National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Department of Ecology and Plant Polymers Technology

Processing of Scientific and Technical Information

Work Program of the Discipline (Silabus)

Discipline Details	
Level of higher education	***Second (master's)***
Branch of knowledge	*10 Natural sciences*
Specialty	*101 Environmental Studies*
Educational program	*Environmental safety*
Discipline status	*Selective*
Form of study	*Full-time (day)| distance| mixed*
Year of preparation, semester	*1st course, spring semester*
The scope of discipline	*4 (120)*
Semester control / control measures	*Offset*
Lessons schedule	*3 hours a week (2 hour of lectures,1 hour of laboratory work)*
Language of instruction	*Ukrainian*
Information about course leader / teachers	*Lecturer: https://eco-paper.kpi.ua/pro-kafedru/vykladachi/vizytky/sirenko-lyudmila-viktorivna.html* ***Practical classes*** */ https://eco-paper.kpi.ua/pro-kafedru/vykladachi/vizytky/sirenko-lyudmila-viktorivna.html*
Course placement	*https://do.ipo.kpi.ua/course/view.php?id = 6473*

Academic Discipline Program

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

The global changes in ecological systems that are taking place today are the result of the effects of human activities. Therefore, an important task of science is to predict changes in ecological systems under the influence of natural and anthropogenic factors. The application of processing scientific and technical information methods in ecology makes it possible to build mathematical models of ecological objects or processes, estimate their parameters, test hypotheses about the properties of these indicators and the forms of their connection, which ultimately serves as the basis for analysis, forecasting and making informed decisions in the field of environmental protection.

The subject of the discipline «Processing of Scientific and Technical Information» *- comprehensive, practical use of methods of collection, processing, interpretation of scientific and*

technical environmental information in conditions of uncertainty and finding the relationship between environmental factors and processes, for analysis and forecasting of the state of the environment.

The purpose of discipline «Processing of Scientific and Technical Information. *The purpose of studying this discipline is the formation of master's complex knowledge on the application of methods of processing and interpretation of scientific and technical environmental information to determine general trends in the development of ecological processes and to make informed decisions in the field of management of environmental activities.*

According to the goal, the training of masters in this specialty requires the formation of the following competencies:

- *Ability to search, process and analyze information from various sources. 3**K06.***
- *Ability to organize works related to environmental assessment, environmental protection and optimization of nature use in conditions of incomplete information and conflicting requirements. FK08.*
- *The ability to collect and process information in order to obtain parameters characterizing the state of the environment. FC14*

*According to the program requirements of the educational discipline **"Processing of scientific and technical information"**, students must demonstrate the following learning outcomes after mastering it:*

- *Know and understand fundamental and applied aspects of environmental sciences. **PR01.***
- *Know the latest methods and instrumental means of environmental research, including methods and means of mathematical and geo-informational modeling. **PR06.***
- *Be able to use modern methods of information processing and interpretation when conducting environmental research. **PR18.***

2. Pre-requisities and post-requisities of the discipline (place in the structural and logical scheme of the education according to the relevant educational program)

*The study of the discipline **"Processing of scientific and technical information"** is based on the principles of integration of various knowledge obtained by students during the bachelor's degree when studying natural and engineering disciplines. The discipline **"Processing scientific and technical information" should** ensure the solution of complex problems in the field of environmental protection in the assessment of the state of the environment, rational use of natural resources.*

3. The content of the discipline

Section 1. Statistical methods of processing and analysis of scientific and technical environmental information.

Applying methods peculiarities of mathematical statistics in ecological research. Primary statistical processing of experimental data. A number of observations, general and selective populations. Statistical observations and indicators. Types, schemes and methods of data selection. Ranking of a series of statistical population, range of variation, number of intervals of random variable for generalization of statistical data. Graphic construction of the histogram of the distribution and the curve of accumulated frequencies. Determination of statistical characteristics of random variables: centers of grouping and measures of variation. Interval estimates of distribution parameters. Errors of selective observation.

Section 2. Statistical hypotheses.

Statistical hypotheses, selection of statistical test characteristics, determination of significance level, area of hypothesis acceptance and critical area. Statistical hypothesis testing scheme. Basic parametric statistical criteria. Testing the hypothesis about the mathematical expectation of a normally distributed population. Testing the hypothesis about the significance of the difference in mathematical expectations of two normally distributed populations.

Section 3. Models of statistical relationships in ecology.

Prognostic pattern recognition scheme of background air pollution. Prognostic scheme of air pollution taking into account weather conditions and atmospheric stability.Elements of the theory of correlation and regression analysis. Sampling straight line regression equation. Adequacy of regression models.

4. Training materials and resources

4.1. Basic literature

1. Probability theory and mathematical statistics: educational manual. Barkovsky V.V. - K. Center of educational literature. 2016, – 422 p.
2. Mathematical statistics.: educational manual. V. M. Rudenko - K. Center of educational literature. 2017.– 303 p.
3. Zhlukhtenko V.I., Nakonechnyi S.I. Probability theory and mathematical statistics: education-methodological manual. - Part 1. Theory of probabilities. - K.: KNEU, 2000. - 304 p.
4. Zhlukhtenko V. I., Nakonechny S. I. Probability theory and mathematical statistics: Educat. method. manual. - Part 2. Mathematical statistics. - K.: KNEU, 2001.-336 p.
5. Sirenko L.V., Radovenchyk Y.V. Methods of mathematical statistics in ecology. Laboratory practice. Study guide for students majoring 101 – "Ecology". - K: KPI, 2018.-72 p.

4.2. Additional literature

6. Methodical instructions for conducting practical classes and performing independent work from the course "Methods of mathematical statistics in ecology" [Electronic resource] / Red. Sirenko L.V. - Kyiv: NTUU»KPI», 2012.-http://library.kpi.ua.
7. Methodological instructions for course work in the discipline "Mathematical statistics methods in ecology" / L.V. Sirenko - K.: Entepreneur Bubon O.I. 2012. – 55 p.
8. Slipchenko V.G., Brydun E.V. etc.. Environmental and economic damages: quantitative assessment. Kyiv, "Polytechnic", 2001.

Informational internet resources

1. Ministry of Environmental Protection and Natural Resources of Ukraine- https://mepr.gov.ua/
2. Industrial ecology. Community of ecologists - http://www.eco.com.ua/
3. Professional Association of Environmentalists of Ukraine- https://paeu.com.ua/
4. State Statistics Service of Ukraine - http://www.ukrstat.gov.ua/

Educational Content

5. Mastering methods of academic discipline (educational component)

Lecturers

Lectures are aimed at: providing modern knowledge in the discipline " Processing scientific and technical information"; ensuring in the course of the lecture the active work of students in order to form in them the necessary interest in the discipline, the development of independent creative thinking; accessibility for perception by the given audience, explanation of all newly introduced terms and concepts; highlighting the main ideas and provisions, emphasizing the conclusions.

№	Title of the lecture and a list of key issues (list of teaching aids, references to literature and tasks for independent work of students (IWS))	Hours
1	Mathematical methods of processing scientific and technical information. Application peculiarities of mathematical statistics methods in ecological research. Tasks on IWS: the law of large numbers. Literature: 1; 3 p. 75-99; 4 p.4-32; 7 p. 6-11.	2

2	*Primary statistical processing of experimental data. A number of observations, general and selective populations. Statistical observations and indicators. Tasks on IWS: Types, schemes and methods of data selection. Literature: 3 p. 75-99; 4 p.4-32; 7 p. 6-11.*	***2***
3	*Ranking of statistical population series, range of variation, number of intervals of random variable for generalization of statistical data. Graphic construction of the histogram of the distribution and the curve of accumulated frequencies. Tasks on IWS: empirical distribution function and its properties. Literature: 4 p. 4-32; 7 p. 6-11*	***2***
4,5	*Determination of statistical characteristics of random variables: centers of grouping and measures of variation. Tasks on IWS: group statistical indicators. Literature: 2 p. 43-61; 6; 7 p. 13-17.*	***4***
6	*Interval estimates of distribution parameters. Tasks on IWS: Normal population distribution law. Literature: 1; 2; 4 p. 43-85; 7 p. 18-24.*	***2***
7	*Errors of selective observation. Task on SRS: Confidence interval for the sample mean Literature: 4 p. 61-85.*	***2***
8,9	*Statistical hypotheses. Selection of the statistical characteristics of the test, determination of the significance level. The area of acceptance of the hypothesis, the critical area. Statistical hypothesis testing scheme. Tasks on IWS: errors of the first and second kind when testing statistical hypotheses. Literature: 2; 4 p. 112-153; 3 p. 206-218; 7 p. 26-34*	***4***
10	*Basic parametric statistical criteria. Tasks on IWS: give answers to control questions. Literature: 2; 4 p. 112-153; 7 p. 26-34*	***2***
11	*Testing the hypothesis about the mathematical expectation of a normally distributed population. Task on IWS: Testing the hypothesis about the variance of a normally distributed population. Literature: 4 p. 112-153; 7 p. 26-34*	***2***
12	*Testing the hypothesis about the significance of the difference in mathematical expectations of two normally distributed populations. Tasks on IWS: Verification of the hypothesis about the equality of variances of normally distributed populations. Literature: 2; 4: 7 p. 26-34*	***2***
13	*Prognostic pattern recognition scheme of background air pollution. Tasks on IWS: The main indicators of background air pollution in the city. Literature: 5p. 53-56.*	***2***
14	*Prognostic scheme of air pollution taking into account weather conditions and atmospheric stability. Tasks on IWS: give answers to control questions. Literature: 5 ; 8*	***2***
15	*Elements of correlation and regression theory. Literature (1,3). Tasks on IWS: correlation moment, sample correlation coefficient. Literature: 4 p. 173-220; 7 p. 36-46.*	***2***
16,17	*Sampling straight line regression equation. Tasks on IWS: checking the significance of the sample correlation coefficient at a given reliability Literature: 4; 7.*	***4***
18	*Adequacy of regression models. Adequacy criteria. Tasks on IWS: the method of least squares. Literature: 2: 4 p. 173-220; 7 p. 36-46*	***2***
	Total hours	***36***

Practical classes

Practical classes, being a supplement to the lecture course, lay and form the basis of the qualification of masters in ecology, namely for solving problems in the field of processing, analysis and interpretation of environmental information. The content of these classes and the method of conducting them should

ensure the development of the creative activity of the individual. They develop scientific thinking and the ability to use special terminology, allow to check knowledge, therefore this type of work is an important means of operational feedback. Practical classes should perform not only cognitive and educational functions, but also contribute to the growth of students as creative workers in the field of environmental protection.

The main tasks of practical classes:

- help students systematize, consolidate and deepen knowledge of a theoretical nature in the field of statistical processing of environmental data;

- teach students how to solve practical problems, to promote the mastery of skills and abilities to perform calculations, graphic and other tasks;

- teach them to work with scientific and reference literature and diagrams;

- form the ability to learn independently, that is, to master the methods and techniques of self-learning, self-development and self-control.

№	***Name of practical classes and list of main questions (a list of didactic support, references to the literature and tasks on the IWS)***	***Hours***
1	*Ranking of statistical series of experimental data. Construction of a distribution histogram (polygon) and their graphic representation. Calculation of numerical characteristics of statistical distribution Tasks on IWS: complete tasks for homework. Literature: 4; 6; 7*	***2***
2	*Determination of parameters interval estimates of the general population - confidence intervals for estimating mathematical expectation and root mean square deviation. Tasks on IWS: complete tasks for homework. Literature: 3; 6 p. 12-22*	***2***
3	*Assessment of experimental data suitability. Hypotheses about mathematical expectation and equality of variances of two normally distributed populations Tasks on IWS: complete tasks for homework. Literature: 3, 6 p. 12-29*	***2***
4,5	*Compilation of a correlation table based on sample data. Calculation of the sample correlation coefficient. Determination of the sample equation of the straight line of regression based on sample data. Tasks on IWS: complete tasks for homework. Literature: 2; 3; 6 p. 12-35*	***4***
6	*Research of the ecological, economic and social system by methods of mathematical modeling. Formation of the structure of the system according to the nature of the goals and the method of management. Definition of system elements and connections between them. Tasks on IWS: complete tasks for homework. Literature: 5 p. 5-16*	***2***
7	*Analysis of the economic effectiveness of planned environmental protection measures. Tasks on IWS: complete tasks for homework. Literature: 5 p. 17-25.*	***2***
8	*Statistical processing of monitoring data at different levels of the system. Determination of statistical probability and consequences of ecologically dangerous events of a technical and social nature. Tasks on IWS: complete tasks for homework. Literature: 5 p. 26-41.*	***2***
9	*Assessment of the level of development of the system according to technical and economic, social and environmental indicators. Development of recommendations on the optimal level of environmental cleanliness. Literature: 5 p. 42-50.*	***2***
	Total	***18***

Student's Individual Work

Independent work of students takes 70% of studying the course time, it also includes preparation for the assessment and performance of the HCW. The main task of students' independent work is the acquisition of scientific knowledge in the field, which is not included in the list of lecture questions, through a personal search for information, the formation of an active interest in a creative approach to educational work. In the process of independent work within the framework of the credit module, the student must learn the methods of theoretical and numerical processing of experimental and calculated data and, based on the analysis of calculations, come to his own well-founded conclusions regarding the adoption of necessary measures in the field of management of environmental activities.

#	Topic submitted for individual study	IWS Hours/ Quantity
1	The law of large numbers. Literature: 1; 3 p. 75-99	2
2	Types, schemes and methods of data selection. Literature: 3 p. 75-99; 4 p.4-32; 7	2
3	Empirical distribution function and its properties. Literature: 4 p. 4-32; 7 p. 6-11	2
4	Group statistical indicators. Literature: 2; 6; 7 .	2
5	Normal population distribution law. Literature: 1; 2; 4	2
6	Confidence interval for the sample mean. Literature: 4 p. 61-85.	2
7	Errors of the first and second kind when testing statistical hypotheses. Literature: 2; 3; 4; 7 p. 26-34	2
8	Verification of the hypothesis about the equality of variances of normally distributed populations. Literature: 2; 4: 7 p. 26-34	2
9	The main indicators of background air pollution in the city. Literature: 5p. 53-56.	2
10	Correlation moment, sample correlation coefficient.Literature: 4 p. 173-220; 7 .	2
11	Checking the significance of the sample correlation coefficient at a given reliability Literature: 4; 6 p. 12-35	2
12	The method of least squares. Literature: 2; 4 p. 173-220; 7 p. 36-46	2
13	Preparation for lectures	12
14	Performing practical homework	14
15	Execution of HCW	10
16	Offset	6
	Total hours	66

Individual Tasks

In order to deepen the knowledge of students in the discipline, to gain experience of independent work in the field of analysis and processing of scientific and technical data, it is proposed to perform an individual task in the form of a homework test, the performance of which has the following goals: systematization and consolidation of the knowledge that students acquired during the study of theoretical material, acquisition and consolidation of practical skills of independent work on the application of methods of processing and analysis of scientific and technical data. The list of tasks for HCW is given in Chapter 9.

Provision of program results by components of the educational component

Program result	*Lecture classes*	*Practical and laboratory classes, individual assignments*
Know and understand fundamental and applied aspects of environmental sciences	*Lecture 1. Mathematical methods of processing scientific and technical information. Application peculiarities of mathematical statistics methods in ecological research.*	
Know the latest methods and instrumental means of environmental research, including methods and means of mathematical and geo-informational modeling	*Lecture 2. Primary statistical processing of experimental data.* *Lecture 13. Prognostic pattern recognition scheme of background air pollution.* *Lecture 14. Prognostic scheme of air pollution taking into account weather conditions and atmospheric stability.* *Lecture 15. Elements of correlation and regression theory.* *Lecture 16,17. Sampling straight line regression equation.* *Lecture 18. Adequacy of regression models.*	*Practical classes 4,5. Compilation of a correlation table based on sample data. Determination of the sample equation of the straight line of regression based on sample data.* *Practical classes 6. Research of the ecological, economic and social system by methods of mathematical modeling.* *Practical classes 7. Analysis of the economic effectiveness of planned environmental protection measures.*
Be able to use modern methods of information processing and interpretation when conducting environmental research	*Lecture 3. Ranking of statistical population series.* *Lecture 4,5. Determination of statistical characteristics* *Lecture 6. Interval estimates of distribution parameters* *Lecture 7. Errors of selective observation.* *Lecture 8,9 Statistical hypotheses* *Lecture 10. Basic parametric statistical criteria.* *Lecture 11 Testing the hypothesis about the mathematical expectation of a normally distributed population.* *Lecture 12. Testing the hypothesis about the significance of the difference in mathematical expectations of two normally distributed populations*	*Practical classes 1. Ranking of statistical series of experimental data. Calculation of numerical characteristics of statistical distribution.* *Practical classes 2. Determination of parameters interval estimates of the general population .* *Practical classes 3. Assessment of experimental data suitability.* *Practical classes 8. Statistical processing of monitoring data at different levels of the system.* *Practical classes 9. Assessment of the level of development of the system according to technical and economic, social and environmental indicators.* *Individual assignments (home control work -HCW)*

Policy and Control

6. Academic discipline policy (educational component)

Rules for attending classes and behavior in class

Students are obliged to take an active part in the learning process, not to be late for classes and not to miss them without serious reason, not to interfere the teacher to conduct classes, not to be distracted by actions that are not related to the learning process.

Rules for reward and penalty points

- *Reward points can be awarded by the teacher only for the performance of creative work in the discipline or additional online profile courses with the appropriate certificate: : https://www.coursera.org/learn/problem-solving*

Amount of reward points cannot exceed 10% of the rating scale.

- *penalty points are not provided within the academic discipline.*

Policy of deadlines and rearrangements

In the event of discipline arrears or any force majeure, students should contact the teacher through available (provided by the teacher) communication channels to resolve issues and agree on an algorithm for actions to work out.

The policy of academic integrity

Plagiarism and other forms of dishonesty are not allowed. Plagiarism includes the lack of links when using printed and electronic materials, citations, opinions of other authors. Invalid hints and write-offs during writing tests, conducting classes; passing the exam for another student; copying materials protected by the copyright system without the permission of the author of the work.
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

Policy of academic behavior and ethics

Students must be tolerant, respect the opinions of others, formulate objections in the correct form.
Ethical behavior norms 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

7. Types of control and assessment rating system of learning outcomes (ARS)

Distribution of study time by types of classes and tasks in the discipline according to the working curriculum:

Semester	Study time		Distridution of study hours				Control measures	
	Credits	Acad. Hours	Lectures	Practical work	Lab. work	IWS	HCW	Semester control
2	4	120	36	18		66	1	Offset

**HCW (home control work)*

For the full-time form of education, it is proposed to implement a rating system for assessing the success of students' assimilation of educational material from the credit module. The student's rating from the credit module "Processing scientific and technical information" consists of points obtained for:

1) survey during lectures;
2) work in practical classes;
3) HCW

Semester's control is offset.

8.System of rating (weighted) points and scoring criteria

System of rating points and scoring criteria:

1. Express control at lectures: Weighted score –3. The maximum number of answers is 4

4×4=16 points

Criteria for evaluating students' knowledge:

Completeness and signs of response	***Points***
A clear and complete answer to the question	*4*
Some inaccuracies or errors in the answer	*3-2*
No terms, laws and formulas in the answer	*1*
The answer is not credited	*0*

2. Practical works:

The weighted point is 6. The maximum number of points for all practical works is:

6 points × 9 p/w = 54 points.

Criteria for evaluating students' knowledge:

Completeness and signs of response	***Points***
For active and creative work	*6-4*
Well work	*3-1*
Lack of work	*0*

3. Home control work is valued at 30 points according to the following criteria:

Completeness and characteristics of the answer	***Points***
correct application of analysis and calculation methods, qualitative and quantitative assessment of the obtained results	*30…24*
the correctness of the application of analysis and calculation methods, qualitative and quantitative assessment of the obtained results, there are some inaccuracies	*23…17*
the level of substantiation of the decisions made and the correctness of the conclusions are not sufficient	*16…10*
the work does not meet the requirements for "satisfactory"	*9…1*
lack of work	*0*

Calculation of the Rating (R) Scale:

The sum of the weighted points of control measures during the semester is:

R_s*= 16+54+30=100 points.*

According to the results of academic work in the first 7 weeks, the "ideal student" should score 30 points. At the first attestation (8th week), the student receives "credited" if his current rating is at least 20 points.

According to the results of academic work for 13 weeks of study, the "ideal student" should score 60 points. At the second attestation (14th week), the student receives "credited" if his current rating is at least 40 points.

Semester control: offset. The maximum number of points is 100. To receive credit from the credit module "automatically" you need to have a rating of at least 60 points. Conditions for admission to semester control: a necessary condition for admission to offset is a rating of at least 40% of the rating scale (R), i.e. 40 points.

Students who scored a rating of less than 0.6 R during the semester, as well as those who want to improve the overall rating, complete a control work. At the same time, all the points they received during the semester are cancelled. Test tasks contain questions that refer to different sections of the credit module.

The credit control work is estimated at 100 points. Control tasks of this work consist of two theoretical questions and a practical task.

System for estimation theoretical issues:

- *"excellent", complete answer (at least 90% of the required information) 30-25 points;*
- *"good", a fairly complete answer (at least 75% of the required information), or an answer with minor inaccuracies 24-18 points;*
- *"satisfactory", incomplete answer (at least 60% of the required information and some errors) 17 - 10 points;*
- *"unsatisfactory", unsatisfactory answer – 9-0 points.*

The practical task is evaluated at 40 points according to the evaluation system:

- the correct application of calculation methods, qualitative and quantitative assessment of the obtained results - 40-32 points;

- the correctness of calculation methods application, qualitative and quantitative assessment of the obtained results, there are minor inaccuracies and errors of 31-21 points;

– there are shortcomings regarding the choice of calculation method and certain errors -20-10 points;

- task not completed - 9-0 points.

The list of assessment questions is given in Chapter 9.

To get an offset grade, the sum of all rating points received during the semester translated according to the table:

Rating points conformity table to grades on the university scale:

Applicant's rating	*Acquired competencies level*
95...100 points	*Perfect*
85...94 points	*Very good*
75...84 points	*Fine*
65...74 points	*Satisfactorily*
60...64 points	*Enough*
R<60 points	*Unsatisfactorily*
R_s<40 points or Failure to comply conditions of admission to the semester control	*Not allowed*

9. Additional information of the discipline

- approximate list of questions submitted for semester control and tasks for HCW (Annex A)

- output data for the implementation of HCW (Annex B)

Work program of the discipline (Silabus):

Compiled by: *prof., Ph.D, Sirenko L.V.*

Approved by the Department *:E and PPT (protocol № 14 _23.05.24__)*

According to the Methodical Commission of the Faculty[1](protocol No 11 from_28.06.24