction. Additional discussion to provide essential background, necessary for the description and/or understanding of the material in the chapter may be added as well.

## 3. How to write conclusions

The conclusion section should be aligned with the goals of the dissertation and the main results submitted for the defense. By no means it should be a simple repetition of the material in the introduction, where the reader was just getting familiar with the content of the dissertation. Instead it should be the highlight of the dissertation and written for those, who have already read your dissertation. After an introductory paragraph devoted to the main objectives and possibly novelty, there could be a simple statement like “The main results of the dissertation are:”, followed by the list of the main results in the same order they were listed in the “*main results submitted for the defense*” section, but with more detailed description and specifics, relevant to the problems solved in the dissertation, as well as relating them to particular achievements, findings, conclusions, implications, etc. This section should emphasize the most important aspects of the work, yet it should be concise and descriptive. Remember, too many words may have opposite effect and dilute the impression on the impact and quality of the research.

Finally, it is strongly recommended to add some material on possible future extensions and limitations of the work. It would be good to align the discussion with both theoretical and practical significance of the results of the dissertation. For example it can mention that the method/approach developed in the dissertation is a new promising direction in such and such field of research, further development of which would contribute to progress in the field of . . . . The need for the future research should be elaborated. The section could be followed with the statement like “The most promising directions for further development of the research are:”, followed by itemized list of directions with some information on preliminary research done in each area or some justification/elaboration, why the author envisions these directions to be promising.

At the end of the conclusion it is highly recommended to put an acknowledgment paragraph, where you thank your adviser, PhD committee members, collaborators, and other people who helped you or supported you during the dissertation. Be generous and specific. Commonly used phrases for this section are:

- the author extremely grateful to . . . for guidance, support, . . .

- the author expresses his deep gratitude to ...for fruitful cooperation in ... ,
- the author thanks ...for invaluable help in the realization and development of the ...
- the author would like to thank ...for support, encouragement, discussion, ...
- the author appreciates ...insightful contributions, support, guidance, patience, ...
- the author extends his/her highest appreciation to ...
- the author would like to give a special thanks to ...for ...
- the author is thankful for [computer time, facilities, etc.] provided by ...

Note that since this paragraph is a part of the conclusions it is recommended to write this section from the third person of view.

#### 4. How to organize the bibliography

For those of you, who use the PhD L<sup>A</sup>T<sub>E</sub>X Dissertation Template for organizing the dissertation the formatting of the bibliography is done automatically. For those of you who use MSWord, even with tools like *Mendeley*, most likely you will need to do extra work yourself to format the bibliography to comply to GOST standard. Usually there are two common mistakes in organizing the bibliography. The first is incorrect organization. The bibliography should consist of two parts:

1. first is the references to other people work starting with articles written in English, followed by the articles published in Russian or other languages;
2. the second part should have a separate subtitle “Publications of the Author on the Subject of the Dissertation” followed by the list of author’s own work.

The second common mistake is that references do not satisfy the GOST standard. The rule is simple, each bibliography item should start with the **only** first author name and initials, followed by the title and the complete list of authors and other items depending whether the paper was published in a journal, conferences proceeding, etc.

An example of a bibliography with a variety of English and Russian references followed by the references to the work of the author of the dissertation is shown below.

## Bibliography

1. Angot, P. Analysis of singular perturbations on the Brinkman problem for fictitious domain models of viscous flows / P. Angot // Mathematical Methods in the Applied Science. — 1999. — Vol. 22. — P. 395–1412.
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100. Владимиров, В. С. Уравнения математической физики / В. С. Владимиров. — 5е издание. — Наука, 1988.
101. Годунов, С. К. Разностный метод численного расчета разрывных решений уравнений гидродинамики / С. К. Годунов // Математический Сборник. — 1959. — Т. 47, № 89. — С. 271–306.
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199. Федоренко, Р. П. О скорости сходимости одного итерационного процесса / Р. П. Федоренко // Журнал вычислительной математики и математической физики. — 1964. — Т. 4, № 3. — С. 559–564.

## Publications of the Author on the Subject of the Dissertation

200. Author, N. I. Title of the first article / N. I. Author, N. I. Second, N. I. Third // Journal Name. — 2015. — July. — Vol. 141, 690A. — P. 1712–1726.
201. Author, N. I. Title of the second article / N. I. Author, N. I. Second, N. I. Third // Journal Name. — 2014. — Vol. 262. — P. 344–357.
202. Автор, И. О. Название книги / И. О. Автор, И. О. Второй — Название Издательства, 2024.
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205. Автор, И. О. Название последней статьи / И. О. Автор, И. О. Второй, И. О. Третий, И. О. Четвертый // Название журнала. — 2018. — Т. 30, № 5. — С. 117–133.