Prospective directions for the development of energy- and resource-efficient processes, equipment and technologies

Working program of the academic discipline (Syllabus)

Details of the academic discipline

Level of higher education	*Third (Ph.D.)*
Branch of knowledge	*13 mechanical engineering*
Specialty	*133 industrial engineering*
Educational program	*Industrial engineering*
Discipline status	*normative*
Form of education	*daytime*
Year of training, semester	*2nd year, spring semester*
Scope of the discipline	*120 hours (18 hours of lectures)* *36 hours - practical* *66 hours - SRS*
Semester control/ control measures	*examination*
Lessons schedule	*https://ecampus.kpi.ua/*
Language of teaching	*Ukrainian*
Information about the course leader / teachers	*Lecturer: Professor Y.M. Kornienko, Ph.D.YNK@kpi.ua* *Practical: Kornienko Y.M.*
Placement of the course	*https://ecampus.kpi.ua/*

Program of educational discipline

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

The discipline is aimed at deepening the ideas of graduate students regarding promising directions for creating energy- and resource-efficient processes and developing innovative equipment. The chemical and oil refining industries consume significant amounts of energy and resources. In particular, it is oil, natural gas, water, air. In addition, outdated technology at domestic enterprises is accompanied by significant environmental pollution, which negatively affects the quality of human life. Therefore, for the implementation of the principles of sustainable development, specialists in the field of chemical engineering are challenged to increase the efficiency of heat and mass exchange processes in technological equipment while reducing energy consumption, resources and negative risks to the environment.

Therefore, the modern global trend is to develop and implement principles "Green" economy of the state, the success of which depends on the level of development of "Green" energy, which is expressed in the use of renewable sources, with a gradual transition to zero-waste production. It is these principles that are laid down in the new development direction of resource-efficient and cleaner production (RECV).

The second component in the implementation of the principles of the "Green" economy is the development of technologies and innovative equipment for the disposal of industrial and household waste, which can be used in industry, everyday life and used as means of preserving soil fertility in Ukraine.

The main attention is paid to the reduction of energy costs for heat and mass exchange processes in the equipment of the chemical and oil refining industry.

The subject of the academic discipline

The main modern theories and approaches regarding the implementation of the principles of "green" energy through

intensification of heat and mass exchange processes and creation of innovative equipment for their implementation.

The purpose of this discipline*is the formation of postgraduate students of a set of knowledge necessary for the analysis of existing technologies in chemical production and the formation of a methodological approach for the creation of resource- and energy-efficient processes and equipment for their implementation.*

In accordance with the goal of training doctors of philosophy, deepening of competencies developed in graduate students is required:

- *the ability to perform original research, achieve scientific results that create new knowledge in mechanical engineering and related interdisciplinary areas and can be published in leading scientific publications in mechanical engineering and related fields;*

- *the ability to present and discuss orally and in writing scientific results research and/or innovative developments in Ukrainian and English (or others) languages, deep understanding of English-language (or other foreign-language) scientific texts in the engineering industry;*

-*the ability to critically analyze, evaluate and synthesize new and complex ideas in the field of mechanical engineering and related interdisciplinary issues.*

After mastering the discipline, graduate students should acquire the following knowledge:

- Freely present and discuss with specialists and non-specialists the results of research, scientific and applied problems of mechanical engineering in national and foreign languages, publish the results of research in scientific publications in leading international scientific publications.

- Formulate and test hypotheses; use appropriate evidence to substantiate conclusions, in particular, the results of theoretical analysis, experimental studies and mathematical and/or computer modeling, available literature data.

- Develop and research conceptual, mathematical and computer models of processes and systems, effectively use them to obtain new knowledge and/or create innovative products in mechanical engineering and related interdisciplinary areas.

- *Apply*modern tools and technologies for searching, processing and analyzing information, in particular, statistical methods for analyzing data of a large volume and/or complex structure, specialized databases and information systems

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

The study of the discipline is based on the principles of integration of various knowledge obtained by graduate students during the bachelor's and master's degrees, the study of natural and engineering-technological disciplines.

The presented discipline is a fundamental basis that will contribute to the solution of complex problems in the field of development of innovative energy-efficient processes of chemical technology and equipment for their implementation.

3. Content of the academic discipline

Chapter 1 World trends in energy development

Topic 1. Potential opportunities for increasing the level of energy security of Ukraine.

Topic 2. Analysis of energy security risks on a global and national scale.

Topic 3. Formation of directions for increasing the level of energy security of Ukraine. .

Chapter 2. Principles of implementation of the "Green" economy in Ukraine.

Topic. 4. Global trends in the development of the "Green" economy

Topic. 5. Main directions of the "Green" modernization of the economy of Ukraine

Topic.6 Indicators of the "Green" economy

Section 3. Utilization of industrial waste through the creation of technology for the production of new organo-mineral fertilizers

Increasing the efficiency of transfer processes in a fluidized bed.

Topic 7. Theoretical principles of creating a new generation of organo-mineral fertilizers from chemical, coal mining and food industry waste.

Topic 8. Justification of the choice of the fluidization technique as an energy-efficient and ecologically safe method of obtaining granular organo-mineral fertilizers with specified properties during the lysis of ammonium sulfate solutions.

Topic 9. Theoretical principles of increasing the intensity of diffusion-controlled processes during the dehydration and granulation of liquid heterogeneous systems by using inhomogeneous plume-pulsation fluidization.

4. Educational materials and resources

Basic literature

1. Standard of higher education (hereinafter - the Standard) of the third (educational and scientific) level, the degree of Doctor of Philosophy) in the field of mechanical engineering, specialty 133 Industrial mechanical engineering.

Approved and put into effect by the order of the Ministry of Education and Science of Ukraine dated May 30, 2022 No. 503

2. Basic principles of the implementation of the "green" economy model in Ukraine: education. manual / T.P. Galushkina, L.A. Musina, V.G. Potapenko and others. ; for sciences ed. T.P. Galushkina - K.:

Institute of Ecological Management and Balanced Nature Management, 2017. - 154 p. (Library of ecological knowledge) ISVN 978-966-916-455-1

3. Energy efficiency of Ukraine. Best project ideas [electronic edition]: Project "Professionalization and stabilization of energy management in Ukraine" / Composer: S.P. Denisyuk, O.V. Kotsar, Yu.V. Chernetska – K.: KPI named after Igor Sikorskyi, 2016. – 79 p

4. PROJECT "PROGRAM FOR GREEN MODERNIZATION OF THE ECONOMY OF UKRAINE" OF THE GERMAN SOCIETY OF INTERNATIONAL COOPERATION (GIZ) HMBH
CONCEPT OF RESOURCE EFFICIENT AND CLEANER PRODUCTION

5. Kornienko Y. M. Processes and equipment of chemical technology 1: textbook / Y. M. Kornienko, Yu. Yu. Lukach, I. O. Mikulonok, V. L, Rakytskyi, G. L. Ryabtsev // K.: NTUU "KPI". – 2011. – Part 1. - 300 C.

6. Y. M. Kornienko Processes and equipment of chemical technology 2: Textbook / Y. M. Kornienko, Y. Yu. Lukach, I. O. Mikulonok, V. L. Rakytskyi, G. L. Ryabtsev // K.: NTUU "KPI". - 2011. - Part 2. - 416 p.

7. Kornienko Y. M. Increasing the efficiency of the process of obtaining granular humic-mineral fertilizers / Y. M. Kornienko, S. S. Gaidai, O. V. Martyniuk // NTUU "KPI". – 2014. – 349 p.

8. Y. M. Kornienko, The process of dehydration of composite liquid systems in a fluidized bed with the use of a mechanical dispersant / Y. M. Kornienko, D. S. Semenenko, O. V. Martyniuk. S. S. Gaidai // NTUU "KPI". - Kyiv. – 2015. – 167 p.

8. Kornienko, Y. M. The process of obtaining modified granulated humic-mineral fertilizers / Y. M. Kornienko, A. M. Lyubeka, S. S. Gaidai // KPI named after Igor Sikorsky. – Kyiv: KPI named after Igor Sikorsky. – 2017. – 210 p.

10. Kornienko Y. M. Processes of granulation of mineral-humic fertilizers / Y. M. Kornienko, R. V. Sachok // Electronic edition. - 2014 - 158 p.

Additional literature

11. SECTORAL INTEGRATION OF UKRAINE INTO THE EU: PREREQUISITES, PROSPECTS, CHALLENGES

Author team of the Analytical Report:¬from the Razumkov Center: M. PASHKOV (project manager), co-director of foreign policy and international security programs; V. SIDENKO, scientific consultant on economic issues; K. MARKEVYCH, leading expert of economic and social programs; P. STETSYUK, scientific consultant on legal issues;¬from the Center for Global Studies "Strategy XXI": M. HONCHAR, president; I. STUKALENKO, head of energy programs

12. Zaverbnyi A. S. GLOBAL ENERGY DEVELOPMENT TRENDS AND POTENTIAL OPPORTUNITIES FOR INCREASE THE LEVEL OF ENERGY SECURITY OF UKRAINE IN THE CONDITIONS OF INTEGRATION OF ITS ENERGY SECTOR./ Zaverbnyi A. S. Psuy M.S., Kernytskyi I.S.// MES of Ukraine. National Lviv University. Polytechnic Social and Legal Studies. 2018. Issue 1. P. 121-127

13 Nagursky O. A. Regularitiesencapsulationsubstances in the state of fluidization and their diffusion release: a monograph / O. A. Nagurskyi // Ministry of Education and Science, Youth and Sports of Ukraine, Nat. Lviv Polytechnic University. - L.: Vid-vo Lviv. polytechnics – 2012. – 188 p.

Information resources on the Internet

9. Ministry of Strategic Industries of Ukraine [Electronic resource]. – 2021. – Access mode:https://mspu.gov.ua.

10. Union of Chemists of Ukraine [Electronic resource]. – 2021. – Access mode: http://chemunion.org.ua/uk.

11. International congress of chemical process [Electronic resource]. – 2021. – Access mode: https://2020.chisa.cz.

12. Digital management of the construction process – developed by entrepreneurs for entrepreneurs [Electronic resource]. – 2021. – Access mode: https://www.chisa.dk.

Educational content

1. **Methods of mastering an educational discipline (educational component)**

Lecture classes

Lectures are aimed at:

- *provision of modern, comprehensive in-depth knowledge of the discipline, the level of which is determined by the target attitude to each specific topic;*
- *provision of critical creative work together with the teacher in the process of work;*
- *education of postgraduate students' professional qualities and development of their independent creative thinking;*
- *awareness of world trends in the development of science in the field of intensification of heat and mass exchange processes in industrial equipment;*
- *awareness of the methods of processing information resources and determining the main directions for solving specific scientific and technical problems;*
- *teaching research materials in a clear and high-quality language in compliance with structural and logical connections, clarification of all given terms and concepts available for perception by the audience.*

No s/p	***The name of the topic of the lecture and a list of the main questions (a list of didactic tools, references to the literature and tasks on the SRS)***	***Number hours***
1	*2*	*3*
Chapter 1 World trends in energy development		
1	*Potential opportunities for increasing the level of energy security of Ukraine.* *Conducting an analysis of the state of energy resources in Ukraine, consider the sources of their formation and determine directions for the use of renewable sources and measures for rational use and energy saving in production and everyday life* *Literature: [1, 2, 3, 4]* *Tasks on SRS. Learn about energy production and conservation measures in the countries of Central and Northern Europe.*	***2***
2	***Analysis of energy security risks in a global dimension and****on a national scale.* *An analysis of the global energy balance and how the lack of energy resources affects the international economy and politics is given. Classification of risks that determine the economic, environmental and national security of the state.* *Literature: [1, 2, 3, 4, 5]* *Tasks on SRS. In the period after 1945, to analyze the development of the energy sector in the countries of Central and Eastern Europe and the impact of this factor on the environmental and national security of states.*	*2*
3	***Formation of directions for increasing the level of energy security of Ukraine***	*2*

	The main principles of rational energy supply using non-traditional energy sources and complex measures for use in housing, agriculture and industry are presented. *Literature: [1, 2, 3, 4]* *Tasks on SRS. Analyze existing energy saving measures in Ukraine. Determine the share of chemical technology for the production of nitrogen fertilizers in the overall structure of energy consumption in Ukraine.* *.*	

Chapter 2. Principles of implementation of the "Green" economy in Ukraine		
4	***Global trends in the development of the "Green" economy*** *The formation of prerequisites in the industrially developed countries of the world for the gradual introduction of the "green" economy are considered. At the same time, the main attention is directed to the preservation of natural capital, as a guarantee of proper existence for future generations.* *Literature: [1, 2, 3, 4]* *Tasks on S.R.S. Determine the influence of technological, environmental and institutional factors on the implementation of the principles of the "green" economy in Ukraine.*	***2***
5	***The main directions of "Green" modernization of the economy of Ukraine*** *To conduct an analysis of the modern possibilities of "green" modernization of the economy of Ukraine in the basic sectors: industry, agro-industrial complex, transport and housing and communal services. To determine the role of scientific and research work on the development of processes, equipment and energy conservation systems, as well as resources at production facilities.* *Literature: [1, 2, 3, 4]* *Tasks on SRS. To offer technical proposals for increasing the energy efficiency of thermal processes in the production of mineral fertilizers in Ukraine.*	***2***
6	***Indicators of the "Green" economy*** *The methodology and criteria for evaluating the main criteria of the "green" economy are considered. The conditions for the transition from the "brown" economy to the economy of "sustainable development" and to the "green" economy are determined.* *Literature: [1, 2, 3, 4]* *Tasks on SRS. Get acquainted with the features of the transition to "green" in countries with the maximum and minimum GDP*	***2***
	Chapter 3. Disposal of industrial waste	
7	***Utilization of industrial waste through the creation of technology for the production of new organo-mineral fertilizers*** *Conducting an analysis of heat and mass transfer processes in systems: gas – solid body, gas – liquid, accompanied by isothermal crystallization during dehydration and granulation of ammonium sulfate solutions with admixtures of nutrients and stimulants of mineral and organic origin, most of which are chemical, coal mining, and food waste productions* *Literature: [5,6,7,8,9,10]*	***2***

	Tasks on SRS. To determine the limiting stages of the moisture removal process during drying, dehydration and granulation of mono- and multi-component liquid systems.	
8	***Justification of the choice of the fluidization technique as an energy-efficient and ecologically safe method of obtaining granular organo-mineral fertilizers with specified properties during the lysis of ammonium sulfate solutions.*** *Methods of intensification of heat and mass exchange processes of the gas-solid system during dehydration and granulation processes are considered:* *The factors influencing the intensity of diffusion-controlled processes during the contact of the heated coolant with the surface of solid particles have been determined. The possibility of increasing the intensity of volumetric three-dimensional mixing of granular material during heterogeneous fluidization.* *The method of evaluating the kinetic characteristics of the granulation process when using non-homogeneous fluidization is given* *Literature: [5,6,7,8,9,10]* *Tasks on SRS. With a useful temperature difference ΔT = $T_{entrance}$ – T_{sh} = 100 ºC, calculate the heat consumption for the evaporation of 1 kg of moisture and compare with the theoretical values. Analyze the dynamics of changes in the mass percentages of individual fractions and determine the granulation mechanism - layer-by-layer or agglomeration.*	***2***
9	***Theoretical principles of increasing the intensity of diffusion-controlled processes during the dehydration and granulation of liquid heterogeneous systems by using inhomogeneous column-pulsation fluidization.*** *Theoretical principles of heat and mass transfer in devices with a fluidized bed. Implementation of interphase contact in devices with a fluidized bed. Homogeneous fluidization. Peculiarities of heat exchange during drying and dehydration and granulation of liquid systems.* *Literature: [5,6,7,8,9, 10]* *Tasks on S.R.S. To determine the influence of hydrodynamic regimes of fluidization on the efficiency of transfer processes during drying and dehydration and granulation of liquid systems.*	***2***
	Together	***18***

Practical training

Postgraduate students should be helped to develop creative thinking, a creative approach to scientific substantiation of the research direction and methodology.

The main tasks of the cycle of practical classes:

- *to help graduate students systematize and deepen knowledge of a theoretical nature in the field of heat and mass transfer in dynamic dispersed systems;*
- *to contribute to the training of graduate students in the methodology of determining the limiting factors of the processes of transferring the amount of motion, heat and mass in dynamic systems in the presence of a phase transition;*
- *form criteria for evaluating the efficiency of transfer processes and be able to determine the level of specific energy consumption.*

No s/p	***The name of the subject of the practical session and a list of the main questions (list of didactic support, references to the literature and tasks on the SRS)***	***Number hours***
1	*2*	*3*
1	***Potential opportunities for increasing the level of energy security of Ukraine.*** *Conducting an analysis of the state of energy resources in Ukraine, consider the sources of their formation and determine directions for the use of renewable sources and measures for rational use and energy saving in production and everyday life* *Literature: [1, 2, 3, 4]* *Tasks on SRS. To assess the possibility of using non-traditional and renewable energy sources in Ukraine. Compare approaches to the term "energy efficiency" in Ukraine and EU countries.*	***4***
2	***Analysis of energy security risks in a global dimension and****on a national scale.* *An analysis of the global energy balance and how the lack of energy resources affects the international economy and politics is given. Classification of risks that determine the economic, environmental and national security of the state.* *Literature: [1, 2, 3, 4,* *Tasks on SRS. Give examples of energy supply in the Scandinavian countries and the main measures to reduce these risks.*	***2***
3	***Formation of directions for increasing the level of energy security of Ukraine*** *The main principles of rational energy supply using non-traditional energy sources and complex measures for use in housing, agriculture, transport and industry are presented.* *Literature: [1, 2, 3, 4]*	***2***

	Tasks on SRS. Analyze existing energy saving measures in Ukraine. Determine the share of chemical technology for the production of nitrogen fertilizers in the overall structure of energy consumption in Ukraine.	
4	***Global trends in the development of the "Green" economy*** *The formation of prerequisites in the industrially developed countries of the world for the gradual introduction of the "green" economy are considered. At the same time, the main attention is directed to the preservation of natural capital, as a guarantee of proper existence for future generations.* *Literature: [1, 2, 3, 4]* *Tasks on S.R.S. Determine the influence of technological, environmental and institutional factors on the implementation of the principles of the "green" economy in Ukraine.*	***4***
5	***Evaluation of the effectiveness of ensuring the active movement of granular material on the working surfaces of hydraulic fracturing.*** *Calculation of the kinetic energy of the gas jet directed along the working surface of the hydraulic fracturing to prevent the formation of stagnant zones.* *Literature: [6, 7, 8].* *Tasks on SRS. Analyze hydraulic fracturing structures that minimize the risk of stagnant zones on the hydraulic fracturing surface and promote the creation of active directional mixing of granular material in the apparatus.*	***4***
6	***The main directions of "Green" modernization of the economy of Ukraine*** *To conduct an analysis of the modern possibilities of "green" modernization of the economy of Ukraine in the basic sectors: industry, agro-industrial complex, transport and housing and communal services. To determine the role of scientific and research work on the development of processes, equipment and energy conservation systems, as well as resources at production facilities.* *Literature: [1, 2, 3, 4]* *Tasks on SRS. To offer technical proposals for increasing the energy efficiency of thermal processes in the production of mineral fertilizers in Ukraine.*	***4***
7	***Utilization of industrial waste through the creation of technology for the production of new organo-mineral fertilizers*** *Conducting an analysis of heat and mass transfer processes in systems: gas – solid body, gas – liquid, accompanied by isothermal crystallization during dehydration and granulation of ammonium sulfate solutions with admixtures of nutrients and stimulants of mineral and organic origin, most of which are chemical, coal mining, and food waste productions*	***4***

	Literature: [5,6,7,8,9,10] *Tasks on SRS. To determine the limiting stages of the moisture removal process during drying, dehydration and granulation of mono- and multi-component liquid systems. To determine the limiting stage of the process of dehydration and granulation and to establish the weight of influence on the process of technological parameters and hydrodynamic parameters.*	
8	***Justification of the choice of the fluidization technique as an energy-efficient and ecologically safe method of obtaining granular organo-mineral fertilizers with specified properties during the lysis of ammonium sulfate solutions.*** *Methods of intensification of heat and mass exchange processes of the gas-solid system during dehydration and granulation processes are considered:* *The factors influencing the intensity of diffusion-controlled processes during the contact of the heated coolant with the surface of solid particles have been determined. The possibility of increasing the intensity of volumetric three-dimensional mixing of granular material during heterogeneous fluidization.* *The method of evaluating the kinetic characteristics of the granulation process when using non-homogeneous fluidization is given* *Literature: [5,6,7,8,9,10]* *Tasks on SRS.* *Tasks on SRS. With a useful temperature difference ΔT = $T_{entrance}$ – T_{sh} = 100 ºC, calculate the heat consumption for the evaporation of 1 kg of moisture and compare with the theoretical values. Conduct an analysis of the dynamics of changes in mass percentages of individual fractions and determine the granulation mechanism - layer-by-layer or agglomeration. At a useful temperature difference ΔT=$T_{entrance}$ – T_s = 100 ºC, calculate the heat consumption for the evaporation of 1 kg of moisture and compare with the theoretical values. Conduct an analysis of the dynamics of changes in the mass percentages of individual fractions and determine the granulation mechanism - layer-by-layer or agglomeration*	***4***
9	***Theoretical principles of increasing the intensity of diffusion-controlled processes during the dehydration and granulation of liquid heterogeneous systems by using inhomogeneous column-pulsation fluidization.*** *Theoretical principles of heat and mass transfer in devices with a fluidized bed. Implementation of interphase contact in devices with a fluidized bed. Homogeneous fluidization. Peculiarities of heat exchange during drying and dehydration and granulation of liquid systems.* *Literature: [5,6,7,8,9, 10]*	***4***

	Tasks on S.R.S. To determine the influence of hydrodynamic regimes of fluidization on the efficiency of transfer processes during drying and dehydration and granulation of liquid systems.	
10	***Examination***	***4***
	Together	***36***

6. Independent work of a student/graduate student

Independent work makes up 70% of the study of the credit module, which also includes preparation for the credit. The main task of the independent work of graduate students is to deepen worldview and scientific knowledge in the directions specified in the lectures, by searching for the necessary information, forming perseverance and creative search in the formation of working hypotheses for the intensification of transfer processes.

No s/p	***The name of the topic submitted for independent processing***	***Number hours***
1	*2*	*3*
	Chapter 1 World trends in energy development	
1	*. To assess the possibility of using non-traditional and renewable energy sources in Ukraine. Compare approaches to the term "energy efficiency" in Ukraine and EU countries.* *Give examples of energy supply in the Scandinavian countries and the main measures to reduce these risks.* *Analyze existing energy saving measures in Ukraine. Determine the share of chemical technology for the production of nitrogen fertilizers in the overall structure of energy consumption in Ukraine.* *Literature: [5,6, 7, 8,9].*	***10***
	Chapter 2. Principles of implementation of the "Green" economy in Ukraine	
2	*Determine the influence of technological, environmental and institutional factors on the implementation of the principles of the "green" economy in Ukraine* *To offer technical proposals for increasing the energy efficiency of thermal processes in the production of mineral fertilizers in Ukraine.* *Get acquainted with the features of the transition to "green" in countries with the maximum and minimum GDP* *Literature: [5,6, 7, 8,9].*	***12***

	Chapter 3. Disposal of industrial waste	
	To determine the limiting stages of the moisture removal process during drying, dehydration and granulation of mono- and multi-component liquid systems. *With a useful temperature difference $\Delta T=T_{entrance}- T_{sh}= 100$ ºC, calculate the heat consumption for the evaporation of 1 kg of moisture and compare with the theoretical values. Conduct an analysis of the dynamics of changes in the mass percentages of individual fractions and determine the granulation mechanism - layer-by-layer or agglomeration* *To determine the influence of hydrodynamic regimes of fluidization on the efficiency of transfer processes during drying and dehydration and granulation of liquid systems.* *Literature: [5,6, 7, 8,9].*	***14***
3	***Preparation for the exam***	***30***
	Together	***66***

Policy and control

Policy of academic discipline (educational component)

Rules of attending classes and behavior in classes

Attending classes is mandatory. Postgraduate students are obliged to take an active part in the educational process, not to be late for classes and not to miss them without valid reasons, not to interfere with the teacher conducting classes and not to be distracted by activities unrelated to the educational process.

Rules for assigning incentive and penalty points

- *incentive points can be awarded by the teacher exclusively for the performance of creative works and working hypotheses.*
  But their sum cannot exceed 25% of the rating scale.
- *Penalty points are not provided within the academic discipline.*

Policy of deadlines and rescheduling

In case of academic debts arising from the academic discipline or any force majeure circumstances, graduate students should contact the teacher to coordinate the algorithm of actions related to the solution of existing problems.

Policy of academic integrity

Plagiarism and other forms of dishonest work are unacceptable. Plagiarism refers to the absence of references when using printed and electronic materials, quotes, opinions of other authors. Inadmissible tips and write-offs during writing tests, conducting classes.
The policy and principles of academic integrity are defined in Chapter 3 of the Code of Honor of the National Technical University of Ukraine "Ihor Sikorsky Kyiv Polytechnic Institute". More details:https://kpi.ua/code

Policy of academic behavior and ethics

Graduate students must be tolerant, respect the opinion of others, formulate objections in the correct form, adequately support feedback during classes.

Standards of ethical behavior of students and employees are defined in Chapter 2 of the Code of Honor of the National Technical University of Ukraine "Ihor Sikorskyi Kyiv Polytechnic Institute". More details:https://kpi.ua/code

2. Types of control and rating system for evaluating learning outcomes (RSO)

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

Semester	Training time		Distribution of study hours				Control measures		
	Credits	Acad. hours	Lectures	Practical	Lab. do	SRS	MKR	RR	Semester control
4	4	120	18	36	–	66	-	–	examination

The student's rating in the discipline consists of the points he receives for:

The rating of the graduate student in the credit module consists of the points he receives for work in practical classes.

Semester control is credit.

System of rating (weighted) points and evaluation criteria

System rating points and evaluation criteria:

Performing tasks in practical classes.

The weighted score for 1 and 2 practical classes is 15 points each; in practical lessons 3 - 9 - 10 points each.

Criteria for evaluating the performance of a practical task

Completeness and signs of task completion	Points	
The task is fully completed	15	10
Minor defects according to point 1	13-14	8-9
Untimely completion of the task	10-12	7
Untimely completion of the task, deficiencies under clause 1	2-9	2-6
Poor performance of the task	1	1
Failure to complete the task	0	0

Thus, the rating semester scale from the credit module is:

$$R = 2 \cdot 15 + 7 \cdot 10 = 100 \text{ points}$$

According to the results of academic work in the first 7 weeks, the "ideal graduate student" should score 40 points. At the first certification (8th week), the graduate 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 graduate student" should score 90 points. At the second certification (14th week), the graduate student receives "credited" if his current rating is at least 40 points.

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.

A necessary condition for admission to credit is a rating of at least 40% of the rating scale (R), i.e. 40 points.

Postgraduate students who scored less than 0.6 R during the semester, as well as those who want to improve the overall rating, complete a credit test. 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 list of assessment questions is given in Chapter 9.

To obtain a passing grade, the sum of all rating points received during the semester R translated according to the table:

Scores	***Rating***
95...100	*perfectly*
85...94	*very good*
75...84	*fine*
65...74	*satisfactorily*
60...64	*enough*
RD<60	*unsatisfactorily*
Admission conditions not met	*not allowed*

3. Additional information on the discipline (educational component)

An approximate list of questions submitted for semester control

1. *The essence of the concept of energy efficiency in developed countries.*
2. *Analysis of energy security risks on a global and national scale*
3. *European guidelines for the formation of a policy of increasing energy efficiency*
4. *Formation of energy efficiency policy by the International Energy Agency*
5. *State of energy consumption and energy use in Ukraine*
6. *What is the energy saving potential in Ukraine*
7. *State policy of Ukraine in the field of energy efficiency*
8. *Directions of energy efficiency policy formation in Ukraine*
9. *The essence of the evolution of the system of the institutional model of resource use*I
10. *The essence of the concept of "green" economy*
11. *The main processes in the nature management system affecting the formation of sustainable development*
12. *The main factors that caused the development of the "green" economy*
13. *What is the concept of "green" economy*
14. *The essence of the concept of "natural capital" (Natural capital)*
15. *What is the concept of "green" economy*
16. *Directions of transformation for the implementation of the concept of "green" economy*
17. *Basic principles of industrial waste disposal.*
18. *Peculiarities of mass transfer in the gas-solid system.*
19. *The main parameters of the gas coolant as a drying agent.*
20. *Factors affecting the first and second drying period. Methods of intensification of the drying process during convective and conductive drying.*
21. *Explain the essence of diffusion-controlled processes. Identify the forms that limit the speed of the process and provide proposals for its intensification.*
22. *The physical essence of the fluidization process. Characteristics of the process, porosity ε, fluidization number Kw, hydraulic resistance of the layer.*
23. *Methodology for calculating the equivalent diameter of particles in the layer and the total surface of the layer due to the hydraulic resistance of the layer.*

24. *Explain how the shape of the apparatus and the design of the hydraulic fracturing affect the nature of fluidization*
25. *Form the basic requirements for the gas distribution device (GRP).*
26. *To justify the methods of averaging stagnant zones on the working surfaces of hydraulic fracturing.*
27. *The method of determining the coefficient of hydraulic resistance of hydraulic fracturing, what is the physical essence of this parameter?*
28. *Methodology for calculating the critical velocity of fluidization (according to Todes and Lyashchenko)*
29. *Determination of the activity of the hydrodynamic regime through the Archimedes criterion.*
30. *Principles of organization of heterogeneous fluidization without installation of a pulsating gas supply unit.*
31. *The method of introducing gas jets to create the conditions for their unification and the creation of a gas bubble.*
32. *Calculation of the size of a gas bubble in a state of equilibrium in a granular layer.*
33. *Conditions for the formation of gas bubbles to ensure volumetric 3D circulation with a frequency of more than 2 Hz.*
34. *Methodology for calculating the main kinetic characteristics of the dehydration and granulation process.*

4. Additional information on the discipline (educational component)

Working program of the academic discipline (syllabus):

Folded *prof.., Doctor of Technical Sciences, Y. M. Kornienko*

Approved *by the Department of the Academy of Medical Sciences (protocol No. 20 dated June 21, 2022)*

Agreed *Methodical commission of the faculty*[1]*(protocol No. 10 dated 24.06.2022)*

[1]Methodical council of the university - for general university disciplines.