sDiscipline Details

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

Department of Ecology and Plant Polymers Technology

Environmental Modelling and Forecasting. Basis of GIS

Work Program of the Discipline (Silabus)

Discipline Details

Level of higher education	***First (bachelor's)***
Branch of knowledge	*10 Natural sciences*
Specialty	*101 Environmental Studies*
Educational program	*Environmental safety*
Discipline status	*Normative*
Form of study	*Full-time (day)/ full-time (evening)*
Year of preparation, semester	*4th year, spring semester*
The scope of discipline	*4 (120)*
Semester control / control measures	*Examination*
Lessons schedule	*Examination 3 hours per week (1 hour of lectures and 2 hours of laboratory work)*
Language of instruction	*Ukrainian*
Information about course leader / teachers	*Lecturer: Ph.D., Associated professor Sirenko L.V., https://eco-paper.kpi.ua/pro-kafedru/vykladachi/sirenko-lyudmila-viktorivna.html. Laboratory work: Ph.D., Associated professor Radovenchik Y.V. - https://eco-paper.kpi.ua/pro-kafedru/vykladachi/radovenchik-yaroslav vyacheslavovich.html*
Course placement	*https://do.ipo.kpi.ua/course/view.php?id=6511*

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 use of mathematical methods and approaches to solve this problem allows: to study the patterns and features of the spread of harmful substances; to carry out rational placement of industrial enterprises, which are the main sources of pollutants; take measures to prevent dangerous consequences of pollution and in general to effectively organize and optimize the process of environmental management.

The subject of the discipline " Environmental Modelling and Forecasting. Basis of GIS "- the process of formalizing the problems that arise in the organization and optimization of the process of environmental management, in the form of mathematical models and their study by methods of mathematical modeling.

The purpose of studying this discipline is to form in students a set of knowledge in the field of information systematization, methods of processing and analysis of experimental research, methods of modeling and forecasting. In accordance with the purpose of training in this specialty requires the formation of the following competencies in students:

- skills in using information and communication technologies.

- the ability to use up-to-date information resources for environmental research.

In accordance with the requirements of the discipline " Environmental Modelling and Forecasting. Basis of GIS " students after mastering it must demonstrate the following program learning outcomes:

-to be able to search for information using appropriate sources to make informed decisions;

- to be able to use software, GIS- technologies and Internet resources for information support of environmental research;

-to be able to communicate the results of activities to a professional audience and the general public, to make presentations and messages.

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)

Study of the discipline "Environmental Modelling and Forecasting. Basis of GIS" is based on the knowledge gained by students in the study of the following disciplines: "Environmental Monitoring", "Technoecology", "Standardization of anthropogenic pressure on the environment", "Organization and management of environmental activities". Course " Environmental Modelling and Forecasting. Basis of GIS " ensures the implementation of the diploma project and the discipline of the second master's level of higher education.

3. The content of the discipline

Section 1. *General principles of modeling and forecasting the environment state*

Topic 1. A set of interrelated problems of analysis and forecasting of environmental processes.

Topic 2. Physical bases of modeling and forecasting of environmental pollution processes.

Section 2. *The main directions of modeling and forecasting the state of the environment*

Topic 3. Numerical-analytical and empirical-statistical methods of modeling and forecasting of environmental pollution processes.
Topic 4. Expert systems in ecological problems.

4. *Training materials and resources*

Basic literature

1. *1. Yaskovets I.I., Protas N.M., Osypova T.Yu., Kasatkin D.Yu. MODELING AND FORECASTING THE STATE OF THE ENVIRONMENT [textbook] / I.I. Yaskovets, N.M. Protas, T.Yu. Osipova, D.Yu. Kasatkin // - K.: NUBiP of Ukraine, 2018. - 566 p.*
2. *Mathematical modeling of systems and processes. / Pavlenko P.M., Filonenko S.F., Cherednikov O.M., Treityak V.V. / - K., NAU, 2017.- 392p.*
3. *Modeling and optimization of systems: textbook / Dubovoy V.M., Kvetny R.N., Mikhalov O.I., Usov AV / -Vinnytsia: PE "TD" Edelweiss ", 2017. - 804 p.*
4. *Modeling and forecasting the state of the environment: Course of lectures. Specialty 101 "Ecology"/ Comp.: O.B. Rubalova. - H: NUCDU, 2016. - 221 p.*
5. *V. O. Barannik. Outline of lectures on the discipline "Modeling and forecasting of the state of the environment" (for students of the specialty 101 - Ecology.) / V. O. Barannik; Kharkiv. national city university farm named after O. M. Beketova. – Kharkiv: XNUMX named after O. M. Beketova, 2017. – 146 p.*
6. *Methodical instructions for the implementation of calculation and graphic work and independent work on the course "Modeling and forecasting of the environment state" [Electronic resource] / Comp. Sirenko L.V. - Kyiv: NTUU "KPI".*

Additional literature

7. *Geoinformation technologies in ecology: Textbook / Pitak I.V., Negadailov A.A., Masikevichuk L.D., Shaporev V.P., Moiseev V.F. /– Chernivtsi , 2012.– 273p.*
8. *Bilyaev, M. M. Modeling and forecasting the state of the environment: a textbook for university students. education institutions / M. M. Bilyaev, V. V. Bilyaeva, P. S. Kirichenko. - Kryvyi Rih: Publisher R.A. Kozlov, 2016. - 207 p.*
9. *Modeling and forecasting of the environment state: textbook / [Lavrik V.I.] - "Academiya", 2010.– 400p.*
10. *Tarasova V.V. Ecological statistics. - K.: TsUL, 2008. - 392 p.*
11. *Modeling and forecasting of the state of the environment: training. manual. / P. I. Kovalchuk. - Kyiv: Lybid, 2003. - 208 p.*
12. *Modeling and forecasting the state of the environment: a textbook / T.B. Mykhailivska, V.M. Isaenko, V.A. Groza, V.M. Kryvorotko - K.: NAU Book Publishing House, 2006. - 212 p.*
13. *Dykhanov S.M. Modeling and forecasting of the state of the environment. Manual and collection of tasks for independent and individual work. – Odesa State Academy of Refrigeration, 2010. – 390 p.*

Informational internet resources

14. *Ministrty of Environmental Protection and Natural Resources of Ukraine- https://mepr.gov.ua/*
15. *http://www.eco-paper.kpi.ua/for-student*

Educational Content

5. Mastering methods of academic discipline (educational component)

Lectures

Lectures are aimed at: providing modern knowledge in the discipline " Environmental Modelling and Forecasting. Basis of GIS "; ensuring in the course of the lecture the active work of students in order to form in 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	The place and role of modeling tasks in the complex of analysis and ecological forecasting processes tasks. Lit. (1; 3; 6; 7; 9; 10). Tasks for IWS: answer the control questions. Lit. (4p.12-13)	2
2	System aspects of ecological processes research. Lit. (2; 6; 7; 9; 10). Tasks for IWS: give answers to control questions. Lit. (4 p.12-13)	2
3	General characteristics of the system modeling problem. Classification of system modeling types. Lit. (1; 3). Tasks for the IWS: get acquainted with general scheme of model construction. Lit. (1 p.27-29)	2
4	Analysis of physical phenomena underlying environmental processes and their mathematical description. Criteria for turbulent atmospheric motion. Lit. (2; 9; 10). Tasks for IWS: get acquainted with anthropogenic climate change in cities. Lit. (2 p.14-22).	2
5	Derivation of the turbulent diffusion equation and displacement of harmful impurities in the atmosphere. Lit. (1 p.38-45; 9). Tasks for IWS: get acquainted with the assessment of water quality in river basins and reservoirs under conditions of anthropogenic impact. Theoretical foundations of calculation methods. Lit. (12 p.92-205).	2
6	Prognostic equations, their integration. Lit. (1 p.47-49; 10). Tasks for IWS: answer the control questions. Lit. (4 p.13-14)	2
7	Characteristics of turbulence and wind speed in the surface layer of the atmosphere. Lit. (6; 9; 10). Tasks for IWS: get acquainted with the methods of discretization of prognostic differential equations. Lit. (1 p.51-54)	2
8	Application of expert systems for environmental problems decision-making. The general structure of the decision support system. Lit. (2 p.45-57; 11). Tasks for IWS: answer the control questions Lit. (4 p.14)	2
9	GIS technologies for demonstrating properties and forecasting changes in the environment. Lit. (7). Tasks for IWS: determining the parameters of the pollution process using the decision support system. Lit. (2; 11).	2
	Total hours	18

Laboratory classes

Laboratory works are aimed at consolidating the theoretical provisions of the credit module, acquired during lectures and in the process of studying educational information submitted for self-study. The main tasks of the cycle of laboratory works: to help students to systematize, consolidate and deepen the knowledge of a theoretical nature in the field of mathematical modeling and forecasting of the environment; teach students to use modeling knowledge to solve problems that arise in the process of control and analysis of environmental pollution; teach students of practically apply numerical-analytical, empirical methods and expert systems in the problems of mathematical modeling and forecasting of the process of environmental pollution; teach students to work with scientific and reference literature.

№	*Topic of the lesson*	*Classroom Hours/ Quantity*
1	*Forecast of the harmful impurities concentration spread from several sources on the industrial plane using a computer program that implements a generally accepted method. IWS task: prepare initial data for the job.*	*6*
2	*Work with electronic databases of environmental information.*	*6*
3	*Familiarization with EOL+ software (Software complex for calculating the dispersion of emissions of harmful substances in atmospheric air).*	*4*
4	*Determination of the emission capacity of pollutants during the combustion of different fuels.*	*6*
5	*Computer modeling of air basin pollution from power plants.*	*6*
6	*Modeling and assessment of the impact of man-made accidents on the environment using GIS. IWS task: prepare initial data for the job.*	*6*
7	*Modular test work.*	*2*
	Total hours	*36*

Student's Individual Work

Individual work takes 55% of the time studying the credit module, including exam preparation. The main task of students' individual work is to master scientific knowledge in areas that are not included in the list of lecture questions by personal search for information, the formation of active interest in the creative approach in educational work.

п	Topic submitted for individual study	IWS Hours/ Quantity
1	General scheme of air pollution model construction. Lit. (1 p.27-29)	2
2	Anthropogenic climate change in cities. Lit. (2 p.14-22)	2
3	Assessment of water quality in river basins and reservoirs under conditions of anthropogenic impact. Theoretical foundations of calculation methods. Lit. (12 p. 92-205).	2
4	Methods of discretization of prognostic differential equations. Lit.(1 p.51-54)	2
5	General features of GIS. Lit. (8)	2
6	Preparation for lectures	4
7	Performing practical homework	5
8	Modular test work	2
9	Calculation and graphic work	15
10	Examination	30
	Total hours	66

Individual Tasks

In order to deepen students' knowledge of the discipline, gain experience in individual work in mathematical modeling and forecasting the environment state, it is proposed to perform an individual task in the form of calculation and graphic work on "Modeling air pollution from a single source", which has the following targets:

- systematization and consolidation of knowledge acquired by students during the study of theoretical material,

- acquisition and consolidation of practical skills at individual work on the application of numerical and analytical methods in the problems of mathematical modeling and forecasting in the process of environmental pollution. Requirements for the structure, content and design of the work are given in Lit. (4).

Provision of program results by components of the educational component

Program result	Lecture classes	Practical and laboratory classes, individual assignments
To be able to search for information using appropriate sources to make informed decisions	Lecture 2. System aspects of ecological processes research. Lecture 4. Analysis of physical phenomena underlying environmental processes and their mathematical description. Lecture 5. Derivation of the turbulent diffusion equation and displacement of harmful impurities in the atmosphere.	Laboratory classes 2. Work with electronic databases of environmental information. Laboratory classes 4. Determination of the emission capacity of pollutants during the combustion of different fuels.

	Lecture 6. Prognostic equations, their integration. *Lecture 7. Characteristics of turbulence and wind speed in the surface layer of the atmosphere*	*Laboratory classes 6. Modeling and assessment of the impact of man-made accidents on the environment using GIS.*
To be able to use software, GIS-technologies and Internet resources for information support of environmental research	*Lecture 1. The place and role of modeling tasks in the complex of analysis and ecological forecasting processes tasks.* *Lecture 3 .General characteristics of the system modeling problem.* *Lecture 8. Application of expert systems for environmental problems decision-making* *Lecture 9. GIS technologies for demonstrating properties and forecasting changes in the environment.*	*Laboratory classes 1. Forecast of the harmful impurities concentration spread from several sources on the industrial plane using a computer program that implements a generally accepted method.* *Laboratory classes 3. Familiarization with EOL+ software (Software complex for calculating the dispersion of emissions of harmful substances in atmospheric air).* *Laboratory classes 5. Computer modeling of air basin pollution from power plants.*
To be able to communicate the results of activities to a professional audience and the general public, to make presentations and messages		*Individual assignment (Calculation and graphic work)*

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;

- https://www.coursera.org/learn/ecosystem-services.

Amount of reward and penalty points cannot exceed 25% of the rating scale.
Penalty points are awarded for late submission of calculation and graphic work (CGW).

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 the CGW and exam.

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	MCT	CGW	Semester control
8	4	120	18	-	36	66	1	1	Examination

**MCT (modular test work)*
**CGW (calculation and graphic work)*
The student's rating in the discipline consists of the points he receives based on the results of the current control (starting rating of 50 points) and the examination rating (50 points).
Current control: performance of 6 laboratory works, CGW, MCT.
Scoring criteria:
1. Execution of laboratory works:
- correctly performed, designed and defended work - 4 points;
- some insignificant shortcomings in the performance or defense of work - 3 points;
- some certain shortcomings in the preparation, implementation and defense of work - 1-2 points;
- failure to perform work - 0 points,
- penalties are charged for absence from classes without good reason - 1 point.

2. Modular control work is evaluated with 10 points:
- full answer (not less than 90% of the required information) - 9-10 points;
- sufficiently complete answer (not less than 75% of the required information) or complete answer with minor inaccuracies - 7 - 8 points;
- incomplete answer (not less than 60% of the required information) and minor errors -5- 6 points;
- superficial answer - 1-4 points.
- no answer 0 points.

3. Calculation and graphic work is evaluated with 16 points.
- all work requirements are met - 15-16 points;
- almost all requirements for work are fulfilled or there are insignificant errors - 12-14 points:
- there are shortcomings of the requirements of work and certain errors - 9-11 points;
- unsatisfactory work - 1-8 points,
- work not credited (work not done) - 0 points.
- for each week of delay with the submission of the CGW for inspection, there are penalties - 2 points.
Calendar control: conducted twice a semester to monitor the current state of compliance with the requirements of the syllabus.
The condition of the first certification is to obtain at least 10 points and perform laboratory work (at the time of certification). The condition of the second certification is to obtain at least 18 points, perform all laboratory work (at the time of certification) and enroll in the CGW.
Semester control: exam. At the exam, students perform a written test. Each task contains two theoretical questions. Each theoretical question is evaluated in 25 points

System for estimation theoretical issues:
- "excellent", complete answer (at least 90% of the required information) 25-23 points;
- "good", a fairly complete answer (at least 75% of the required information), or an answer with minor inaccuracies 22-18 points;
- "satisfactory", incomplete answer (at least 60% of the required information and some errors) 17 - 15 points;
- "unsatisfactory", unsatisfactory answer - 0 points.

Thus, the rating semester scale of the discipline is:

$R = 6 \cdot 4 + 1 \cdot 10 + 16 + 2 \cdot 25 = 100$ *points*

Conditions of admission to the semester control: minimum positive assessment according to the CGW / enrollment of all laboratory works / semester rating more than 25 points.
The sum of starting points and points for the examination test is transferred to the examination grade according to the table:

Rating points conformity table to grades on the university scale:

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

8. Additional information of the discipline

- *approximate list of questions submitted for semester control (Appendix A)*
- *output data for the implementation of CGW (Annex B)*

Work program of the discipline (Silabus):

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

Approved by the Department *E and PPT (protocol № 17 23.05.24)*

According to the *Methodical Commission of the Faculty*[1] *(protocol No 11 from* 28.06.24