APPROVED
Computer Modelling
Study Program Committee
At the sitting of 26 February 2016 (protocol No. 3)

VILNIUS UNIVERSITY
FACULTY OF MATHEMATICS AND INFORMATICS
INSTITUTE OF COMPUTER SCIENCE
DEPARTMENT OF COMPUTATIONAL AND DATA MODELING

COMPUTER MODELING STUDY PROGRAM
REQUIREMENTS FOR MASTER SCIENTIFIC RESEARCH PROJECT AND FOR FINAL MASTER THESIS

1. General information

In the study program „Computer Modeling" the following subjects are devoted to the preparation of the master's Scientific Research Project and the Final Master Thesis:

2nd semester (spring)	„Scientific Research Project"	9 credits 235 working hours of a master's student
3rd semester (autumn)	„Final Master Thesis"	30 credits 800 working hours of a master's student

In preparing and defending the Scientific Research Project and the Final Master Thesis, postgraduates must acquire skills in the design and implementation of research work and research results.

Both the Scientific Research Project and the Final Master Thesis are independent scientific works, which are subject to requirements such as relevance, justification and completeness of the topic.

2. Thesis topic, supervisor and reviewer

The topic of the dissertation and the supervisor are chosen by the date set by the Department of Computational and Data Modeling. If not chosen in time, the supervisor and the topic are assigned by the department. When choosing a topic, it is first necessary to **reconcile** this decision with a possible supervisor. If a topic that is not in the list of topics published by the Department of Computational and Data Modeling has been agreed with the supervisor, the title of the topic in Lithuanian and English must be communicated to the person responsible for the coordination of studies at the department (e-mail: `infokk@mif.vu.lt`). The topic of the work must be the field of research.

The reviewer of the work is selected at least 1 month before the defense of the „Scientific Research Project". It is desirable that the reviewer be nominated and approved by the supervisor. If a reviewer is not found in time, he/she is appointed by the Department of Computational and Data Modeling.

In different semesters, the topic of the thesis may (but does not have to) be the same. The adjustment of the topic must be agreed with the supervisor upon writing the request on changing the subject of the work.

The work manual can be changed by writing a reasoned request indicating both the new manual and the topic. The request to change the supervisor must be approved (by signing): the former supervisor (his signature is not obligatory, but desirable), the future supervisor (signature is obligatory).

3. Requirements for work content

☞ The work must be neat, written in a scientific style, in **correct** Lithuanian or English.

Each semester, the master's student prepares and defends a completed work consisting of **all** compulsory parts:

- title page,
- content,
- preface (if necessary),
- a contractual list of terms (if necessary),
- summary in Lithuanian,
- summary in English,
- introduction,
- the main part (reflecting both the topic of the work, the review and analysis of the concepts, models, algorithms, methodologies, comparison with related work, development of solutions, implementation and description of independent practical research and experiments, analysis of results), consisting of separate sections and the subdivisions and sections which make up those sections,
- conclusions and recommendations,
- future research plan (Scientific Research Project) or guidelines (Final Master Thesis),
- references (all items of the bibliography must be cited in the text of the work),
- work annexes may also be provided (if necessary).

☞ It is recommended to submit a **declaration** of all meetings (during the current semester) with the supervisor (between the title page and contents, the declaration should not be mentioned in the contents of the work, should not have a page number and should not affect the numbering of the pages), indicating the date of each meeting and briefly (1-2 sentences) describing what goals were discussed during the meeting. The declaration should not be visible when the work is made public, so *submit it in a separate file* in the electronic version of the work.

Some works require a preface. In the preface, a brief expression of gratitude can be made – for example, for the data provided, the time spent, the consultation. Acknowledgments can be expressed to both people (from other departments of Vilnius University or organizations and companies not related to Vilnius University), and local faculty members who are not supervisors but have made a significant contribution to the work by commenting or working on the project together, into which the student's work is integrated.

The whole paper must be written by the defending master's student (without the help of other persons) or by the master's students (if the same work is written by not one but two students; in this case, the contribution of each of the authors must be highlighted in the work). The use of fragments of text (including literal translation from another language) and illustrations is prohibited, copied

from other sources (books, articles, student works, online materials, etc.), including the author's previously defended and positively evaluated works (coursework, bachelor's thesis). *Exception* – when writing „Final Master Thesis" it is allowed to use material (text fragments, illustrations) from the Scientific Research Project by the same author, provided that the introduction to the Final Master Thesis" is listed, what is taken from the work of the previous semester („Scientific Research Project").

The paper must indicate what programming language(s), tools, etc. were used to write the code. If code inserts, program libraries, tools, etc. created by the author of the work were used in programming, it is obligatory to list them in the work, mentioning the extent of the program code written by the author himself.

The body of the work must not contain fragments of program code. To reveal the principles of operation of the algorithm in question, it is possible to present a pseudocode (without abusing it) instead of code in the text of the work. If necessary, snippets of program code can be added to work appendices. Fragments of the program code can be provided in the work itself only in exceptional cases (if there are good reasons for it, in agreement with the supervisor) - for example, creating or improving a database query optimizer may require a sample query when developing a programming language or its library, it may be necessary to illustrate its use.

The work can be written and defended *in Lithuanian or English*, however a mixture of these languages is not allowed. Full text of the work, including explanations in the illustrations must be written in the same language except for the annotation in another language.

If large-scale calculations are planned in the practical part of the work experiments, it is advisable to carry them out on the supercomputer (see http://mif.vu.lt/cluster) at Vilnius University, Faculty of Mathematics and Informatics, Digital Science and Computing Center. When programming parallelism algorithms for compiling and executing code on a supercomputer, it is recommended to use MPI (Message Passing Interface) standard for communication (exchange of data) between different cores belonging to one or more processors.

☞ In order for the reviewer to properly evaluate the specific software used in the practical part of the work, it is recommended to **install** it in Vilnius University, Faculty of Mathematics and Informatics in the **cloud** (see http://mif.vu.lt/cloud) and specify in the work how to connect to the demonstrated resource. If standalone software is being developed, it must be installed in the MIF cloud or it must be compiled and/or run using the MIF infrastructure.

4. Requirements for the structure of the work

`A contractual list of terms` (signs, symbols, units, abbreviations) is formed if the total number of signs, symbols, units and abbreviations the number is greater than 10 and each is repeated more than 3 times in the text.

`Summary in Lithuanian`. Mandatory even if all work is written in English. Very briefly, in 5-6 sentences (about 100 words) describes the essence of the work, the purpose of the work and the achievement results. The annotation in Lithuanian must be shorter than abstract in English (summary).

`Summary in English`. The student should write the title of thesis here, in English. Also, the student should shortly describe the main goals of the work, analyzed, researched, or created subjects, experiments that have been done, and made conclusions as well as recommendations. The length of the summary is at least half of a page and maximum is one page.

`Introduction` describes the topic of the work, shows the relevance of the topic, motivation, formulates the problem to be solved and seeked to achieved/achieved results. After reading the introduction, it should be clear:

- what was work motivation;
- what were the aims and objectives of the work;
- what was created, what problems were solved, what research was carried out;
- what results have been achieved.

The `Introduction` must include:

- lists what is taken from the previous master's semester work of the same author („Scientific Research Project");
- a brief description of the structure of the work (emphasizing the role of each of the main sections of the work in the work).

The `main part` describes and substantiates the methodology of the whole work, analyzes the material, developed systems/models/methodologies/technologies/algorithms (hereinafter referred to as decisions), their evaluations, comparisons, described results achieved, detailed conclusions. Depending on the nature of the work, it may contain the following parts:

- an overview and analysis of the topics of the work, the concepts covered, including the motivation and a description of the related work - if the motivation of the work is not fully substantiated in the introduction, whether the work itself requires a detailed description of certain related work;
- a comparison of the solutions being developed with the work involved and a detailed description (including details of implementation), justifying each step or imagined improvement/innovation, why such proposals were accepted, what results are expected;
- analysis, verification, comparisons of independent practical research (if several solutions are compared in the work), evaluations;
- conditions of performed experiments/tests, expediency, what was expected, what results were obtained, conclusions were made.

These parts are listed as examples and do not necessarily have to be in the work, as the structure of each work depends on the topic and the nature of the research. Specific parts of the work should be agreed with the supervisor.

In `Conclusions and recommendations` the most important conclusions of the work are formulated in detail, recommendations for the application and development of the work are given. Remember that conclusions are not a list of work done!

`Appendices` (if necessary) provide program texts, tables, diagrams, illustrations and other additional material to supplement the content of the work. If the illustrations and tables are small and not numerous, they should be presented in the main part of the work.

5. Work layout requirements

When writing a working text, it is recommended to use LaTeX which is the most popular tool for preparing technical texts, however, other text editing tools can be used, such as LibreOfffice Writer, Microsoft Word.

An example of properly formatted text with a cover page, the main parts of the work, including

the requirements for illustrations, tables, pseudocode, for a bibliography (with examples), you can find in [1].

☞ ***Minimum*** workload:

- „Scientific Research Project" – 15 pages (without appendices);
- „Final Master Thesis" – 40 pages (without appendices).

If not one, but two students write the same work – the requirements for the minimum workload are 1.5 times higher.

Recommended workload is 10 pages larger than the minimum.

Registration requirements:

- The work must be printed and bound.
- The work is written in one column (one column).
- Margins: top – 20 mm, bottom – 20 mm, left – 30 mm, right – 15 mm.
- Font settings: Times or Times New Roman or Palemon or Libertine, 12 pt, font style normal (except for the title of the work and the titles of sections and subsections where bold type may be used; the title of the work and the titles of the main sections may be collected in larger letters). Smaller letters may be used in the titles of illustrations and tables (short descriptions next to an illustration or table).
- Spacing between lines of text: 1.1 (10% larger than the standard single spacing).
- Pages are numbered at the top or bottom, right.
- The main sections of the work (should go one after the other in exactly this order): declaration of meetings with the supervisor (recommended), contents, preface (if any), contractual list of terms (if any), summary in Lithuanian, summary in English, introduction, each chapter (1st, 2nd, etc.), conclusions and recommendations, plan or guidelines for future research, ☞ bibliography, appendices (if any) *start on a new page* . The subsections and sections that make up the current section (1.1, 1.2, 1.2.1, 1.3, etc.) must not be forced to start on a new page.
- The declaration of the meetings with the supervisor (recommended to be submitted) should not be visible when publicizing the work, therefore in the electronic version of the work, *submit this declaration in a separate file*. It should not be included in the contents, should not have a page number and should not affect the numbering of the pages.
- The bibliography is numbered in numbers, in alphabetical order (according to the name of the first author, if it coincides, the names of other authors are taken into account). Literature sources can be: books, articles, students' bachelor's and master's theses, material posted on the Internet. The bibliography must include at least five sources from the category of books and articles (try to refer to the most recent sources where possible). All items in the bibliography must be cited in the text of the work. The bibliography must be formalized and cited as in the example given in [1] (see ""Scriptures"").
- Illustrations, tables, and pseudocodes must meet the requirements specified in [1] (see "Papers").

The title page is designed as shown in Example [1] (see "Scriptures").

The content contains the titles of the parts of the work (starting with the annotation in Lithuanian, including chapters, subsections and sections) with links to the pages.

Chapters, subsections, and sections must be numbered in Arabic numerals (1, 2, 3, etc.). Chapter, subsection and section numbers are separated from each other by dots (1.1, 1.2, 1.2.1, 1.3, etc.).

Unnumbered: content, preface, contractual list of terms (if any), summary in Lithuanian, summary in English, introduction, conclusions and recommendations, future research plan or guidelines, and bibliography. The appendices are numbered separately in capital Latin letters (A, B, C, etc.).

6. Submission requirements

The Department of Computational and Data Modeling determines the date of delivery of works to the department, as well as the date of defense of works (which is not earlier than 5 working days from the published date of delivery of works to the department) and informs all master students about it in advance by e-mail (students must check their VU MIF e-mail regularly) and on the website [1].

☞ The printed and bound work ***in duplicate*** must be submitted to the Department of Computational and Data Modeling no later than announced date of delivery of works. ***Late submission of work is not allowed to be defended***. Each of the (two) printed and bound copies must have a medium (CD or DVD, or USB, or SD card) with the recorded final electronic version of the work. Contents of the electronic version:

README.txt – a text file indicating the author of the work and a brief content of the electronic version of the work;

doc/ – a catalog with the text of the work in PDF format, one of the original formats (for example, TEX, ODT or DOCX) and graphic files of all illustrations used in the work; the declaration of meetings with the supervisor (recommended to be submitted) must be in a separate (non-working text) file in PDF format;

bin/ – a catalog with a working prototype compiled for the intended platform (if applicable to the work) and minimum instructions for running the prototype. If remote resources are used, a description of the remote resources and connection options must be provided. All files in this directory **must be zipped**;

src/ – directory with source codes (if remote resources are used, the necessary scripts or source codes must be provided for their installation) and the ability for the reviewer to compile and/or evaluate the work, structure, and scope. Detailed instructions must be provided on how the work should be compiled (for example, using subnet tools of the Faculty of Mathematics and Informatics or other tools available to the reviewer). All files in this directory **must be zipped**.

If the electronic final version of the work is not submitted in time, *it is not allowed to defend the work.*

The supervisor's signature on the work is not required. The supervisor informs the work defense commission about his/her evaluation of the work. If **the supervisor evaluates the work** ☞ **unsatisfactorily** (less than 5 points), the graduate student has the right to write a motivated request (to the chairman of the defense commission) to allow the defense of the work. In this case, the defense commission votes against the defense whether to allow the work to be defended.

Before submitting the work to the department, it is important to remember to correct proofreading errors (there are computer tools for spell checking), language (including punctuation) and style ills. Long sentences and paragraphs should be avoided when writing. When reading a work from the beginning, it should not use abbreviations, terms or specific terms, the meaning of which will be defined only in the following part of the text. The structure of the work needs to be carefully reviewed - does it have all the required parts? Perhaps it is worth splitting up certain long chapters,

or distinguishing between shorter subsections and subsections?

☞ **Uploading of intermediate versions of the work to Vilnius University virtual learning environment.** In order to control students' work throughout the semester, students are required to upload a current (draft) version of the text in PDF format on a monthly basis. to the virtual learning environment of Vilnius University. There are no requirements for this draft version of the paper, but once the final version of the paper has been submitted for defense, the supervisor, reviewer or any member of the defense commission will have the opportunity to check that work has been done consistently and systematically throughout the semester.

Deadlines for uploading current versions of the work to the virtual learning environment of Vilnius University in the autumn semester:

- by 3 October (inclusive) – draft text versions of the work in PDF format and declarations of meetings with the supervisor (recommended to be submitted) in a separate file in PDF format;
- by 3 November (inclusive) – draft text versions of the work in PDF format and declarations of meetings with the supervisor (recommended to be submitted) in a separate file in PDF format;
- by 3 December (inclusive) – draft text versions of the work in PDF format and declarations of meetings with the supervisor (recommended to be submitted) in a separate file in PDF format;
- by the published date of delivery of works to the department (inclusive) – final versions of the text in PDF format and declarations of meetings with the supervisor (it is recommended to submit) in a separate file in PDF format.

Deadlines for uploading current versions of the work to the virtual learning environment of Vilnius University in the spring semester:

- by 3 April (inclusive) – draft text versions of the work in PDF format and declarations of meetings with the supervisor (recommended to be submitted) in a separate file in PDF format;
- by 3 May (inclusive) – draft text versions of the work in PDF format and declarations of meetings with the supervisor (recommended to be submitted) in a separate file in PDF format;
- by the published date of delivery of works to the department (inclusive) – final versions of the text in PDF format and declarations of meetings with the supervisor (it is recommended to submit) in a separate file in PDF format.

Prisijungimas prie Vilniaus universiteto virtualiosios mokymosi aplinkos ir bylų įkėlimas.
The virtual learning environment of Vilnius University is available at:
https://emokymai.vu.lt

after selecting "VU Faculty of Mathematics and Informatics", then the corresponding course:
"KM: Scientific Research Project" or
"KM: Final Master Thesis".

Files will be uploaded online with your login name and password (same as those used to connect to Vilnius University information system or e-mail).

7. Defense

The work must be defended. The defense takes place during the meeting of the public defense commission (during the session period, at the end of the current semester).

☞ The defense of the dissertation is a procedure , during which**evaluates** not only the content of the dissertation, but also the eloquence of the master's student, the ability to present research results within a limited time, to answer questions and comments, to defend one's opinion in an argumentative manner. Rating is reduced by: reading a pre-prepared language from a sheet or literally from presentation slides, silent, incoherent language, unreasonable rush or vice versa - time lag in non-critical message locations.

Up to 10 minutes are allowed for the presentation of the „Scientific Research Project". In total (including questions and discussion after the presentation) the defense is scheduled for up to 20 minutes (The defense may take longer in exceptional cases if the commission has a large number of questions after the presentation of the work).

Up to 15 minutes are allowed for the presentation of the „Final Master Thesis". In total (including questions and discussion after the presentation) the defense is scheduled for up to 25 minutes (The defense may take longer in exceptional cases if the commission has a large number of questions after the presentation of the work).

☞ It is obligatory to prepare **slides** in PDF or Microsoft PowerPoint format presenting the work, without which it is not allowed to defend the work. It is recommended that the slides be numbered to make it easier to name the information on a particular slide. It is advisable to rehearse the work several times before the actual defense, paying attention to whether the work can be delivered within the set number of minutes, is the optimal amount, content and order of slides, or are the accents of the work arranged correctly when speaking?

The author of the work may be asked questions - from the research topic and from the disciplines heard during the study year, which are close to the topic of the defended work.

Examples of message slides LaTeX Beamer format provided [1] (see "Written Papers", these examples demonstrate a presentation of a research paper at a conference or lecture, rather than slides for the defense of a master's thesis).

☞ ***It is not allowed to defend the work*** if any of the following conditions are true:

- the printed work was submitted late or not submitted to the Department of Computational and Data Modeling;
- the electronic final version of the work was submitted late or not submitted;
- the supervisor evaluates the work as unsatisfactory (less than 5 points) and the defense commission by voting decided not to satisfy the motivated request written by the master's student (to the chairman of the defense commission) to allow the defense of the work;
- the work does not have any of the following components: title page, annotations in Lithuanian, summaries in English (summary), introduction, conclusions and recommendations, a list of literature, or there is no practical part in the work (development of solutions, implementation and description of independent practical research and experiments, analysis of results);
- the author of the work came to the defense without preparing the slides presenting the work in PDF or Microsoft PowerPoint format.

8. Things to look out for when preparing and defending a work

The aim is for the work to have the following characteristics:

- the topic of the work is complex, modern and original;
- the work meets all the requirements given in section Work layout requirements, as well as the requirements specified in other sections;
- the introduction presents the aim of the work and the set tasks, clearly and simply (understandable not only for the research specialists) the essence of the problem and the main results of the work;
- clear, convincing presentation of work motivation;
- analysis of other authors' works on a similar topic;
- the paper clearly describes the models/algorithms/methodologies developed by the author, as well as based on practical research/experiments;
- innovative results of the work are presented, they are compared with similar results of other authors;
- the work is written in correct language, in a solid scientific style;
- the initiative shown in the course of work in refining the object of research and the methodologies used;
- was able to present the main conclusions of the work in the "Conclusions and Recommendations" and to look at his work critically – formulating insufficiently solved or new problems to be solved in the course of work;
- qualified response to the reviewer's remarks and questions of the Defense Panel;
- consistent and systematic work has been done throughout the academic period to prepare the work;
- the research carried out in the work and its results were presented to the academic community (seminars, conferences, scientific publications).

9. Work evaluation

The work is independently evaluated by: the supervisor (before the defense), the reviewer (before the defense) and the Defense Panel. **The final grade for the work is given by the Defense Panel.** The preliminary assessments of the supervisor and the reviewer are only advisory to the Defense Panel. If the supervisor and/or the reviewer are members of the Defense Panel, they do not award work evaluation points during the Defense Panel meeting.

☞ **Criteria for work evaluation.** Everyone who evaluates the work (supervisor, reviewer and member of the Defense Panel participating in the defense, provided that the member of the Defense Panel is neither the supervisor nor the reviewer) evaluate the work separately according to the following criteria:

B_T : theoretical (referential) part (review and analysis of the topic, concepts, models, algorithms, methodologies, comparison with related works) – after evaluating this part of the work, the grade B_T is assigned;

B_P : practical part (development of solutions, implementation and description of independent practical research and experiments, analysis of results) – after evaluating this part of the work, the grade B_P is assigned;

B_L : logical consistency (whether the work goals were thoroughly and systematically pursued and conclusions were reached throughout the work), validity of conclusions – after evaluation, the grade B_L is assigned;

B_A : compliance with design requirements – after evaluation, the grade B_A is assigned;

B_K : language and style – after evaluation, the grade B_K is assigned;

B_G : *each member of the Defense panel* additionally evaluates the author's eloquence demonstrated during the presentation of the work, the ability to present the research results within a limited time, answer questions and comments, defend the opinion with arguments – after evaluating the defense, the grade B_G is assigned.

Work evaluation by the supervisor and the reviewer. The supervisor and the reviewer submit their grades $B_{supervisor}$ and $B_{reviewer}$ to the Department of Computational and Data Modeling before the defense, evaluating the work according to the evaluation criteria B_T (40% by weight in the evaluation of the „Scientific Research Project" and 20% by weight in the evaluation of the „Final Master Thesis"), B_P (20% by weight in the evaluation of the „Scientific Research Project" and 40% by weight in the evaluation of the „Final Master Thesis"), B_L (20% by weight), B_A (10% by weight) and B_K (10% by weight).

If at least one of the grades B_T, B_P, B_L, B_A, or B_K in the evaluation of the supervisor is less than 5, the supervisor is considered to evaluate the work unsatisfactorily. In this case, the supervisor's assessment $B_{supervisor}$ is considered to be the lowest of all the mentioned grades: $B_{supervisor} = \min\{B_T, B_P, B_L, B_A, B_K\}$. Recal that if the supervisor evaluates the work as unsatisfactory (less than 5 points), the Defense Panel votes – whether to satisfy the request written by the master's student (to the chairman of the Defense Panel) to allow the defense of the work.

Also in the evaluation of the work by reviewer – *if at least one of the grades B_T, B_P, B_L, B_A, or B_K in the evaluation of the reviewer is less than 5, the reviewer is considered to evaluate the work unsatisfactorily.* In this case, the reviewer's assessment $B_{reviewer}$ is considered to be the lowest of all the mentioned points: $B_{reviewer} = \min\{B_T, B_P, B_L, B_A, B_K\}$. Defence of the work (if it was evaluated positively by the supervisor), negatively evaluated by the reviewer, is allowed.

☞ **Final grade.** The evaluation of the works in the Defense Panel is performed during the closed Defense Panel meeting, which takes place after all the presentations of the works were heard on that day – by open voting, by the majority of votes of the participating Defense Panel members.

If the supervisor and/or the reviewer are members of the Defense Panel, they shall not vote. The results are recorded in the protocols of the defense of the works in the prescribed form and published on the same day.

When voting for the final evaluation score of the „Scientific Research Project", the members of the Defense Panel take into account the author's reports in the seminars during the semester. (about 30% of the weight of the final assessment score can be awarded for them) and for work defense (about 70% of the weight of the final assessment score).

When voting for the final evaluation score of the „Scientific Research Project" or „Final Master Thesis", the members of the Defense Panel take into account the following additional factors:

- for each delay (see the dates specified in Chapter 6 "Submission requirements") to upload the current version of the work text in PDF format to the virtual learning environment of Vilnius University, the final work evaluation grade may be reduced up to 0.5 points;
- if the author of the work has made a presentation on the topic of the work at a scientific conference (possibly also with co-authors, but the presentation had to be made in person by the author of the work), this is mentioned in the work and the supervisor confirms it, the

final work evaluation grade can be increased by up to 1 point;
- if the author of the work has a published article on the topic of the work in a peer-reviewed scientific publication (possibly also with co-authors) and this is mentioned in the work, the final work evaluation grade can be increased up to 2 points.

Contact for questions and suggestions

Ask questions about these requirements and provide suggestions for their improvement to the Chairman of the Computer Modeling Study Program Committee Assoc. Prof. Dr. Severinas Zubė (e-mail: `severinas.zube@mif.vu.lt`).

References

[1] Vilnius University, Faculty of Mathematics and Informatics, Institute of Computer Science, Computer Modeling Study Program. Information for students.
https://mif.vu.lt/lt3/en/studies/master-studies-info#computer-modelling.