



**MODERN SCIENTIFIC APPROACHES TO SUSTAINABLE DEVELOPMENT IN
ECOLOGY.
COURSE WORK**

Work program of the educational component (Syllabus)

Details of the educational component

Higher education level	<i>Second (Master's)</i>
Field of Knowledge	<i>E Natural Sciences, Mathematics and Statistics</i>
Speciality	<i>E2 Ecology</i>
Educational program	<i>Digital technologies for environmental protection</i>
Status of the educational component	<i>Normative</i>
Form of study	<i>full-time (full-time)/mixed</i>
Year of preparation, semester	<i>1st year, spring semester</i>
Scope of the educational component	<i>1/(30)</i>
Semester control / control measures	<i>Passed</i>
Class schedule	<i>-</i>
Language of instruction	<i>Ukrainian</i>
Information about the course leader / teachers	Teacher: https://eco-paper.kpi.ua/pro-kafedru/vykladachi/nosachova-yuliya-viktorivna.html
Course placement	https://do.ipk.kpi.ua/course/view.php?id=2151

Program of the educational component

1. Description of the educational component, its purpose, subject of study and learning outcomes

1.1. The purpose of the educational component.

The purpose of the educational component is to form the following competencies in students:

- 1. Ability to learn and master modern knowledge;*
- 2. Ability to generate new ideas (creativity);*
- 3. Ability to search, process and analyze information from various sources;*
- 4. Ability to develop and improve methods and technologies;*
- 5. • Awareness at the level of the latest achievements necessary for research and/or innovation activities in the field of ecology, environmental protection and balanced nature management;*
- 6. Ability to use the principles, methods and organizational procedures of research and/or innovation activities;*
- 7. Ability to organize work related to the assessment of the ecological state, environmental protection and optimization of nature management, in conditions of incomplete information and contradictory requirements;*
- 8. Ability to self-educate and improve skills based on innovative approaches in the field of ecology, environmental protection and balanced nature management;*
- 9. Ability to independently develop environmental projects by creatively applying existing ones and generating new ideas;*

10. Ability to assess the level of negative impact of natural and anthropogenic environmental hazards on the environment and humans.

1.2. The main program learning outcomes of the educational component.

According to the requirements of the educational and professional program, students after mastering the educational component must demonstrate the following program learning outcomes:

1. Know and understand the fundamental and applied aspects of environmental sciences
2. Be able to use conceptual ecological patterns in professional activities
3. Know at the level of the latest achievements the basic concepts of natural science, sustainable development and methodology of scientific knowledge;
4. Be able to clearly and unambiguously convey professional knowledge, own justifications and conclusions to specialists and the general public;
5. Demonstrate the ability to organize collective activities and implement complex environmental projects, taking into account available resources and time constraints;
6. Demonstrate awareness of the latest principles and methods of environmental protection;
7. Be able to use modern information resources on ecology, nature management and environmental protection;
8. Be able to assess landscape and biological diversity and analyze the consequences of anthropogenic impact on natural environments;
9. Be able to assess the potential impact of man-made objects and economic activities on the environment;
10. Apply new approaches to develop a decision-making strategy in difficult unpredictable conditions;
11. Assess environmental risks under conditions of insufficient information and conflicting requirements
12. Choose the optimal management and/or nature management strategy depending on environmental conditions;
13. Critically comprehend theories, principles, methods and concepts from various subject areas to solve practical problems and problems of ecology
14. Be able to use modern methods of processing and interpreting information in carrying out innovative activities
15. Be able to independently plan the implementation of an innovative task and formulate conclusions based on its results
16. Possess the basics of environmental engineering design and environmental expert assessment of environmental impact
17. Know the main advantages of resource-efficient industries (economic, environmental, financial, legal), the main directions of reorganization of existing industries to ensure the rational use of natural resources, energy, preservation of the health of the company's personnel and the population in a given area;
18. To modernize the environmental control systems of the enterprise taking into account modern standards of environmental management in compliance with the principles of resource efficiency within the framework of the sustainable development strategy.

Pre-requisites and post-requisites of the educational component (place in the structural and logical scheme of education according to the relevant educational program)

The educational component "Modern scientific approaches to sustainable development in ecology. Course work" is preceded by academic disciplines, such as: "Chemistry with the basics of biogeochemistry", "Analytical chemistry", "Technology and equipment for atmospheric protection", "Waste disposal and recovery", "Membrane methods of water purification", "Physical and chemical foundations of water purification processes by coagulation", "Sorption and ion exchange in water purification technologies", "Water purification by flotation", which were studied during bachelor's studies. The educational component "Promising areas of scientific research in environmental protection" provides the disciplines "Fundamentals of Certification and Statistics in Ecology",

"Standards and Technical Information in Ecology", "Resource-Efficient and Waste-Free Technologies", "Fundamentals of Certification and Statistics", master's thesis.

19. CONTENT OF THE EDUCATIONAL MATERIAL

Chapter 1. General information about the concept of science.

General information about the concept of science. The main tasks of science. Science as a system of knowledge. System of organization of scientific research. System of training of scientific personnel.

Chapter 2. Methodology of scientific research

Methods of scientific research. Methods of empirical level research. Methods of theoretical level of research. Basic rules for putting forward and testing a hypothesis. Requirements for new theories. Methods of theoretical and empirical levels of research. The main stages of scientific research.

Chapter 3. Information search in scientific research

Scientific information and its organization. The most important sources of information in the field of ecology. Abstract information. Express information. Patent information. Patent search. Methods of working with scientific literature.

Chapter 4. Mathematical planning of the experiment

Planning of experiments and its tasks. Basic concepts of the mathematical theory of experiment planning. Full factor experiment. Fractional factor experiment.

Chapter 5. Conducting experimental research

General concepts of experiment. Development and design of laboratory installations. Organization and conduct of experimental research. Measurements, measuring instruments and their characteristics. Modeling of physical phenomena and technical devices.

Chapter 6. Processing the results of experimental research and their design

Statistical analysis of the results of the experiment. Determination of experiment errors. Detection of gross errors. The use of computers in scientific research. Preparation of experimental research results for publication. Preparation of an article, report, abstract. Deposit of handwritten works. Special requirements for the design of materials of various scientific journals. Legislation of Ukraine on Patenting. Registration and filing of an application for an invention, patent. Algorithm for solving inventive problems. Registration of research results in the form of a scientific report. Structure of the R&D report. Requirements for its registration.

Training materials and resources

Basic

1. Nosacheva Yu.V., Ivanenko O.I., Radovenchyk Y.V. Fundamentals of Scientific Research. Kyiv: Condor Publishing House, 2020. – 294 p. 130 p. (in Russian).
2. Promising areas of scientific research in environmental protection. Laboratory practicum [Electronic resource]: study. Manual. for students. specialty 101 "Ecology" / KPI. Igor Sikorsky; compiled by: T. O. Shabliy, Y. V. Nosachova, O. I. Ivanenko. – Electronic text data (1 file: 131 KB). – Kyiv: KPI. Igor Sikorsky, 2022. – 86 p. (in Russian).
3. Nosacheva Y.V. Methodical Instructions for the Implementation of Course Work on the Course "Perspective Directions of Scientific Research in Environmental Protection" Certificate No E 02/13-09 dated 24.12.2012.

Secondary

4. Partyko Z. Fundamentals of scientific research. Preparation of a dissertation. – Kyiv: Lira-K, 2017. – 232 p. (in Russian).
5. Kolesnikov O. V. Fundamentals of scientific research. – Kyiv: TsNL, 2019. – 144 p. (in Russian).
6. Anatoly Konversky. Fundamentals of methodology and organization of scientific research. – Kyiv: TsNL, 2019. – 350 p. (in Russian).
7. State Standard of Ukraine. DSTU 8302:2015 Information and documentation. Bibliographic reference. General provisions and rules of assembly.

Information resources on the Internet

<https://www.grafiati.com/uk/>

[Http://ukrlit.org/transliteratsiia#source=0jhqu9c+0yjquc40l3qsa==](http://ukrlit.org/transliteratsiia#source=0jhqu9c+0yjquc40l3qsa==)

Professional Association of Ecologists of Ukraine (PAEU) - <https://pae.com.ua/>

Educational content

1. Methods of mastering the educational component

<i>Semester week</i>	<i>Name of the stage of work</i>	<i>Study time of the SRS</i>
1-2	Getting a topic and assignment	0,5
3-5	Selection and study of literature sources	5
6-8	Selection and justification of objects and methods of research	4
9	Description of methods and methods implemented in research	1
10-13	Conducting experimental research	10,5
14	Calculation of the results obtained	4
15	Drawing up an explanatory note	4
16	Submission of course work for review	0,5
17-18	Course work defense	0,5

Providing program results with components of the educational component

<i>Name of PR</i>	<i>Individual task</i>
<i>Know and understand fundamental and applied aspects of environmental sciences</i>	<i>Selection and study of literature sources Description of methods and methods implemented in research</i>

<i>you use conceptual ecological patterns in professional activities</i>	<i>Selection and study of literature sources Selection and justification of objects and methods of research Description of methods and methods implemented in research</i>
<i>Know at the level of the latest achievements the basic concepts of natural science, sustainable development and methodology of scientific knowledge</i>	<i>Selection and study of literature sources Selection and justification of objects and methods of research Description of methods and methods implemented in research</i>
<i>Demonstrate the ability to organize collective activities and implement complex environmental projects, taking into account available resources and time constraints</i>	<i>Selection and justification of objects and methods of research</i>
<i>Be able to clearly and unambiguously convey professional knowledge, own justifications and conclusions to specialists and the general public</i>	<i>Selection and justification of objects and methods of research</i>
<i>Demonstrate awareness of the latest environmental principles and practices</i>	<i>Selection and study of literature sources Selection and justification of objects and methods of research Description of methods and methods implemented in research</i>
<i>Be able to use modern information resources on ecology, nature management and environmental protection</i>	<i>Selection and study of literature sources Description of methods and methods implemented in research Course work defense</i>
<i>Be able to assess landscape and biological diversity and analyze the consequences of anthropogenic impact on natural environments</i>	<i>Selection and study of literature sources Selection and justification of objects and methods of research</i>
<i>Be able to assess the potential impact of man-made objects and economic activities on the environment</i>	<i>Selection and study of literature sources Selection and justification of objects and methods of research</i>
<i>Apply new approaches to develop a decision-making strategy in difficult unpredictable conditions</i>	<i>Selection and study of literature sources Selection and justification of objects and methods of research</i>
<i>Assess environmental risks under conditions of insufficient information and conflicting requirements</i>	<i>Description of methods and methods implemented in research</i>
<i>Choose the optimal management and/or environmental management strategy depending on environmental conditions</i>	<i>Description of methods and methods implemented in research</i>
<i>Critically comprehend theories, principles, methods and concepts from various subject areas to solve practical problems and problems of ecology</i>	<i>Selection and justification of objects and methods of research Course work defense</i>
<i>Be able to use modern methods of processing and interpreting information in carrying out innovative activities</i>	<i>Conducting experimental research Calculation of the results obtained</i>

<i>Possess the basics of environmental engineering design and environmental expert assessment of environmental impact</i>	<i>Selection and justification of objects and methods of research Conducting experimental research</i>
<i>Be able to independently plan the implementation of an innovative task and formulate conclusions based on its results</i>	<i>Conducting experimental research Calculation of the results obtained Drawing up an explanatory note</i>
<i>Know modern approaches to the organization of environmentally friendly production, reorganization and reconstruction of existing industries from the standpoint of resource saving, taking into account the life cycle of the product</i>	<i>Selection and study of literature sources Description of methods and methods implemented in research</i>
<i>To analyze the results of environmental control of enterprises, to assess the engineering and technical level of environmental protection from the harmful effects of production</i>	<i>Conducting experimental research Calculation of the results obtained Drawing up an explanatory note Course work defense</i>

List of topics (options for initial data)

1. Wastewater treatment in the fish processing industry.
2. Water treatment for the needs of an urban-type settlement.
3. Preparation of drinking water from underground water supply sources.
4. Disposal of solid household waste.
5. Ecological fuel based on coal enrichment waste.
6. Membrane purification of water from biphenol-A.
7. Hybrid silica coatings for environmentally friendly anti-corrosion protection of aluminum.
8. Removal of sulfates from wastewater by the reagent method.
9. Complexation in water purification from fluorides.
10. Coal and mineral sorbents and their modification.
11. Modern methods of biological wastewater treatment.
12. Coal and mineral sorbents and their modification.
13. Purification of water from nitrates by reagent-enhanced ultrafiltration.
14. Wastewater treatment of animal complexes.
15. Treatment of wastewater of galvanic enterprises from chromium compounds.
16. Features of wastewater treatment of a meat processing plant.
17. Wastewater treatment of margarine production.
18. Wastewater treatment of municipal waste landfills.
19. Solid waste collection and disposal system.
20. Development of a technology for cleaning wastewater from car washes.
21. Wastewater treatment technology of the yeast plant.
22. Purification of storm water from the territory of cities.
23. Ecological fuel based on highly concentrated suspensions of brown coal.
24. Stabilization water treatment for water circulation systems.
25. Closed recirculating cooling systems.
26. Treatment of municipal wastewater.

The initial data for options 15 and 26 are given in Appendix A.

The names of topics and initial data are specified for each student of the group when forming the final list of names and purposefully, taking into account the requirements of interested enterprises and organizations.

Rating system for assessing learning outcomes

The rating assessment for the course work is 100-point and has 2 components: 1 component - assessing the current state of the problem; substantiation and selection of theoretical and experimental methods of studying the assigned tasks; scientific analysis and generalization of factual material; use of

mathematical methods for planning an experiment; 2 component of the ability to adequately present the work when defending the term paper. The size of the scale of components is 20 points each.

Regulations on the rating system for assessing student performance in the course work of the credit module "Promising areas of scientific research. Course work" is given in Appendix B.

Methodological recommendations

The term paper consists of a report on the course work and illustrative material for the defense of the work.

The following general requirements are set for reports on course work, as well as scientific essays, term papers and diploma papers: clarity and logical sequence of presentation of the material; persuasiveness of argumentation; brevity and accuracy of wording, including the possibility of ambiguous interpretations; specificity of presentation of the results of work; validity of recommendations and suggestions.

The report on the course work should contain the following structural elements: title page, abstract, content, introduction, essence of the report; conclusions, list of references, appendices.

To provide students with methodological literature, methodological guidelines for the implementation of course work [3], recommended by the Academic Council of the IHF, have been developed.

Policy and control

20. Policy of the academic discipline (educational component)

Rules for attending classes and behavior in the classroom

Students are obliged to take an active part in the educational process, not to be late for classes and not to miss them without a good reason, not to interfere with the teacher's conduct, not to be distracted by actions not related to the educational process.

Rules for assigning incentive and penalty points

Semester certification is carried out in the form of a course work defense. To assess learning outcomes, a 100-point rating system and a university scale are used.

Rules for assigning incentive and penalty points

- Incentive points are not provided within the academic discipline
- Penalty points are not provided within the academic discipline.

Deadline and retake policy

In case of arrears in the academic discipline or any force majeure circumstances, students should contact the teacher through the available (provided by the teacher) communication channels to solve problematic issues and agree on an algorithm of actions for practice.

Academic Integrity Policy

Plagiarism and other forms of dishonest work are unacceptable. Plagiarism includes the absence of references when using printed and electronic materials, quotes, opinions of other authors. Hints and cheating are unacceptable when writing tests, conducting classes; passing a test for another student; copying materials protected by the copyright system without the permission of the author of the work.

The policy and principles of academic integrity are defined in Section 3 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute". Read more: <https://kpi.ua/code>

Academic Conduct and Ethics Policy

Students should be tolerant, respect the opinions of others, formulate objections in the correct form, and constructively maintain feedback in the classroom.

The norms of ethical behavior of students and employees are defined in Section 2 of the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute". Read more: <https://kpi.ua/code>

21. Types of control and rating system for assessing learning outcomes (RSO)

The rating assessment of the course work has two components. The first (starting) characterizes the student's work on course design and its result - the quality of the explanatory note and graphic material. The second component characterizes the quality of the student's defense of the course work.

The scale size of the starting component is 40 points, and the defense component is 60 points.

1. Starting Warehouse:

- timeliness of the schedule of work on course design – 5-3 points;
- assessment of the current state of the problem – 12-7 points;
- substantiation and selection of theoretical and experimental methods of research of the assigned

tasks – 10-6 points;

- scientific analysis and generalization of factual material – 6-4 points;
- the use of mathematical methods of experiment planning – 7-4 points.

2. Component of the course work defense:

- the quality of the report – 10-6 points;
- degree of mastery of the material – 15-9 points;
- the degree of justification of the decisions made – 15-9 points;
- the ability to defend one's opinion – 20-12 points.

The sum of the points of the two components is converted to the credit score according to the table:

Points Starting component + protection component	Score
100... 95	Perfectly
94... 85	Very good
84... 75	Well
74... 65	Satisfactory
64... 60	Enough
Less than 60	Disappointing
The course work is not allowed to be defended	Not allowed
Violation of the principles of academic integrity or moral and ethical norms of behavior	Eliminated

22. Additional information on the educational component

Table A.1. Initial data for the development of methods for municipal wastewater treatment.

Indicator	Indicator value
Consumption	40,000 m ³ /day
Suspended substances	280 mg/dm ³
BSC _{Full}	283 mg/dm ³
Content of fats and floating organic impurities	Up to 22 mg/dm ³
pH reaction	7,3
Chemical oxygen consumption	677 mg/dm ³
Ammonium nitrogen	29.6 mg/dm ³
Phosphates	19.3 mg/dm ³
Chlorides	119.5 mg/dm ³
Sulphates	81.95 mg/dm ³
Iron	3.15 mg/dm ³
Water consumption	10000 m ³ /day

Table A.2. Requirements for purified water

Nº	Wastewater quality indicators	Requirements for purified water	Background concentration
1	Temperature, °C	≤5	14,4
2	Ph	6,5 – 9,0	8,1
3	Dry residue, mg/dm ³	≤1000	1000
4	Dissolved oxygen, mg/dm ³	≥6	5,5
5	Suspension concentration, mg/dm ³	≤ 0,25-0,75	24,8
6	Petroleum products, mg/dm ³	≤0,85	0,55
7	Chemical oxygen consumption, mg/dm ³	80	40
8	BSC _{full} , mg/dm ³	15	6,5
9	Sulfates, mg/dm ³	100	120,1

10	Phosphates, mg/dm ³	0,1 - 0,2	2,4
11	Chlorides, mg/dm ³	≤350	34,9
12	Ammonium nitrogen, mg/dm ³	0,2-0,6	1,7
13	Total iron content, mg/dm ³	0,50	0,77
14	Aluminum, mg/dm ³	0,90	0,84

Table A.3. Characteristics of wastewater and requirements for purified water of electroplating industries

№	Indicator name	Characteristics of wastewater	Requirements for purified water
	Consumption, m ³ /day	10	
1	pH	5,5 - 7	6,5 - 9
2	Content, mg/dm ³ : suspended pH	15	350
3	Nitrates	15	-
4	Sulphates	30	500
5	Chlorides	45	350
6	iron	3	5
7	zinc	5	0,3
8	Chromium(III)	10	1
9	Chromium(VI)	100	0,1
10	Mineralization	150	1000

Work program of the educational component (syllabus):

Compiled by Assoc. Prof., Ph.D., Nosachova Y.V.

Approved by the Department of ___E and TPP___ (Minutes No. 4 dated 08.10.2025)

Approved by the FAPIE Methodological Commission (Minutes No. 2 dated 15.10.2025)