MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
NATIONAL TECHNICAL UNIVERSITY
"KHARKIV POLYTECHNIC INSTITUTE"

METHODICAL RECOMMENDATIONS

**for the structure and content of Bachelor's theses
for students of speciality 122 "Computer Science"
of the study programme "Computer Science and Intelligent Systems**

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INTRODUCTION

The methodical recommendations contain a description of the requirements for the mandatory structure and the minimum content of the explanatory notes for Bachelor's theses of students studying in speciality 122 "Computer Science" on the study programme "Computer Science and Intelligent Systems".

GENERAL INFORMATION

A Bachelor's thesis is a work that is a solution to an applied professional task or the educational and practical development of a student at the final stage of study.

A Bachelor's thesis demonstrates the author's ability to apply the acquired competences and learning outcomes in accordance with the educational programme. Based on the results of the bachelor's thesis, the student must demonstrate the acquisition **of integral competence [1]:** *the ability to solve complex professional and practical problems in the field of computer science and intelligent control systems or in the learning process, which involves the application of theories and methods of information technology and is characterized by complexity and uncertainty of conditions.*

A Bachelor's thesis in the speciality 122 – "Computer Science" of the study programme "Computer Science and Intelligent Systems" should, in essence, consist of independently developed software to solve problems arising in the management and functioning of organizational, technical, natural and socio-economic systems, including the developed intelligent system. The thesis describes the full cycle of software or intelligent system development: requirements analysis, identification of technological solutions, design, coding and testing. Software solutions are not limited to specific technological frameworks, approaches or programming languages (including the use of scripting, visual or high-level interpreted programming languages, including specialized languages for software systems).

A Bachelor's thesis is certified to confirm that the competences and learning outcomes acquired by the applicant meet the requirements of the Higher Education Standard in the speciality 122 – "Computer Science" [1] and the content of the study programme [2]. The certification takes place through a public defiance of a qualification thesis. The student must present his/her results in a logical,

coherent and reasonable way, draw conclusions and formulate proposals or recommendations for the problem solved.

A Bachelor's thesis that qualifies for an excellent or very good grade (A-B) must have a high level of algorithmic and/or architectural complexity. For a Bachelor's thesis with a grade **above 95 points,** it is desirable to **demonstrate elements of research** aimed either at the subject area with the use of developed solutions, or at the effectiveness of computer science and intelligent systems methods (machine learning, neural networks, fuzzy logic, natural language processing, pattern recognition, swarm and evolutionary intelligence, expert and agent systems, adaptive control, etc.). In the dissertations of this educational programme, it is obligatory to use mathematical methods and algorithmic principles in the modelling, design, development and application of intelligent technologies to solve problems [2].

The text of the Bachelor's thesis must be written by the author. A Bachelor's thesis that contain facts of textual borrowing, use of results obtained by other authors without proper references, distortion or falsification of results are not allowed to be defended. The use of methods, technical solutions, results obtained by other authors as auxiliary or initial data in the thesis must be accompanied by obligatory references to the original works. The main part of the Bachelor's thesis is submitted for automatic plagiarism check by the system officially used at NTU "KhPI" before submission for defense. **Establishing the fact of violation of academic integrity is the basis for preventing the defense or cancelling the decision of the Examination Commission (EC) and revoking the Bachelor's thesis.**

The evaluation of the thesis (final attestation) is carried out by the Examination Committee on the basis of the results of the public defense.

The members of the Examination Committee are determined in accordance with the Regulations of the Examination Committee of the National Technical University "Kharkiv Polytechnic Institute" [3].

CHAPTERS OF THE BACHELOR'S THESIS AND THEIR CONTENTS

The Bachelor's thesis must necessarily consist of structural parts that are filled with content according to the requirements below [4].

Introduction

Explains the general relevance of software development (intelligent systems) to the field defined by the problem to be solved in the thesis.

Defines the purpose of the thesis, the object and the subject of the research.

Recommended volume: 1-2 pages.

Section 1

(the title should be specific according to the topic of the Bachelor's thesis)

Paragraph 1.1.

Give a general description of the problem to be solved in the thesis. A brief description of the field in which this problem is to be solved.

Recommended volume: 2-3 pages.

Paragraph 1.2

The main problems in the development of modern software (information technology, intelligent software systems) used to solve the problem considered in the subject area are highlighted.

Give a brief overview of existing intelligent systems solving similar problems, analyze their advantages and disadvantages.

Recommended volume: 2-3 pages.

Paragraph 1.3

An overview of the methods for solving the problem considered in the field is given, as well as a brief overview of the methods of computer science and intelligent systems (machine learning, neural networks, fuzzy logic, natural language processing, etc.) that can be used to solve the problem posed in the thesis. The advantages and disadvantages of the methods considered are identified.

Recommended volume: 2–3 pages.

Paragraph 1.4

A statement of the problem to be solved (based on the review in the previous paragraphs), the purpose of the work, and the specific tasks to be solved to achieve that purpose are formulated. A motivated choice of method to solve the problem is made.

Recommended volume: 1–2 pages.

Section 2

(the title should be specific according to the topic of the Bachelor's thesis)

Paragraph 2.1

Describes the business processes of solving the problem or the business processes to be improved by solving the problem. Business process models "as-is" created using one (or more at different levels of decomposition) of the graphical modelling notations (IDEF0, DFD, BPMN, EPC, etc.), as well as "to-be" models considering future improvements, are presented.

Or a general algorithm for solving the task will be provided. Present the developed algorithmic software using simple flowcharts, UML activity diagrams and/or other graphical notations.

Recommended volume: 3–5 pages.

Paragraph 2.2, 2.3 etc.

The algorithmic support for solving the task based on the use of the selected intelligent technology (one or a combination of several) is detailed. Mathematical models and methods for solving problems within the algorithmic framework are presented. The proposed algorithmic software will form the basis of the software to be developed in the Bachelor's thesis.

Recommended volume: 3–7 pages.

Section 3

(the title should be specific according to the topic of the Bachelor's thesis)

Paragraph 3.1

A description of the vision of the future software (definition of business requirements) is provided. Define functional and non-functional requirements for the software to be developed. It is recommended to provide diagrams of options for using UML notation and/or SysML requirements diagrams. A requirements specification (e.g. in the form of an SRS) or a technical task may be provided.

Recommended volume: 3–4 pages.

Paragraph 3.2

Describe the architecture of the software to be developed. The choice of the type of system architecture (e.g. two or three tier client-server architecture,

etc.) of the software is justified.

Recommended volume: 1–2 pages.

Paragraph 3.3

The software structure (main elements) is described according to the selected type of system architecture.

The appropriate UML diagrams are provided:

- Components;
- Placement (Deployment);
- Sequences, etc. (States, Interactions, etc.).

The content and purpose of each of the identified software components (elements of the software structure) are explained.

A detailed description of the software components developed is provided using UML class diagrams.

Recommended volume: 3–5 pages.

Paragraph 3.4

The choice of database technology (relational or NoSQL) and the appropriate database management system (DBMS) to be used by the software for data storage and processing is justified. A conceptual model of the subject area data is presented in the form of an ER model (the so-called Chen notation). In the case of a relational database, descriptions of the logical and physical data models are provided (e.g. in the form of IDEF1X models). In the case of NoSQL technologies, other means of representing the structure of the stored data may be used (e.g. data warehouses, etc.).

Recommended volume: 3–5 pages.

Paragraph 3.5

The choice of software development tools (development environments - IDEs, software platforms, servers, frameworks, libraries, etc.) is justified.

Recommended volume: 1–2 pages.

Paragraph 3.6

The results of testing the developed software are presented, indicating how the tests were performed. For example, for each test case, time intervals for processing requests with different numbers of users can also be defined, etc. The software defects found during testing and the measures taken to correct them are indicated.

Recommended volume: 2–3 pages.

Section 4

(the title should be specific according to the topic of the Bachelor's thesis)

Paragraph 4.1

Examples of graphical user interface elements (forms, Web pages, etc.) are given with a brief description of their operation. The requirements for deployment and operation of the software (hardware and software, etc.) are specified. A user manual for the use of the developed software is provided.

Recommended volume: 3–5 pages.

Paragraph 4.2, 4.3 etc.

Control examples of using the developed software to solve the task are considered. The description of input and output data (data acquisition technologies) is given. The peculiarities of output data formation for solving the problem are indicated. An analysis of the results obtained (in the form of tables, graphs, etc.) is given.

In addition, the elements of the study of the method(s) of Computer Science and Intelligent Systems used may be covered.

For example, in the case of solving a specific machine learning problem in a thesis, an error (inconsistency) matrix may be used to study the effectiveness of the chosen method of solving the problem and the algorithmic and software developed accordingly. If necessary, other methods can be used to evaluate the effectiveness of the chosen method.

Recommended volume: 4–7 pages.

Section 5

Economic justification

The economic feasibility study [5], i.e. the analysis, calculation and evaluation of the economic efficiency of software development, is covered. The relevance and economic viability of the software development and its use by potential users are demonstrated [5].

Recommended volume: depending on the volume of the settlements.

Conclusions

The results of the work carried out should be briefly outlined. The following questions should be answered clearly

- Was the aim stated in the introduction achieved?
- How were specific research problems solved (if any)?

Recommendations for the practical use of the results of the dissertation are given, as well as directions for possible further work in the case of further education in a Master's programme.

Recommended volume: 1–2 pages.

References

The student must refer to the sources of information, materials, results and ideas used during the preparation of the Bachelor's thesis.

References should be to recent publications in Ukrainian or English (5-10 years old for scientific sources, internet links; 10-20 years old for "classic" textbooks, books).

To simplify the list of references, it is recommended to use specialized software tools: Mendeley, EndNote, Zotero, etc.

Do not include in the bibliography works that are not referenced and not used in the text of the thesis.

The reference list should contain at least 15-20 titles directly related to the topic of the Bachelor's thesis **(**excluding those related to the economic justification section).

Recommended volume: depends on the number of sources used.

The approximate volume of the Bachelor's thesis is 35-60 pages, including the title page, list of documents, assignment, abstracts in Ukrainian and English, economic justification section, list of references and attachments. Attachments must be titled.

The explanatory note of the Bachelor's thesis will be prepared in accordance with the current standards of NTU "KhPI" (current templates for the explanatory note and cover sheets are available on the cloud resources of the department, to which the thesis writers and supervisors have access) [4].

The structure of the Bachelor's thesis is recommended and may vary depending on the topic and methodology of software development. The structure of the Bachelor's thesis will be agreed with the dissertation supervisor and the study programme supervisor.

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