



Alternative energy sources

Work program of the discipline (Syllabus)

Details of the discipline

| | |
|---|---|
| Level of higher education | <i>Second (master's)</i> |
| Field of knowledge | <i>10 Natural sciences</i> |
| Speciality | <i>101 Environmental Studies</i> |
| Educational program | <i>Environmental safety</i> |
| Discipline status | <i>Custom</i> |
| Form of study | <i>full-time/full-time (accelerated)/remote/mixed</i> |
| Year of preparation, semester | <i>1st year, spring semester</i> |
| Scope of discipline | <i>4 ECTS credits (120 hours)</i> |
| Semester control/control measures | <i>Test</i> |
| Schedule of classes | <i>3 hours a week (2 hours of lectures and 1 hour of practical classes)</i> |
| Language of instruction | <i>Ukrainian</i> |
| Information about the eminent course / teachers | Lecturer: https://eco-paper.kpi.ua/pro-kafedru/vykladachi/vizytka/radovenchik-vyacheslav-mikhajlovich.html Practical /Seminary: https://eco-paper.kpi.ua/pro-kafedru/vykladachi/vizytka/radovenchik-vyacheslav-mikhajlovich.html |
| Course placement | https://do.ipo.kpi.ua/course/view.php?id=4241 |

The program of the discipline

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

The development of human society today is difficult to imagine without energy. Absolutely all spheres of life and activity of each person are most closely connected with the possibility of using a sufficient amount of energy, and, in all its forms and environmental impacts. Over the past century, the population on the planet has grown from 1.6 to 6.5 billion. Residents. Even with constant specific energy consumption, the required amount of energy would increase more than 4 times. At the same time, real growth is much more significant.

Today, most scenarios for the further development of mankind necessarily involve the use of renewable energy sources that do not have a negative impact on the environment. Today, 90% of all energy consumption in the world is covered by oil, gas and coal, which is accompanied by global environmental problems. On the other hand, despite the significant reserves of these minerals, at the current pace of consumption, they will be enough for humanity for no more than 100 ÷ 250 years, since fossil fuel reserves are significant, but not infinite.

Another factor in the urgent introduction of alternative energy sources is the anthropogenic human impact on the environment. It is the production and use of energy carriers that forms the bulk of global environmental problems. As a result of burning huge volumes of fossil fuels from the earth's interior, the carbon dioxide content in the atmosphere reached its maximum over the past 800 thousand years. On the other hand, with approximate calculations of specialists, the modern energy potential of alternative energy sources is more than 200 billion tons per year, which is almost 10 times higher than modern energy consumption by mankind.

The subject of the discipline "Alternative Energy Sources" is the implementation of technical and technological approaches that guarantee a stable supply of mankind with a sufficient amount of environmentally friendly renewable energy.

To a large extent, the solution of the problems of providing humanity with energy will be determined by the level of training of specialists working in the field of environmental protection, including state environmental safety management institutions, scientific institutions and organizations, enterprises.

To successfully solve the problems of protecting and preserving the environment while meeting the needs of mankind in "clean" energy, specialists must be fluent in information, be able to solve complex problems of protecting the environment from pollution at the highest technological and scientific level.

The purpose of the discipline "Alternative energy sources"

The purpose of studying this discipline is to form in the masters a set of knowledge in the field of modern technologies for obtaining energy, scientific developments in the field of improving the efficiency of the use of natural energy resources, a set of skills and abilities necessary for the introduction into production and management of modern methods and technologies. Gamgeneration of clean energy, creation of efficient energy supply systems in industry and municipal enterprises.

- *the ability to search, process and analyze information from various sources C 06;*
- *awareness at the level of the latest achievements, necessary for research and/or innovative activities in the field of ecology, environmental protection and balanced nature management C 09;*
- *the ability to organize works related to the assessment of the environmental state, environmental protection and optimization of nature management, in conditions of incomplete information and conflicting requirements C 15;*
- *the ability to assess the level of negative impact of natural and anthropogenic factors of environmental hazards on the environment and humans C 18.*

According to the requirements of the program of the discipline "Alternative Energy Sources", students after mastering it must demonstrate the following programmatic learning outcomes:

- *to demonstrate the ability to organize collective activities and implement complex environmental projects, taking into account available resources and time constraints. PO 05.*
- *to be able to assess the potential impact of man-made objects and economic activities on the environment. PO 13.*
- *to choose the optimal management strategy and/or nature management depending on ecological conditions. PO 16.*
- *to know up-to-date approaches to the organization of environmentally cleaner production, reorganization and reconstruction of existing production from the standpoint of resource conservation, taking into account the life cycle of the product. PO 21.*

2. Prerequisites and post-requisitions of disciplines (place in the structural and logical scheme of education according to the relevant educational program)

The study of the discipline "Alternative Energy Sources" is based on the principles of integration of various knowledge gained by students during the study of natural and engineering-technical disciplines. The discipline "Alternative Energy Sources" is a fundamental basis that should provide solutions to complex problems in the field of environmental protection in obtaining energy, rational use of energy resources and is aimed at a deep rethinking of existing and creating new holistic knowledge and professional practice in the field of providing humanity with environmentally friendly energy.

3. Contents

Section 1. Energy needs of mankind.

Energy consumption by mankind. Modern and promising reserves of fossil fuels. Providing energy carriers from different countries. Energy consumption and provision of Ukraine's own energy carriers. Environmental problems of fossil fuel consumption. General concepts of alternative energy sources.

Section 2. Solar power engineering.

The intensity of solar radiation. The main parameters of solar radiation. The laws of the spread of solar radiation in different parts of the globe. Classification of solar systems. Photovoltaic conversion of solar radiation. Materials and designs of solar cells. Block diagram of the conversion of solar radiation into electricity. Solar heat supply systems. Concentration of solar radiation. The main elements of solar heat systems. Other methods of converting solar radiation.

Section 3. Wind energy and possibilities of its use.

Wind formation. Intensity of wind energy on the territory of Ukraine. The principle of operation of the wind turbine. The concept of an ideal windmill. Classification of wind turbines according to the principle of operation. The torque and power of the windmill. Block diagram of the wind power plant.

Section 4. Energy resources of the ocean.

Classification of usable ocean energy resources. Use of tidal energy. The structure of tidal power plants. Estimation of the power of tidal currents. The energy transformation of ocean waves. Classification of devices for converting wave energy. Efficiency of implementation of wave power plants. The use of the energy of ocean currents. Assessment of the power of the most well-known ocean currents. Transformation of ocean thermal energy.

Section 5. Hydropower resources of the planet.

The main types of hydropower installations. Evaluation of land hydropower in different regions of the world and Ukraine. Development of hydropower resources. Small hydropower and its prospects. The main types of devices for the selection of energy of rivers at low cost.

Section 6. Use of geothermal energy.

Thermal regime of the earth's crust. Methods of using the thermal energy of the earth's crust. Underground thermal waters and their distribution. The use of geothermal energy to obtain heat and electricity. The principle of operation of the heat pump. Geothermal power plants and systems to provide the population with thermal energy.

Section 7. Biofuels.

The concept and classification of biofuels. The use of biomass for the production of electrical and thermal energy. Modern use of biomass and total volumes of its synthesis. Thermal processes of biomass processing. Biomass processing with biogas production. Raw materials for biogas production. The main properties of biogas and its preparation. Alcohol fermentation and fermentation of biomass. Bioenergy installations.

Section 8. Energy storage

Energy storage systems. Accumulation of electrical energy. Batteries of thermal energy. Energy storage by transferring it to another form. Development of alternative energy sources. Other alternative sources that can be used to meet the future energy needs of mankind.

4. Learning materials and resources

4.1 Basic literature

1. Kudrya S.O. *Non-traditional and renewable energy sources: a textbook*. K.: NTUU "KPI". 2012. 492 pp.
2. Malyarenko V.A. *Energy and environment*. - H.: SAGA Publishing, 2008. – 364 p.
3. Sinchuk I.O. *Non-traditional and renewable energy sources: Textbook* / I.O. Sinchuk, S.M. Boyko, K.I. Losina et al. - Kremenchuk : Publishing House PE Shcherbatykh O.V., 2013. - 192 p.
4. Kovalev O.I. *Alternative energy sources of Ukraine: textbook. posib.* / I.O. Kovalev, O.V. Ratushnyi. – Sumy: View – vo SSU, 2015. – 201 p.

5. Law of Ukraine "On Alternative Energy Sources". – *Bulletin of the Verkhovna Rada*, 2003. - №24. – P. 155.

4.2 Supporting literature

6. *Alternative energy sources. Wind energy : Tutorial. posib.* / S.V. Syrotyuk, V.M. Boyarchuk, V.P. Galchak. – Lviv: "Magnolia 2006", 2018. – 182 p.
7. *Energy saving and use of renewable energy sources. Part I / Compiled by: O.P. Holyk, R.V. Zhesan, I.V. Volkov[et al.].* – Kropyvnytskyi: Publisher Lysenko V.F., 2020 – 192 p.
8. *Alternative Energy: [teaching postibnik]* /M.D. Melnychuk, V.O. Dubrovin, V.G. Myronenko, I.P. Grigoryuk, V.M. Polishchuk, G.A. Golub, V.S. Targonya, S.V. Dragnev, I.V. Svistunova, S.M. Kukharets. – K: "Agrarian Media Group", 2012. – 244 p.
9. *Energy: history, present and future* – [Electronic resource] - <http://energetika.in.ua/ua/books>.
10. *Tidal power plants: what is it and how does it work?* - [Electronic resource] - <https://alternative-energy.com.ua/uk/priplivni-elektrostantsi%D1%97-shho-cze-i-yak-vono-praczu%D1%94>.
11. Chuchuy V.P. *Alternative energy sources* /S.M.Uminsky, S.V. Inyutin. – Odesa: TPP, 2015. – 234 p.

Information resources on the Internet

1. *Ministry of Environmental Protection and Natural Resources of Ukraine* - <https://mepr.gov.ua/>
2. *Industrial Ecology. Community of Environmental Specialists* - <http://www.eco.com.ua/>
3. *Professional Association of Ecologists of Ukraine (PAEU)* - <https://paeu.com.ua/>
4. *State Agency on Energy Efficiency and Energy Saving of Ukraine* - <https://sae.gov.ua/uk/ae>.
5. *About alternative energy sources* - <https://zakon.rada.gov.ua/laws/show/555-15#Text>

5. Methods of mastering the discipline (educational component)

Lectures

Lectures are aimed at:

- provision of modern, holistic, interdependent knowledge of the discipline " **Alternative Energy Sources** ", the level of which is determined by the target setting for each specific topic;
- ensuring in the process of the lecture the creative work of students together with the teacher;
- education of students' professional and business qualities and the development of their independent creative thinking;
- formation of students' necessary interest and providing direction for independent work;
- determining the current level of development of science in the field of the use of alternative energy sources, forecasting its development for the coming years;
- reflection of the methodological processing of the material (selection of the main provisions, conclusions, recommendations, clear and adequate to their formulations);
- use for demonstration of visual materials, combination, if possible, them with a demonstration of results and samples;
- teaching materials in a clear and high-quality language in compliance with structural and logical connections, explaining all newly introduced terms and concepts;
- accessibility for perception by this audience.

| No s/n | The title of the topic of lectures and a list of main issues (list of didactic means, references to literature and tasks for the IWS) | Hours |
|--------|---|-------|
| 1 | <p><u>Energy needs of mankind.</u> With the revitalization of energy by mankind. Environmental problems of fossil fuel consumption. Classification of alternative energy sources. Literature: [2.c.7-30; 3.c.9-21]. Tasks for the IWS: General characteristics of alternative source sand [4.c.8-22; 8.c.7-19].</p> | 2 |
| 2 | <p><u>Solar power engineering.</u> The intensity of solar radiation. The main parameters of solar radiation. The laws of the spread of solar radiation in different parts of the globe. Literature: [1.p.128-141; 2.s.152-166]. Tasks on the IWS: The structure of the Sun and the processes that cause the release of energy [3.c.26-28; 7.s.46-58].</p> | 2 |
| 3 | <p><u>Solar power engineering.</u> Classification of solar systems. Photovoltaic conversion of solar radiation. Materials and designs of solar cells. Block diagram of the conversion of solar radiation into electricity. Literature:[1.p.141-162; 2.pp.216-277]. Tasks at the IWS: The potential of solar energy in Ukraine [4.p.144-147; 3.s.40-41].</p> | 2 |

| | | |
|----|--|---|
| 4 | <p><u>Solar power engineering.</u> Solar heat supply systems. Concentration of solar radiation. The main elements of solar heat systems. Other methods of converting solar radiation. Literature: [1.p.168-198; 2.s.152-166]. Tasks on the IWS: Environmental consequences of the development of solar energy[3.c.70-73; 2.s.287-293].</p> | 2 |
| 5 | <p><u>Solar power engineering.</u> Calculation of solar systems of different types. Literature:[7.c.80-96]. Tasks for the IWS: Main technical and economic indicators and prospects for solar energy [1.p.162-168; 1.s.191-198].</p> | 2 |
| 6 | <p><u>Wind energy and possibilities of its use.</u> Wind formation. Intensity of wind energy on the territory of Ukraine. The principle of operation of the wind turbine. The concept of an ideal windmill. Literature: [1.p.55-87; 3.s.86-97]. Tasks at the IWS: State and prospects of wind energy development in Ukraine [1.p.91-111; 4.s.149-152].</p> | 2 |
| 7 | <p><u>Wind energy and possibilities of its use.</u> Classification of wind turbines according to the principle of operation. The torque and power of the windmill. Block diagram of the wind power plant. Literature: [1.c.79-90; 4.c.85-99]. Tasks for the IWS: Environmental consequences of the introduction of wind power plants [1.c.124-127; 3.c.101-104].</p> | 2 |
| 8 | <p><u>Energy resources of the ocean.</u> Classification of usable ocean energy resources. Use of tidal energy. The structure of tidal power plants. Estimation of the power of tidal currents. Literature: [3.p.32-34; 4.c.80-84; 9, kn.5, part 1, 11.p.]. Tasks for IWS: The impact of tidal power plants on the environment [10].</p> | 2 |
| 9 | <p><u>Energy resources of the ocean.</u> The energy transformation of ocean waves. Classification of devices for converting wave energy. Efficiency of implementation of wave power plants. Literature:[11.c.34-47; 9. kn.5, part 1,]. Tasks for the IWS: Hydrogen energy[1.c.459-471].</p> | 2 |
| 10 | <p><u>Energy resources of the ocean.</u> The use of the energy of ocean currents. Assessment of the power of the most well-known ocean currents. Transformation of ocean thermal energy. Literature:[11.c.47-51; 3. pp.155-161; 9. kn.5, ch.1,]. Tasks on the IWS: Methods for converting the thermal energy of the ocean [11.c.51-71; 3. pp.161-163].</p> | 2 |
| 11 | <p><u>Hydropower resources of the planet.</u> The main types of hydropower installations. Evaluation of land hydropower in different regions of the world and Ukraine. Development of hydropower resources. Literature: [1.p.199-206; 2.s.166-178]. Tasks for the IWS: The structure of hydroelectric stations and the principle of their operation [3.p.67-80].</p> | 2 |
| 12 | <p><u>Hydropower resources of the planet.</u> Small hydropower and its prospects. The main types of devices for the selection of energy of rivers at low cost. Literature: [1.c.219-242; 2.s.398-423]. Objectives on the IWS: The impact of small hydroelectric power plants on the environment[1.c.242-244].</p> | 2 |
| 13 | <p><u>Use of geothermal energy.</u> Thermal regime of the earth's crust. Methods of using the thermal energy of the earth's crust. Underground thermal waters and their distribution. The use of</p> | 2 |

| | | |
|----|---|-----------|
| | <p><i>geothermal energy to obtain heat and electricity.</i> <i>Literature: [1.p.338-351; 3.s.118-127].</i> <i>Tasks for the IWS: Thermal energy capacities on the territory of Ukraine [4.p.147-149].</i></p> | |
| 14 | <p><u><i>Use of geothermal energy.</i></u> <i>The principle of operation of the heat pump. Geothermal power plants and systems to provide the population with thermal energy.</i> <i>Literature: [1.c.326-391; 2.s.354-373].</i> <i>Tasks for the IWS: State and prospects of geothermal energy development in Ukraine [1.p.395-412].</i></p> | 2 |
| 15 | <p><u><i>Biofuels.</i></u> <i>The concept and classification of biofuels. The use of biomass for the production of electrical and thermal energy. Modern use of biomass and total volumes of its synthesis.</i> <i>Literature: [1.p.245-260; 2.pp.308-353].</i> <i>Objectives for IWS: Energy potential of biomass in Ukraine [1.p.264-273; 4.s.155-163].</i></p> | 2 |
| 16 | <p><u><i>Biofuels.</i></u> <i>Thermal processes of biomass processing. Biomass processing with biogas production. Raw materials for biogas production. The main properties of biogas and its preparation.</i> <i>Literature: [1.c.273-303; 8.s.79-115].</i> <i>Tasks for the IWS: Processing of solid waste with the production of biogas [8.c.121-125, 131 - 132]</i></p> | 2 |
| 17 | <p><u><i>Biofuels.</i></u> <i>Alcohol fermentation and fermentation of biomass. Bioenergy installations.</i> <i>Literature: [1.c.288-305; 8.s.125-128].</i> <i>Task for IWS: Human use of liquid biofuels [8.p.176-213].</i></p> | 2 |
| 18 | <p><u><i>Energy storage</i></u> <i>Energy storage systems. Energy storage by transferring it to another form. Development of alternative energy sources. Other alternative sources that can be used to meet the future energy needs of mankind.</i> <i>Literature: [1. pp. 443 – 459; 3.s.34-37;].</i> <i>Tasks on the IWS: The impact of energy facilities on the environment [2.p.252-287].</i></p> | 2 |
| | Just | 36 |

Practical classes

In the system of professional training of students in this discipline, practical classes occupy 33% of the classroom load. Special terminology, allow you 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 objectives of the cycle of practical classes:

- *help students to systematize, consolidate their knowledge of theoretical characteristics in the field of modern alternative energy sources and technologies for the generation of clean energy;*
- *teach students techniques the solution of practical tasks, contribute to the possession of the skills and skills of performing calculations, graphic and other tasks;*
- *teach them to work with scientific and reference literature and schemes;*
- *to form the ability to learn independently, that is, to dominate methods, methods of self-learning, self-development, and self-control.*

| <i>No s/n</i> | <i>The title of the topic of the practical lesson and the list of main issues (list of didactic support, references to literature and tasks to the IWS)</i> | <i>Hours</i> |
|---------------|--|------------------|
| <i>1</i> | <i>Gelio systems and for the production of electrical energy. Oblaspheymy and apparatus. Literature: [1.p.145-154]. Tasks on the IWS – Basic algorithms for calculating solar systems for the generation of electrical energy. Parameters of the equipment of solar systems. Literature: [https://prel.prom.ua/a282912-poryadok-rozrahunku-geliosistem.html]</i> | <i>2</i> |
| <i>2</i> | <i>Geliosystems for obtaining thermal energy. Literature: [1.p.168-177]. Tasks on the IWS – Basic algorithms for calculating solar systems for the generation of thermal energy. Literature: [https://prel.prom.ua/a282912-poryadok-rozrahunku-geliosistem.html].</i> | <i>2</i> |
| <i>3</i> | <i>In the energyand institutions. Determination of the required capacity of the energy supply system of a private house. Literature: [1.pp.111-114]. Tasks on the IWS – Methods for calculating wind power installations. The main design parameters of the equipment. Literature: [http://ntu.org.ua/download/mv_prakroboty_vde.pdf]</i> | <i>2</i> |
| <i>4</i> | <i>Selection of the main components from existing elements. Coordination of all components with each other in a single system. Literature: [3.c.167-183]. The task at the IWS is manufacturers of equipment for wind power installations on the territory of Ukraine. [Internet].</i> | <i>2</i> |
| <i>5</i> | <i>Calculation of the power of tidal power plants. Literature: [11.p.25-34]. The task at the IWS is to change the power of tidal power plants over time. Cycles of tidal power plants. Literature:[9. kn.5, part 1].</i> | <i>2</i> |
| <i>6</i> | <i>Calculation of the main parameters of hydroelectric power plants of various types. Literature:[11.c.71-76]. The task at the IWS is the impact of hydroelectric power plants on the environment. Environmental parameters associated with the main possibilities of obtaining energy at hydroelectric power plants. Literature:[3.c.163-167].</i> | <i>2</i> |
| <i>7</i> | <i>Calculation of the energy of wave stations and ocean currents. Literature: [11.c.34-51]. The task of the IWS is the use of a heat pump in the structure of geothermal power plants. The main design parameters of the heat pump. Literature: [2.p. 222-243; 4.c.102-111].</i> | <i>2</i> |
| <i>8</i> | <i><u>Modular tests</u></i> | <i>2</i> |
| <i>9</i> | <i><u>Test</u></i> | <i>2</i> |
| | <i>Just</i> | <i>18</i> |

6. Independent work of the student

Independent work of students takes 55 % of the time to study the course, also includes preparation for the test. The main task of independent work of students is to master scientific knowledge in the field of environmental protection, which is not included in the list of lecture issues, through personal search for information, the formation of an active interest in a creative approach in educational work. generating and supplying energy to the population and industrial enterprises and, based on calculations, come to their own reasonable conclusions about the effectiveness of the use of traditional and alternative sources.

| No s/n | The name of the topic submitted for independent study | Number of hours of IWS |
|---|--|------------------------------|
| <i>Section 1. Energy needs of mankind.</i> | | |
| 1 | <i>General characteristics of alternative sources [4.p.8-22; 8.pp.7-19].</i> | 3 |
| <i>Section 2. Solar power engineering.</i> | | |
| 2 | <i>The structure of the Sun and the processes that cause the release of energy [3.s.26-28; 7.s.46-58]. The potential of solar energy in Ukraine [4.p.144-147; 3.s.40-41]. Environmental consequences of the development of solar energy [3.p.70-73; 2.p.287-293]. Basic algorithms for calculating solar systems for the generation of electrical energy. [https://prel.prom.ua/a282912-poryadok-rozrahunku-geliosistem.html].</i> | 7 |
| <i>Section 3. Wind energy and possibilities of its use.</i> | | |
| 3 | <i>State and prospects of wind energy development in Ukraine [1.p.91-111; 4.pp.149-152]. Environmental consequences of the introduction of wind power plants [1.p.124-127; 3.pp.101-104]. Methods for calculating wind power plants. Manufacturers of equipment of wind power installations on the territory of Ukraine. [http://tntu.org.ua/download/mv_prakroby_vde.pdf]</i> | 8 |
| <i>Section 4. Energy resources of the ocean.</i> | | |
| 4 | <i>Impact of tidal power plants on the environment [10]. Hydrogen energy [1.p.459-471]. Methods for converting ocean thermal energy [11.c.51-71; 3. pp.161-163]. Change in the power of tidal power plants over time. Literature: [9. kn.5, part 1].</i> | 6 |
| <i>Section 5. Hydropower resources of the planet.</i> | | |
| 5 | <i>The structure of hydroelectric stations and the principle of their operation [3.p.67-80]. Impact of small hydroelectric power plants on the environment [1.p.242-244]. The impact of hydroelectric power plants on the environment. [3.p.163-167].</i> | 6 |
| <i>Section 6. Use of geothermal energy.</i> | | |
| 6 | <i>Thermal energy capacities on the territory of Ukraine [4.p.147-149]. State and prospects of geothermal energy development in Ukraine [1.p.395-412]. The use of a heat pump in the structure of geothermal power plants. [2.p. 222-243; 4.s.102-111].</i> | 6 |
| <i>Section 7. Biofuels.</i> | | |
| 7 | <i>Energy potential of biomass in Ukraine [1.p.264-273; 4.s.155-163]. Processing of solid waste with biogas production [8.s.121-125, 131 - 132]. Human use of liquid biofuels [8.p.176-213]. Energy intensity of biofuels. Economic assessable use of biofuels. [8.p.45-63].</i> | 7 |
| <i>Section 8. Energy storage</i> | | |
| 8 | <i>Impact of energy facilities on the environment [2.p.252-287].</i> | 3 |
| 9 | <i>Preparation for domestication of control works, etc.</i> | 4 |
| 10 | <i>Execution of HCW</i> | 10 |
| 11 | <i>Test</i> | 6 |
| | Total hours | 66 |

Policy and control

7. Policy of the 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 to conduct classes, not to be distracted by actions that are not related to the educational process.

Rules for assigning incentive and penalty points

- *Incentive points can be awarded by the teacher solely for performing creative work in the discipline or additional completion of online specialized courses with the receipt of the appropriate certificate:*
 - <https://www.coursera.org/specializations/renewable-energy>
 - <https://www.coursera.org/learn/solar-energy-basics>;
 - <https://www.coursera.org/specializations/solar-energy>;
 - <https://www.coursera.org/learn/renewable-energy-technology-fundamentals>.

But their amount cannot exceed 10% of the rating scale.

The ethics of deadlines and rescheduling

In case of debts in the 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 working out.

Academic Integrity Policy

Plagiarism and other forms of dishonest work are unacceptable. Plagiarism includes the lack of links when using printed and electronic materials, quotes, opinions of other authors. Unacceptable hints and write-offs when 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.

The policy and principles of academic integrity are defined in Chapter 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, constructively maintain feedback in the classroom.

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

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

Distribution of study time by types of classes and tasks in the discipline in accordance with the working curriculum:

| Semester | Study time | | Distribution of study hours | | | | Control measures | | |
|----------|------------|----------|-----------------------------|-----------|-----------|-----|------------------|-----|------------------|
| | Loans | acad. H. | Lecture | Practical | Lab. Rob. | IWS | HCW | MCT | Semester control |
| 2 | 4 | 120 | 36 | 18 | – | 66 | 1 | 1 | Test |

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

1 - two tests (planned according to the work plan of the MCT is divided into 2 works lasting 45 minutes each);

2 - work in practical classes;

3 – express questioning at lectures;

4 – HCW.

The system of rating (weight) points and evaluation criterion

1. Express survey at lectures:

Weight score –5.

The maximum number of points in the survey at the lecture classes of at least 7 students is $5 \times 5 = 25$ points

Criteria for assessing students' knowledge:

| Completeness and signs of response | Points |
|--|---------------|
| <i>Clear and complete answer to the question</i> | <i>5</i> |

| | |
|--|---------------|
| <i>The answer made some inaccuracies or errors</i> | <i>4... 3</i> |
| <i>The answer does not contain the wording of terms, laws and formulas</i> | <i>2... 1</i> |
| <i>Answer not credited</i> | <i>0</i> |

2. Modular control (R_m)

Weight score – 10. The maximum number of points for all tests is: 10 points x 2 works = 20 points

Criteria for evaluating tests

| Mark | Completeness of the answer |
|---------------|---|
| <i>9...10</i> | <i>"excellent", creative disclosure of one of the issues, fluency in the material</i> |
| <i>6...8</i> | <i>"good", incomplete disclosure of one of the questions or full answer with minor inaccuracies</i> |
| <i>4...5</i> | <i>"satisfactory", Incomplete disclosure of the issue (at least 60% of the information required) and minor errors</i> |
| <i>1...3</i> | <i>Unsatisfactory work (does not meet the requirements for 3 points)</i> |
| <i>0</i> | <i>Lack of work.</i> |

3. Practical work:

Weight score – 5. The maximum number of points for all practical work is equal to:

$5 \text{ points} \times 7 \text{ p/p} = 35 \text{ points.}$

Criteria for assessing students' knowledge:

| <i>Completeness and signs of response</i> | <i>Points</i> |
|--|---------------|
| <i>Clear and timely execution and design of work</i> | <i>5</i> |
| <i>Minor inaccuracies were made in the response</i> | <i>4</i> |
| <i>Mistakes have been made in the work that distort the result</i> | <i>3</i> |
| <i>Late execution of work, deficiencies in the design</i> | <i>1-2</i> |
| <i>Failure to do practical work</i> | <i>0</i> |

4 Home test is estimated at 20 points according to the following criteria:

| Mark | Completeness of the answer |
|-----------------|---|
| <i>17... 20</i> | <i>"excellent", creative disclosure of one of the issues, fluency in the material</i> |
| <i>13...16</i> | <i>"good", incomplete disclosure of one of the questions or full answer with minor inaccuracies</i> |
| <i>10...12</i> | <i>"satisfactory", Incomplete disclosure of the issue (at least 60% of the information required) and minor errors</i> |
| <i>1...9</i> | <i>Unsatisfactory work (does not meet the requirements for 3 points)</i> |
| <i>0</i> | <i>Lack of work.</i> |

Calculation of the scale (R) of the rating:

Thus, the rating scale for the discipline is:

$$R=25+20+35+20=100 \text{ points}$$

According to the results of educational work in the first 7 weeks, the "ideal student" should score 40 points. At the first certification (8th week), a student receives "enrolled" if his current rating is at least 20 points.

According to the results of educational work for 13 weeks of study, the "ideal student" should score 90 points. At the second certification (14th week), a student receives "enrolled" if his current rating is at least 45 points.

The maximum amount of points is 100. To receive credit from the credit module "automatic" you need to have a rating of at least 60 points.

Students who have a rating of less than 60 points at the end of the semester, as well as those who want to improve their grade in the ECTS system, perform a test paper. The task of the test consists of four questions of different sections of the work program from the list provided in the guidelines for mastering the credit module.

Each test question (r_1, r_2, r_3, r_4) is estimated at 25 points according to the grading system:

- "excellent", complete answer (at least 95% of the necessary information) – 25 - 24 points;
- "very good", a sufficiently complete answer (at least 85% of the necessary information or minor inaccuracies) – 23 - 20 points;
- "good", sufficiently complete answer (at least 75% of the necessary information or minor inaccuracies) – 19 - 17 points;
- "satisfactory", incomplete answer (at least 65% of the necessary information and some errors) – 16 - 13 points;
- "enough", incomplete answer (at least 60% of the necessary information and some errors) – 13 - 10 points;
- "unsatisfactory", unsatisfactory answer – 9 - 0 points.

The sum of points for a non-four test questions is transferred to the test score according to the table.

Rating scale in the discipline

| $R = r_1 + r_2 + r_3 + r_4$ | University scale |
|--|------------------|
| 95... 100 points | Perfectly |
| 85... 94 points | Very good |
| 75...84 points | Well |
| 65... 74 points | Satisfactory |
| 60...64 points | Enough |
| $R < 60$ points | Disappointing |
| If $r_c < 40$ points or other conditions for admission to the test are not met | Not allowed |

9. Additional information on the discipline (educational component)

An approximate list of questions that are submitted for semester control

1. Describe the reserves and dynamics of energy consumption in the world.
2. Describe the wave energy converters tracking its profile.
3. Describe the supply of homes with little mineralized thermal water.
4. Cite the environmental problems of fossil fuel consumption.
5. Describe the basics of wave energy conversion.
6. Explain the diagram of a drainless geothermal heat supply system.
7. Describe alternative energy sources.
8. Describe the converters that use the oscillation energy of the water column.
9. Explain the geothermal heat supply using a heat pump.
10. Describe renewable energy in Ukraine – a general characteristic.
11. Provide general information about the use of tidal energy.
12. Explain the scheme of complex geothermal heat supply.
13. Describe the concept of wind energy.
14. Describe the power of tidal currents and the tidal rise of water.
15. Describe wood as biofuel.
16. Describe the types of wind installations..
17. Describe the scheme of power plants on the tidal current.
18. Describe peat as biofuel.
19. Bring wind energy resources on the territory of Ukraine.

20. *Describe the energy use of ocean currents.*
21. *Cite biogas as a biofuel.*
22. *Explain the use of wind power plants.*
23. *Give a description of the technical solutions for the selection of energy of ocean currents.*
24. *Explain the use of household waste as biofuels.*
25. *Explain the operation of the surface when exposed to wind force.*
26. *Describe the designs of promising turbines for the selection of the energy of ocean currents.*
27. *Describe the cauldrons with a boiling layer.*
28. *Explain the concept of an ideal windmill.*
29. *Describe the principle of operation of the volumetric pump.*
30. *Point the cauldrons for burning silt sediment.*
31. *Describe the operation of the wind wheel of the impeller wind turbine.*
32. *Describe the resources of ocean thermal energy.*
33. *Explain the solid waste incineration plants.*
34. *Explain the classic theory of the ideal windmill.*
35. *Describe the closed-loop OTHP scheme.*
36. *Describe biomass production for energy purposes.*
37. *Explain the loss of wind engines.*
38. *Describe the OTHP scheme that works on an open cycle.*
39. *Describe biomass pyrolysis.*
40. *Describe the main disadvantages of wind turbines.*
41. *Explain the use of the ocean-atmosphere temperature difference.*
42. *Explain the thermochemical processes of biomass processing.*
43. *Analyze the economics of using wind installations.*
44. *Explain the scheme of the Arctic OTHP on the water-to-air difference.*
45. *Give the methods of obtaining alcohol.*
46. *Describe the structure of the sun.*
47. *Explain the direct conversion of ocean thermal energy.*
48. *Describe the use of ethanol as fuel.*
49. *Describe the intensity of solar radiation.*
50. *Explain the thermal regime of the earth's crust.*
51. *Describe the history of small hydropower.*
52. *Describe solar energy on the territory of Ukraine.*
53. *Provide reserves of groundwater thermal water.*
54. *Describe water and hydropower resources.*
55. *Explain the balance of solar energy.*
56. *Describe the reserves and distribution of thermal waters.*
57. *Describe the structure of the hydroelectric station.*
58. *Explain the designs and materials of solar cells.*
59. *Cite the geothermal potential of the world.*
60. *Describe the structure of hydro turbines.*
61. *Point the solar heat supply systems.*
62. *Describe the geothermal potential of Ukraine.*
63. *Describe the operation of hydroelectric power plants on the power system.*
64. *Describe the solar collectors.*
65. *Explain the direct use of geothermal energy.*
66. *Explain the benefits of small hydropower.*
67. *Describe the concentrating helio-receivers.*
68. *Explain the operation of a geothermal power plant with a condensing turbine.*
69. *Explain the use of household waste as an energy source.*
70. *Describe the solar absorbers.*
71. *Describe geothermal power plants with a binary cycle.*
72. *Explain the composition and formation of biogas.*
73. *Describe the balance of ocean renewable energy.*

74. Explain the heat supply of houses with highly mineralized thermal water.
75. Give a classification of wind installations.

Questions for tests

MKR 1

№1

1. The main factors for the need to implement the ADE.
2. The structure of energy consumption in Ukraine.
3. The main types of ADE.
4. Geothermal resources of Ukraine.
5. The concept of breezes.
6. Classification of wind potential of localities according to the nature of inequalities.
7. Drum wind turbines.
8. Use of wind turbines.
9. The work of the wind wheel of the impeller wind turbine.
10. The main disadvantages of wind turbines.

№2

1. Category of renewable and non-renewable energy sources.
2. Gas production and consumption in Ukraine.
3. The ratio between the spent and accumulated energies for fuels.
4. Hydropower resources of Ukraine.
5. The concept of monsoons.
6. Change in wind speed in height above the surface of the territory.
7. Schematic diagram of the wind turbine.
8. Functional separation of wind turbines.
9. The concept of an ideal windmill.
10. Potential and actual use of biomass in Ukraine.

№3

1. List of non-traditional and renewable energy sources.
2. Production and consumption of oil by Ukraine.
3. Strategic goals for the use of ADE.
4. Wind energy resources of Ukraine.
5. General circulation of the earth's atmosphere.
6. The concept of speed of wind turbines.
7. Classification of wind turbines by power.
8. Wind turbines for the production of mechanical energy.
9. Change in speed and pressure in the course of air flow through the wind turbine.
10. Efficiency of wind use by drum wind turbines.

№4

1. Fossil fuel reserves.
2. Environmental problems of fossil fuel consumption (list).
3. Energy intensity of GDP of Ukraine and countries of the world.
4. The use of wind energy by mankind.
5. The main areas of wind energy in Ukraine.
6. The main classes of wind turbines.

7. *Approximate service life and payback periods of wind turbines.*
8. *Wind turbines that operate on the power grid.*
9. *The coefficient of energy use of an ideal windmill.*
10. *The concept of breezes.*

№5

1. *Pessimistic forecast of the existence of mankind with a shortage of energy carriers.*
2. *The essence of the "greenhouse effect".*
3. *The most important tasks of Ukraine in the field of energy supply.*
4. *Causes of wind.*
5. *Kinetic energy of the wind flow.*
6. *Winged wind turbines.*
7. *Stimulating the use of wind energy in different countries.*
8. *Autonomous wind turbines.*
9. *Losses of wind turbines.*
10. *The concept of monsoons.*

№6

1. *An optimistic forecast of the existence of mankind with a shortage of energy carriers.*
2. *Basic views on "global warming".*
3. *Potential and actual use of biomass in Ukraine.*
4. *The concept of trade winds.*
5. *Wind flow power.*
6. *Carousel and rotary wind turbines.*
7. *Changes in the capacity and cost of electricity of wind turbines in recent years.*
8. *The effectiveness of the use of wind drum wind turbines.*
9. *The main disadvantages of wind turbines.*
10. *Classification of wind turbines by power.*

MKR 2

№1

1. *The structure of the Sun.*
2. *The concept of coefficients p , a , r .*
3. *Passive solar heating system.*
4. *Absorption of solar energy by the ocean.*
5. *Kinetic and potential wave energy.*
6. *Installation of the engineering laboratory NEL.*
7. *The power of ocean currents.*
8. *Scheme of OTPP with a closed cycle.*
9. *Hydrotherms and their classification.*
10. *Determine the kinetic energy of a unit wave width by amplitude .7 m*

№2

1. *Proton-proton solar cycle.*
2. *The influence of the atmosphere on solar radiation.*
3. *Concentrating solar receivers.*
4. *Balance ocean energy.*
5. *The power of ocean waves.*
6. *Underwater devices for the selection of ocean energy.*
7. *Water wheel for the selection of energy of ocean currents.*
8. *Otes scheme with an open cycle.*

9. Reserves and distribution of thermal waters in the world.

10. Determine the total wave energy at amplitude . 11 м

№3

1. The range of lengths of solar radiation.

2. Solar radiation on the territory of Ukraine.

3. Liquid combined double-circuit solar heating system with parabolic concentrator.

4. Distribution of ocean energy sources.

5. "Salter's Duck".

6. The concept of tides and their characteristics.

7. Promising turbines for the selection of energy of ocean currents.

8. Scheme of the Arctic OTEC on the water-air difference.

9. Reserves and distribution of thermal waters in Ukraine.

10. Determine the power transferred in the direction of wave propagation with an amplitude and a period of 15 s. 5 м

№4

1. The concept and meaning of solar constant.

2. Materials for solar photocells.

3. The structure of a flat solar collector.

4. Characteristic features of surface waves in deep water.

5. The main disadvantages of the "Roller ducks".

6. The main disadvantages of tidal energy.

7. The principle of operation of the volumetric pump.

8. Direct conversion of ocean thermal energy.

9. Direct use of geothermal energy.

10. Determine the potential energy of the tidal with a basin area of 8 km² and a tide height .10 м

№5

1. The main factors influencing the intensity of solar radiation.

2. Active and passive solar systems.

3. Water low-temperature solar heating system with a flat collector.

4. The concept of "waves in deep water"

5. Coquerel raft.

6. Power and efficiency of tidal flow.

7. Resources of thermal energy of the ocean.

8. The concept of a geothermal step.

9. Geothermal power plants with a binary cycle.

10. Calculate the power of the water flow moving at a speed of 33 km / h.

№6

1. The equation of the balance of solar energy.

2. Classification of solar systems.

3. Solar heating system with collector and heat pump.

4. The main characteristics of the wave.

5. Pneumobuy Matsuda.

6. The scheme of the tidal power plant.

7. Distribution of temperature extremes in the oceans.

8. Change in the temperature of rocks with depth.

9. Heat supply with highly mineralized thermal water.

10. Calculate the mechanical power that can be taken from the ocean current by an impeller that rotates freely in diameter at a flow rate of 60 km / h. 33 м

Individual task to perform home test work

1. Describe the principle of operation, calculation option and select the necessary equipment for the following types of alternative energy sources:

Source datasheet for home test

| <i>n</i> | <i>Installation type</i> | <i>Type of energy</i> | <i>Power</i> | <i>Od. vym.</i> |
|----------|--------------------------|-----------------------|---------------------|-----------------|
| 1 | Solar system | Electricity | 1,93 | Kw |
| 2 | Solar system | Thermal | $9 \cdot 10^{-8}$ | Gcal |
| 3 | Wind | Electricity | 3 | Kw |
| 4 | Geoustnovka | Thermal | $12 \cdot 10^{-9}$ | Gcal |
| 5 | Solar system | Electricity | 2,03 | Kw |
| 6 | Solar system | Thermal | $4 \cdot 10^{-7}$ | Gcal |
| 7 | Wind | Electricity | 5 | Kw |
| 8 | Geoustnovka | Thermal | $7 \cdot 10^{-8}$ | Gcal |
| 9 | Solar system | Electricity | 3,33 | Kw |
| 10 | Solar system | Thermal | $3 \cdot 10^{-7}$ | Gcal |
| 11 | Wind | Electricity | 4 | Kw |
| 12 | Geoustnovka | Thermal | $1,1 \cdot 10^{-7}$ | Gcal |
| 13 | Solar system | Electricity | 4,03 | Kw |
| 14 | Solar system | Thermal | $2 \cdot 10^{-7}$ | Gcal |
| 15 | Wind | Electricity | 6 | Kw |
| 16 | Geoustnovka | Thermal | $2 \cdot 10^{-8}$ | Gcal |
| 17 | Solar system | Electricity | 4,93 | Kw |
| 18 | Solar system | Thermal | $6 \cdot 10^{-8}$ | Gcal |
| 19 | Wind | Electricity | 6 | Kw |
| 20 | Geoustnovka | Thermal | $2 \cdot 10^{-9}$ | Gcal |
| 21 | Solar system | Electricity | 7,12 | Kw |
| 22 | Solar system | Thermal | $2 \cdot 10^{-7}$ | Gcal |
| 23 | Wind | Electricity | 9 | Kw |
| 24 | Geoustnovka | Thermal | $15 \cdot 10^{-8}$ | Gcal |
| 25 | Solar system | Electricity | 7,33 | Kw |

Work program of the discipline (syllabus):

Compiled prof., Doctor of Technical Sciences, Radovenchik V.M.

Approved by the Department ___ E and PPT ___ (protocol No. 14 of 8.06.2022)

Approved by the FCE Methodical Commission (Protocol No. 10 of 24.06.2022)