Educational component syllabus
Academic discipline program

Fundamentals of scientific research

Code and name of specialty
E2 – Ecology

Institute
National Research Institute of Mechanical Engineering and Transport

Specialization
-

Chair
Chemical Engineering and Industrial Ecology (154)

Educational program
Engineering ecology

Type of discipline
General. Required

Education level
Second (Master's)

Form of study
Full-time, part-time

Semester
1

Language of instruction
Ukrainian

Teachers, developers

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Candidate of Technical Sciences, Professor of the Department of Chemical Engineering and Industrial Ecology, NTU "KhPI"

Work experience – 30 years. Author and co-author of over 100 scientific and educational and methodological works. Leading lecturer in the following disciplines:
"Technologies for ensuring environmental safety", "Modern problems of ecology", "Anti-corrosion protection of equipment", "New structural materials and design. More information about the teacher on the department website

General information

Annotation

The discipline is aimed at developing in applicants for the second (master's) level of higher education the knowledge and skills necessary to solve problems related to planning and conducting scientific research and implementation of their results

Purpose and objectives of the discipline

To form in students an understanding of the principles and mechanisms of conducting scientific research, analyzing and summarizing scientific literature, organizing experiments, processing results using mathematical statistics methods, and summarizing.

Class format

Lectures, practical work, essay, consultations. Final control - test.

Competencies

ZK-1. Ability to learn and master modern knowledge.

ZK-3. Ability to generate new ideas (creativity).
ZK-6. Ability to search, process and analyze information from various sources.
SK-1. Awareness at the level of the latest achievements necessary for research and/or innovation activities in the field of ecology, environmental protection and sustainable use of nature.
SK-4. The ability to apply new approaches to the analysis and prediction of complex phenomena, critical thinking about problems in professional activities.
SK-11. Ability to integrate modern scientific knowledge to develop and implement effective systems for environmental monitoring and risk management associated with man-made accidents and disasters
SK-12. Ability to use innovative tools and techniques to develop and optimize environmentally friendly technologies.

Learning outcomes

RN-1. Know and understand fundamental and applied aspects of environmental sciences.
RN-2. Be able to use conceptual ecological patterns in professional activities.
RN-3. Know the basic concepts of natural science, sustainable development, and the methodology of scientific knowledge at the level of the latest achievements.
RN-11. Be able to use modern information resources on ecology, nature management and environmental protection.
RN-17. Critically evaluate theories, principles, methods, and concepts from various subject areas to solve practical tasks and problems in ecology.
RN-18. Be able to use modern methods of processing and interpreting information when conducting innovative activities.
RN-21. Know modern methods and tools for conducting a comprehensive environmental audit and environmental monitoring, apply them to assess the state of the environment and the impact of various factors on it.

Scope of the discipline

The total duration of the course is 90 hours (3 ECTS credits): lectures – 16 hours, practical work – 16 hours, independent work – 58 hours.

Prerequisites for studying the discipline (prerequisites)

Possession of competencies and learning outcomes stipulated by the higher education standard education in the specialty E2 "Ecology" of the first bachelor's level, as well as general knowledge in natural sciences

Discipline features, teaching methods and technologies

Lectures are conducted interactively using multimedia technologies. Practical classes use reproductive and problem-solving teaching methods and
The focus is on solving real problems in scientific research.

Academic discipline program

Training sessions

Lectures

Lecture topics	Number of hours
Topic 1. Science and scientific research in the modern world. Characteristics of the process of scientific knowledge. Subjects and objects of knowledge.	4
Topic 2. The essence of scientific research. Types of research in science (qualitative and quantitative, fundamental and applied, theoretical and empirical).	4
Topic 3. Methodology of science.	4

The concept of method, technique, methodology, research procedure. The concept of the method of scientific knowledge. Classification of methods used in scientific research. The role theoretical research methods in scientific research. Types of theoretical research methods and their characteristics. The concept of a model and modeling. Empirical methods of scientific research, their essence and classification.	
Topic 4. Experiment. The essence of the experiment. Types of experiments. Planning of the experiment.	4
Topic 5. Technology of research work. The main stages of scientific research and the logic of their cognitive search.	4
Topic 6. Planning scientific research. Choosing a topic for scientific research that can be attributed to a specific scientific direction or to a scientific problem. Topics for scientific research: theoretical, practical and mixed. Stages performance of scientific research work. The concept of planning scientific research. Terminological and categorical apparatus of research. Scientific apparatus of research.. Plan of master's thesis (diploma) or course work.	4
Topic 7. Working with scientific information. Information approach in the methodology of cognition. Types and requirements for scientific publications: abstract, dissertations, preprint, collection of scientific works, materials of a scientific conference, abstracts of reports scientific conference, popular science publication. Scientometric databases, their varieties and features	4
Topic 8. Writing and formatting scientific papers for higher education students. Systematization of research results. Presentation of conclusions and recommendations in the form of methodological recommendations, scientific article, report abstract, course report, master's thesis report. Scientific article	4
Total hours	**32**

Practical classes

Topics of practical classes	Number of hours	Weighting factors *b*
Topic 1. Science and scientific research in the modern world	2	0.1
Topic 2. Fundamentals of scientific research methodology	2	0.1
Topic 3. Main stages of scientific research	2	0.1
Topic 4. Presentation of scientific research results.	2	0.1
Topic 5. Fundamentals of theoretical and experimental research.	2	0.1
Topic 6. Scientific work of education seekers. Main forms of implementation of scientific research results of education seekers	2	0.1
Topic 7. Information support for scientific research	2	0.3
Topic 8. Coursework as a type of scientific research	2	0.1
Total hours	**16**	$\sum_{i=1}^{n} b_i = 1$

Laboratory classes

Laboratory work is not provided within the discipline.

Tests

One final test covering theoretical and practical issues of the course and taking the form of a test using the Forms resource on the Office 365 platform

Topics of test papers	Weighting factors a
Test work	1
Total hours	$\sum_{i=1}^{n} a_i = 1$

Independent work

The course involves independent study of theoretical material and completion of an individual assignment in the form of an essay.

Studying theoretical material

Topics for self-study	Number of hours
Topic 1. Science and scientific research in the modern world. Scientific schools. Scientific revolutions. Contribution of Ukrainian scientists to science. Scientific medals and prizes of Ukraine and the world. Global crises and the problem of the importance of scientific and technological progress.	10
Topic 2. The essence of scientific research. Ethical principles for conducting scientific research. Academic integrity	10
Topic 3. Methodology of science. Principles of scientific research (unity of theory and practice, historicism, objectivity of coverage of scientific processes, comprehensive study of scientific processes, concreteness of truth, contradiction, negation, development, causality, systematicity). Approaches in the study of scientific phenomena (axiological, complex, structural, functional, formalized, holistic, activity, culturological, subject-object, differentiated, individual, modeling, systemic).	10
Topic 4. Features of the preparation, design and defense of scientific works by higher education students. Abstract and report as types of scientific works of higher education applicants. Features of preparing abstracts and reports. Coursework as a type of scientific research of higher education applicants. Stages of completing coursework. Basic requirements for writing and designing a master's thesis. Procedure for submitting a master's thesis to the department and defending it.	12
Total hours	**42**

Topics of individual tasks

The requirements for completing an individual task and the deadlines for completion are detailed in the link in the methodological instructions
https://repository.kpi.kharkov.ua/items/95226764-1836-4de5-8d24-3499a7175fc2

Individual assignment topics
Abstract topic: 1. Scientific research: concepts, types and forms of organization. 2. Sources of information, their classification. 3. The concept of copyright and scientific research.

4. Training of scientific personnel in modern Ukraine.
5. Library, its main departments.
6. A prospective plan for scientific research.
7. Forms and methods of working with a book in the process of scientific research.
8. Forms and techniques of lecture notes.
9. Structure of scientific work.
10. The role of hypothesis in scientific research.
11. Processing of scientific information in the research process.
12. Organization of science and training of scientific personnel: international experience and problems.
13. The importance of choosing methods in the process of scientific research.
14. Basic principles of scientific knowledge.
15. Functions of science in the society of information civilization.
16. The concept of method, the specifics of scientific research methods.
17. Methodology of scientific research, its levels.
18. Classification of sciences: history and modernity.
19. The concept of scientific revolution in T. Kuhn. Scientific paradigm.
20. The role of facts in scientific research.
21. Scientific hypothesis and its role in cognition
22. The concept of scientific theory, its essence and structure.
23. Scientific theory as the highest level of synthesis of knowledge.
24. Typology of scientific research methods: special and 25. general scientific methods.
26. System analysis as a general scientific research method.
27. Synergetics as a theory of self-organization and development of individual holistic systems.
28. Observation in scientific research.
29. The role of experiment in scientific research.
30. Theoretical methods in scientific research (hypothetico-deductive, axiomatic).
31. General logical methods in scientific research. Analysis and synthesis. Deduction and induction.
32. Monograph as a form of scientific work.
33. Scientific article and review as forms of scientific work.
34. Abstracts and theses as forms of educational and scientific work.
35. General characteristics of course and diploma work.
36. Specifics of preparing and defending a master's thesis.
37. The main stages of organizing scientific research, their relationship.
38. The first stage of scientific research is related to the choice of topic.
39. Formulation of the relevance and novelty of the work.
40. Formulation of the goal and objectives of the research.
41. Accumulation of scientific information in the research process: main problems.
42. Sources of information for scientific research
43. Using the Internet to search for scientific information.
44. Basic requirements for a scientific text.
45. The role of the hypothesis in the process of scientific research.
46. Preparation of an abstract as a stage of scientific research.
47. The problem of copyright protection in the modern era.
48. Scientific degrees and academic titles in the organization of scientific personnel.
49. Mathematization and computerization as leading trends in the development of modern science.
50. Ethical dimensions of scientific activity. 51. Main problems of the development of modern science in Ukraine.

Total hours	**16**

Informal education

The elements of non-formal education recommended in the syllabus can be credited according to a simplified procedure without additional validation of the results (creation of a subject commission).

Publication (conference abstracts, articles in professional publications, monographs, etc.) whose topic corresponds to practical work (work) can be credited instead of such types of work with the maximum score.

Recommended courses, trainings, internships

Literature, educational materials and information resources

Basic literature

1. Fundamentals of scientific research. Lecture course. [Electronic resource]: teaching aids for master's degree applicants in specialty 172 Electronic communications and radio engineering / O. B. Sharpan (comp.); Igor Sikorsky Kyiv Polytechnic Institute. — Electronic text data (1 file 348 KB, 4.58 auto. sheets). — Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2023. — 89 p.
https://ela.kpi.ua/bitstream/123456789/55928/1/OND_KL.pdf
2. Presentation of the results of scientific research [Electronic resource]: a teaching aid for candidates for the degree of Doctor of Philosophy in specialty 104 "Physics and Astronomy" / S. O. Reshetnyak, D. V. Savchenko; Igor Sikorsky Kyiv Polytechnic Institute. – Electronic text data (1 file: 9.4 MB). – Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2021. – 100 p.
https://ela.kpi.ua/bitstream/123456789/45714/1/Prezentatsiia_rezultativ_naukovykh_doslidzhen.pdf
3. Medvid V. Yu., Danko Yu. I., Koblyanska I. I. Methodology and organization of scientific research (in structural and logical diagrams and tables): textbook. Sumy: SNAU, 2020. 220 p.
https://agro.snau.edu.ua/wp-content/uploads/2020/11/20201113_100711.pdf
4. Fundamentals of scientific research: a textbook / Marta Malska, Natalia Pankiv. – Lviv: Publishing House of the Ivan Franko National University of Lviv, 2020. - 226 p.
https://geography.lnu.edu.ua/wp-content/uploads/2021/01/Osnovy-naukovykh-doslidzhen-Pan-kiv-Malska.pdf
5. Methodological instructions for practical classes and independent work on the discipline "Fundamentals of scientific research" for students of all forms of education / compiled by: V.B. Bayrachny, T.B. Novozhilova, N.M. Samoilenko; National Technical University "Kharkiv Polytechnic Institute". - Electronic text data. - Kharkiv: NTU "KhPI", 2024. - 36
https://repository.kpi.kharkov.ua/server/api/core/bitstreams/183daca4-e3d5-4e99-9a1b-9f5aeaf7c928/content

Additional literature

1. Fundamentals of scientific research. Modeling of metal cutting processes: a textbook / I. E. Yakovenko, O. A. Permyakov, Yu. V. Petrakov, O. I. Drachev; National Technical University "Kharkiv Polytechnic Institute".
— Kharkiv: NTU "KhPI", 2021. — 142 p . http://library.kpi.kharkov.ua/uk/node/21000
2. Methodological guidelines for independent work on the course "Fundamentals of Scientific Research" for
students of specialty 053 "Psychology" of all forms of study / Compiled by: Stotsky Ya.V. – Ternopil: Ivan Pulyuy Ternopil National Technical University, 2018. – 36 p.
https://elartu.tntu.edu.ua/bitstream/lib/24898/1/OND_Metodychka-samostijni-zanjattja.pdf
3. Kolesnikov, O. V. Fundamentals of scientific research: a teaching manual / O. V. Kolesnikov. — 2nd ed., corrected and supplemented — K.: Center for Educational Literature, 2011. — 144 p.
http://library.kpi.kharkov.ua/uk/education_science_ond
4. Partiko, Z. V. Fundamentals of scientific research: preparation of a dissertation: textbook / Z. V. Partiko; scientific editor. V. E. Bakhrushin. — 2nd ed., revised and supplemented — Kyiv: Lira-K, 2018. — 232 p. http://library.kpi.kharkov.ua/uk/education_science_Osnado

Information resources

1.
https://web.kpi.kharkov.ua/htpe/vebinar-metodologichni-osnovy-napysannya-naukovyh-tez-dopovidej/

2.
https://fsm.kubg.edu.ua/pro-fakultet/podii/1966-onlain-vebinar-orhanizatsiia-naukovoi-roboty-ta-vymohy-do-oformlennia-rezultativ-naukovykh-doslidzhen.html

Evaluation system

The final grade for the educational component is determined by the responsible lecturer according to topics, types of classes, etc. in accordance with the syllabus and is an integral assessment of the results of all types of educational activities of the higher education applicant. The final grade should reflect all grades for the components of the educational process, taking into account their weighting indicators k :

Current control (practical, seminar, laboratory classes),k_1	Tests (if available),k_2	Individual assignment (if available),k_3	Final control (for OK with exam),k_4
0.35	0.3	0.35	

The sum of the coefficients must be one: $k_1 + k_2 + k_3 + k_4 = 1$. The selection of weighting coefficients for the final assessment is carried out by the course developer.
The final grade is calculated using the formula:

$$О = П \cdot k_1 + K \cdot k_2 + І \cdot k_3 + Пк \cdot k_4$$

where: П– weighted average score for current control
І– assessment for completing an individual task
K– weighted average grade for tests
Пк– final exam score

$$K = \frac{K_1 \cdot a_1 + \ldots + K_n \cdot a_n}{\sum_{i=1}^{n} a_i}$$

where: a_i- weight coefficient for each test work.

$$П = \frac{П_1 \cdot b_1 + П_2 \cdot b_2 + \ldots + П_n \cdot b_n}{\sum_{i=1}^{n} b_i}$$

where: b_i- weighting factor for each practical (seminar) or laboratory session.

Current grades for each component (П, K, І,…) are set on a 100-point scale in accordance with the regulation "On the criteria and system for assessing knowledge and skills and on the rating of higher education applicants" of NTU "KhPI" .

The final grade is given in accordance with the calculated Ograde, rounded up to the nearest whole number.

Rating scale

Total points	National assessment	ECTS
90–100	Perfectly	A
82–89	Good	B
75–81	Good	C
64–74	Satisfactorily	D
60–63	Satisfactorily	E
35–59	Unsatisfactory (additional study required)	FX
1–34	Unsatisfactorily (re-study required)	F

Academic Ethics Standards and Course Policies

A higher education student must adhere to the "Code of Ethics for Academic Relations and Integrity of NTU "KhPI": to demonstrate discipline, politeness, friendliness, honesty, and responsibility. Conflict situations should be openly discussed in study groups with the teacher, and if the conflict cannot be resolved, they should be brought to the attention of the institute's management staff.
Regulatory and legal support for the implementation of the principles of academic integrity of NTU "KhPI" is posted on the website: http://blogs.kpi.kharkov.ua/v2/nv/akademichna-dobrochesnist/

Coordination

Syllabus agreed

08/30/2025

Head of the Department
Alexey SHESTOPALOV

08/30/2025

Guarantor OP
Evgenia MANOYLO