ЗАТВЕРДЖЕНО
на засіданні кафедри
інформаційних систем.
Протокол № 1 від 27.08.2024 р.

ПОГОДЖЕНО
Проректор з навчально-методичної роботи

_____ Каріна НЕМАШКАЛО

МЕТОДОЛОГІЇ НАУКОВИХ ДОСЛІДЖЕНЬ

робоча програма навчальної дисципліни (РПНД)

Галузь знань	**12 "Інформаційні технології"**
Спеціальність	**122 "Комп'ютерні науки"**
Освітній рівень	**другий (магістерський)**
Освітня програма	**Комп'ютерні науки**

Статус дисципліни	**обов'язкова**
Мова викладання, навчання та оцінювання	**англійська**

Розробник:
д.пед.н, к.техн.н,
професор
        підписано КЕП   Олександр КОЛГАТІН

Завідувач кафедри
інформаційних
систем
        підписано КЕП   Дмитро
                БОНДАРЕНКО

Гарант програми   підписано КЕП   Сергій МІНУХІН

Харків
2024

MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
SIMON KUZNETS KHARKIV NATIONAL UNIVERSITY OF ECONOMICS

APPROVED
at the meeting
of the Information Systems Department
Protocol № 1 of 27.08.2024

AGREED
Vice-rector for educational and methodical work

Karina NEMASHKALO

METHODOLOGY OF SCIENTIFIC RESEARCH
Program of the course

Field of knowledge	**12 "Information Technologies"**
Specialty	**122 "Computer Sciences"**
Study cycle	**second (master)**
Study programme	**Computer Sciences**

Course status	**mandatory**
Language	**English**

Developers:
Doctor in Pedagogics,
Professor

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Oleksandr KOLGATIN

Head of Information Systems
Department

Dmytro BONDARENKO

Head of the study programme

Digitally signed

Serhii MINUKHIN

Kharkiv
2024

INTRODUCTION

Elements of scientific research are inherent in any creative human activity and the activity of a computer science specialist is no exception. Modern economic conditions of business require from specialists, independent of their specialization, competence in conducting a review of professional literature, analysis of existing achievements in the field, selection and analysis of project prototypes. In view of the orientation of the economy and society of Ukraine to the global level of scientific, technical and social achievements, to joining the family of the global civilized society, the issues of methodology and organization of scientific research are considered in an international context, therefore it was decided to teach this course in English.

The basics of scientific methodology, scientific communication and social significance of science are the subject of the first module of course. Considerable attention is paid to culture and integrity in the field of science. The presentation of scientific results is considered in the context of the application of information technologies, international and national standards that are used in Ukraine. Comprehensive use of the latest information technologies for information search and organization of scientific conferences are in the center of attention. The second content module is aimed at modelling as one the main methods in computer science for theoretical forecast, simulations and experimental data processing. The proposed course has a practical orientation – a significant number of practical tasks give students the opportunity to practice the skills of using specialized software aimed at supporting scientific activity. The purpose of the course is to form higher education students' worldview on issues of modern science and acquire skills in the practical application of information technologies, information systems and publicly available resources for the implementation of scientific research elements as a component of professional activity in the field of computer science.

The objectives of the course are:
– search and analysis of text and multimedia information in the field of computer science in Ukrainian and English;
– acquiring skills in using national and international bibliographic and scientometric Internet resources in the field of computer science;
– acquiring skills in planning, implementing methodological approaches and presenting the results of scientific research in English;
– acquiring skills of scientific communication in English in the field of computer science;
– understanding approaches and acquiring skills in experimental data processing;
– understanding approaches and acquiring skills in modelling information and logical systems, dynamic systems as well as conducting appropriate simulations.

The subject of the course is a system of methodological approaches, tools and technologies of scientific research.

The object of the course is scientific research in the field of computer science.

The learning outcomes and competencies formed by the course are defined in table 1.

<div align="right">Table 1</div>

Learning outcomes and competencies formed by the course

Learning outcomes	Competencies
LO1	GC01, GC02, GC03, GC05, GC06, GC07, SC01, SC03
LO2	GC01, GC05, GC07, SC06, SC12
LO5	GC04
LO6	GC01, SC03, SC04
LO7	GC01, GC07, SC01, SC04, SC05
LO8	GC01, GC07, SC12
LO16	GC01, GC02, GC05, GC07, SC04, SC06
LO18	GC05, SC01, SC04
LO19	GC02, GC04, GC05, GC06, GC07, SC01, SC02, SC03, SC06, SC10, SC12
LO20	SC01

LO1. Have specialized conceptual knowledge that includes modern scientific achievements in the field of computer science and is the basis for original thinking and conducting research, critical understanding of problems in the field of computer science and at the border of fields of knowledge.

LO2. Have specialized computer science problem-solving skills necessary for conducting research and/or carrying out innovative activities in order to develop new knowledge and procedures.

LO5. Evaluate the results of teams and collectives in the field of information technologies and ensure the effectiveness of their activities.

LO6. Develop a conceptual model of an information or computer system.

LO7. Develop and apply mathematical methods for the analysis of information models.

LO8. Develop mathematical models and data analysis methods (including large ones).

LO16. Conduct research in the field of computer science.

LO18. Collect, formalize, systematize and analyze the needs and requirements for the information or computer system being developed, operated or supported.

LO19. To analyze the current state and global trends in the development of computer sciences and information technologies.

LO20. Develop algorithms and software components of computer information systems for high-performance big data processing systems (including distributed and parallel computing) and cloud platform services.

GC01. Ability to abstract thinking, analysis and synthesis.
GC02. Ability to apply knowledge in practical situations.
GC03. Ability to communicate in the national language both orally and in writing.
GC04. Ability to communicate in a foreign language.
GC05. Ability to learn and master modern knowledge.
GC06. Ability to be critical and self-critical.
GC07. Ability to generate new ideas (creativity).
SC01. Awareness of the theoretical foundations of computer science.
SC02. The ability to formalize the subject area of a certain project in the form of an appropriate information model.
SC03. Ability to use mathematical methods to analyze formalized models of the subject area.
SC04. The ability to collect and analyze data (including large data) to ensure the quality of project decision-making.
SC05. Ability to develop, describe, analyze and optimize architectural solutions of information and computer systems for various purposes.
SC06. Ability to apply existing and develop new algorithms for solving problems in the field of computer science.
SC10. The ability to evaluate and ensure the quality of IT projects, information and computer systems of various purposes, to apply international standards for assessing the quality of software of information and computer systems, models for assessing the maturity of information and computer systems development processes.
SC12. Ability to develop, apply and integrate data processing and analysis technologies in high-performance systems and cloud platforms to ensure efficient use of computing resources of computer systems.

COURSE CONTENT

Content module 1: Methods in computer science

Topic 1. Science as a Part of Universal Culture of Humanity
The purpose and objectives of the course, its place in the educational process. Development of computer science in history and modern days. Ukrainian scientists' contribution in the field of computer science.
Basic concepts of scientific research. Peculiarities of choosing a research topic. Classification of scientific specialties in the world and in Ukraine. The purpose of the research and its connection with the scientific specialty. The object of research as a phenomenon or process that gives rise to a problem. The subject of research as a component of the object to which scientific research is directed. Research hypothesis and methods of its verification. Scientific result, meaning of positive and negative scientific result for science.

Open science as a modern trend in scientific research development. UNESCO Recommendation on Open Science. Support of Open Science in Ukraine.

Scientific ethics and integrity. Intellectual property in scientific research. Prevention of research misconduct.

Topic 2. Principles of Modelling

Methodological approaches in science. Theory and experiment, their unity and relationship. Methods of scientific research. Theoretical and experimental methods. Peculiarities of methodology in computer science.

System methodological approach. Structural components and functional components. Feedback. Control.

Modelling as a method of scientific research. System as an object of modelling. Models. Approaches to classification of models. Forecasting with a model. Using a model to control a system.

Mathematical methods in modelling. Computational mathematics. Model parameters. Solving an optimization problem to build a model. Objective function.

Topic 3: Stochastic Models and Statistical Analysis

Processing experimental data. Descriptive statistics. Inductive statistics. Correlational analysis.

Statistical hypotheses. Null hypothesis tests and their role in science development. Parametric and non-parametric tests. Limits of using null hypothesis testing methods in experimental data processing. Stochastic modelling as a modern view on the processing of experimental data.

The synergistic approach as a methodology for the study of complex non-equilibrium systems. Formulation of the forecasting problem in conditions of uncertainty. Examples of forecasting problems under conditions of uncertainty. Sources of uncertainty. Optimization criteria for model parameters. The method of least squares as an approach to determining model parameters. Linear and non-linear regression models. Neural network as a specific form of representation of functional dependencies. Activation functions. Determination of model parameters (machine learning) as an optimization problem solution.

Topic 4: Mathematical Methods for Information Models Analysis

Deterministic classification systems based on the discrete models. Methods of building a knowledge base. Facts as the basis of the knowledge base. Semantic network. Using chains of reasoning for deductive reasoning. Productions as a rules system for building chains of successive states of a discrete deterministic system.

Application of trees to organize data. Search and optimization algorithms on graphs. Graph exploration methods. Methods of exhaustive search and heuristic methods of optimization.

Classification systems in uncertainty conditions. Using networks as a tool of logic building.

Topic 5: Model Verification and Simulations
Simulation with a model as a process of predicting a system behaviour. Error sources and approaches to evaluate and decrease simulation errors. Numerical stability of a simulation algorithm in iterative processes.
Detecting the bounds of model validity. Evaluation of the model total error. Comparison the results of simulation with experimental data. Real-time simulation in control systems.

Content module 2: Methodologies of scientific communication

Topic 6. Sources of Scientific Information
Classification of sources of scientific information. Printed and electronic editions. Scientific journals. Proceedings of scientific conferences. Scientometric databases. Full-text scientific databases. Open libraries. Websites of universities and scientific institutions. Repositories of universities. National libraries and bibliographical sources of Ukraine. Specialized search systems that are used to search for scientific information.
Determination of the status of scientific publication and scientific publication in Ukraine and in the world. The concept of peer-reviewed publications. The impact factor of a scientific journal. Determination of the status of a scientific publication in Ukraine, the concept of the List of scientific specialized publications of Ukraine, in which the results of dissertations for obtaining the scientific degrees of Doctor of Science, Candidate of Science and Doctor of Philosophy can be published.

Topic 7. Basics of Scientific Documentation
Classification of documents. International and national standards of design of scientific documents.
Designing a scientific publication. Types of scientific publications and requirements for them (review article, brief information about ongoing research, full research article about completed scientific research). Structure of a scientific article. Abstract as a concise presentation of the content of the article for placement in reference databases. Keywords as a model of scientific material for automated search engines. Introduction as a mandatory structural component of a scientific article. A problem that is being solved. Justification of topicality. Analysis of experience in the field of research. Purpose and objectives. Requirements for submitting the main part of the material depending on the type of publication. Requirements for submitting information about the theoretical basis, models, description of the conditions of conducting experimental work, results of experiments, analysis of the results obtained. Conclusions and

prospects for further research as a mandatory component of a scientific article. Theses as a separate type of scientific publication.

Citing of used sources. International and domestic citation standards (DSTU 8302-2015, APA, MLA, Chicago/Turabian, IEEE, Harvard, Oxford, etc.). Standards for the design of scientific documentation text.

Topic 8. Scientific Conference Participation and Organization

Scientific conference as an event for discussion of scientific results and scientific communication. Topic and potential participants of the scientific conference. The purpose and objectives of the scientific meeting. Scientific associations and universities as founders of scientific conferences. The Ministry of Education and Science of Ukraine as the founder of scientific conferences. Approaches to financing the conference, conference fee, sponsors. Plenary session, sections, workshops. Forms of participation in the scientific conference, plenary report, sectional report, short message at the section, poster report.

Informational support of the scientific conference. Conference website, information sheet. Sending messages. Ethics of mailing and informational support of the conference.

Organizational and program committees of the scientific conference. Principles of program committee formation. Preliminary examination of the proposed papers as a guarantee of the authority of the conference and the high status of the materials published as a result of the conference.

Principles and organizational approaches to selection of reports for the conference. Peer-review of submitted papers as a widespread approach to the selection of reports. Preparation of evaluation criteria. Participation in the review of papers submitted to the conference. Avoiding conflicts of interest during peer review of submissions. Ethical issues of mutual evaluation.

Internet resources and specialized software to support the activities of organizational and program committees of scientific conferences. Software to support participation in scientific conferences. Internet resources that help to find a conference according to the specified field of research.

Sources of information about scientific conferences. Selection of a conference for approbation of the scientific research results. Submission of application and materials for the conference. Deadlines for submissions, compliance of deadlines. Content of the material presented for participation in the conference. Scientific novelty as a guarantee of high evaluation of report materials. The principles of academic integrity as an integral condition of the authority of the researcher and his recognition in the scientific community.

Preparation of materials for the report. Making a presentation. Recommendations for the presentation.

Ethics of scientific discussion. The regulation of the speech and its observance. Ethics of questions to the speaker, ethics of answers. Culture of scientific speech.

The list of practical studies in the course is given in table 2.

Table 2

The list of practical studies

Name of the topic and/or task	Content
Topic 1 Task 1	Analyzing the role of Science as a Part of Universal Culture of Humanity
Topic 2 Task 2	Development of a Deterministic Mathematical Model in Computer Science Field
Topic 3 Task 3	Development of a Stochastic Model in Computer Science Field
Topic 4 Task 4	Development of an Information Model in Computer Science Field
Topic 5 Task 5	Analyzing the Model Validity and Error
Topic 6 Task 6	Searching the Scientific Information According to Given Competences and Study Results
Topic 7 Task 7	Preparing Overview Paper According to Given Competences and Study Results
Topic 8 Task 8	Preparing and presenting a scientific conference report

The list of self-studies in the course is given in table 3.

Table 3

List of self-studies

Name of the topic and/or task	Content
Topic 1-8	Studying lecture material. Learning new material: reading and noting literary sources of information; watching videos
Topic 1-8	Preparation for practical classes. Software and documents development according to tasks
Topic 1-8	Training for the module assessment

The number of hours of lectures, practical (seminar) studies and hours of self-study is given in the technological card of the course.

TEACHING METHODS

In the process of teaching the course, in order to acquire certain learning outcomes, to activate the educational process, it is envisaged to use such teaching methods as:
Verbal (lecture (Topic 1–8), problem lecture (Topic 1–8)).
Visual (demonstration (Topic 1–7), illustration (Topic 1–8)).
Practical (practical work (Topic 1–8), presentation, speaking in front of the audience (Topic 1-8), business game (Topic 1, 8), interactive distance learning (Topic 1–8)).

FORMS AND METHODS OF ASSESSMENT

The University uses a 100-point cumulative system for assessing the learning outcomes of students.

Current control is carried out during lectures and practical classes and is aimed at checking the level of readiness of the student to perform a specific job and is evaluated by the amount of points scored:

- for courses with a form of semester control as grading maximum amount is 100 points; minimum amount required is 60 points.

The final control includes current control and assessment of the student.

Semester control is carried out in the form of grading

The final grade in the course is determined as the amount of all points received during the current control.

During the teaching the course, the following control measures are used:

Current control: proving the practical work results (80 points for semester); current assessment (20 points for semester).

Semester control: Grading.

More detailed information on the assessment system is provided in the technological card of the course.

RECOMMENDED LITERATURE

Main

1. Рекомендації щодо запобігання академічному плагіату та його виявлення в наукових роботах (авторефератах, дисертаціях, монографіях, наукових доповідях. статтях тощо). URL: https://zakon.rada.gov.ua/rada/show/v8681729-18

2. Наказ Міністерства освіти і науки України 12.01.2017 № 40 " Про затвердження Вимог до оформлення дисертації" із змінами, внесеними згідно з Наказом Міністерства освіти і науки № 759 від 31.05.2019. – Режим доступу : https://zakon.rada.gov.ua/laws/show/z0155-17#Text.

3. UNESCO Recommendation on Open Science (2021). – Режим доступу : https://unesdoc.unesco.org/ark:/48223/pf0000379949.locale=en pp. 17-18.

4. Пушкар О. І. Методологія та організація наукових досліджень [Електронний ресурс] : навч. посіб. / О. І. Пушкар ; Харківський національний економічний університет ім. С. Кузнеця. - Електрон. текстові дан. (9,76 МБ). - Харків : ХНЕУ ім. С. Кузнеця, 2020. - 866 с. : іл. - Загол. з титул. екрану. - Бібліогр.: с. 849-852. http://repository.hneu.edu.ua/handle/123456789/23346

5. Методичні рекомендації до оформлення звітів, курсових проєктів та дипломних робіт (проєктів) для студентів спеціальності 121 "Інженерія програмного забезпечення", 122 "Комп'ютерні науки", 126 "Інформаційні системи і технології": [Електронне видання] / уклад. І.О.Ушакова, Г.О.

Плеханова, О.М. Беседовський. – Х.: ХНЕУ ім. С. Кузнеця, 2021. – 48 с. – Режим доступу : http://www.repository.hneu.edu.ua/handle/123456789/27413

6. Методичні рекомендації до виконання магістерської дипломної роботи для студентів освітньо-професійної програми "Комп'ютерні науки" спеціальності 122 "Комп'ютерні науки" другого (магістерського) рівня [Електронний ресурс] / уклад. С. В. Мінухін, І. О. Ушакова, Д. Ю. Голубничий, О. В. Щербаков; Харківський національний економічний університет ім. С. Кузнеця. - Електрон. текстові дан. (127 КБ). - Харків : ХНЕУ ім. С. Кузнеця, 2021. - 38 с. - Загол. з титул. екрану. – Режим доступу : http://www.repository.hneu.edu.ua/handle/123456789/26552.

7. Kolgatin O. Stochastic process computational modeling for learning research / O. Kolgatin, L. Kolgatina, N. Ponomareva // Educational Dimension. – 2022. – Jun. 2022. – P. 68-83.. – DOI : https://doi.org/10.31812/educdim.4498. – Access mode : http://repository.hneu.edu.ua/handle/123456789/28513.

Additional

8. Fundamentals of Research Methods and Importance of Scientific Basis for Research // Edubirdie. – 2022, February 27. – Access mode : https://edubirdie.com/examples/fundamentals-of-research-methods-and-importance-of-scientific-basis-for-research/.

9. What Are the Different Types of Scientific Research? – Access mode : https://akjournals.com/page/types-of-scientific-research

10. Open Science in the scientific community. – Access mode : https://akjournals.com/page/open-science

11. March S. T., Smith G. F. Design and natural science research on information technology. – Access mode : https://www.researchgate.net/publication/222484351_Design_and_Natural_Science_Research_on_Information_Technology

Information resources

12. Scopus. – Access mode : https://www.scopus.com.

13. Google Scholar. – Access mode : https://scholar.google.com/.

14. Easy Chair. – Access mode : https://easychair.org/.

15. Web of Science. – Access mode : https://www.webofscience.com/wos/woscc/basic-search.

16. ORCID. – Access mode : https://orcid.org/.

17. Персональна навчальна система «Methodologies of Scientific Research». – Режим доступу : https://pns.hneu.edu.ua/course/view.php?id=10176.