



FUNDAMENTALS OF ENGINEERING AND SUSTAINABLE DEVELOPMENT TECHNOLOGY

Work program of the discipline (Syllabus)

Details of the discipline

Level of higher education	<i>Second (Master's)</i>
Field of knowledge	<i>14 Electrical Engineering</i>
Speciality	<i>141 Electric Power Engineering, Electrotechnics and Electromechanics</i>
Educational program	<i>Engineering of Intellectual Electrotechnical and Mechatronic Complexes</i>
Discipline status	<i>Normative</i>
Form of study	<i>full-time (full-time)</i>
Year of preparation, semester	<i>I course, autumn semester</i>
Scope of discipline	<i>60 hours / 2 ECTS credits (lectures – 6 p.m., practical (seminar) classes – 6 p.m., SRS – 24 p.m.)</i>
Semester control / control measures	<i>Credit / Modular Test (MKR)</i>
Timetable	<i>http://roz.kpi.ua</i>
Language of instruction	<i>Ukrainian</i>
Information about Course Leader / Instructors	<i>Lectures, practical (seminar) classes: Candidate of Technical Sciences, Senior Lecturer Chernetska Yuliia Valentynivna, J.chernetska-ieee@iit.kpi.ua; +38 (068) 596-92-99 (Telegram) – during business hours. Consultations every Monday, 16:00-17:00: face-to-face – 111a-22; remotely (Google Meet) – at the link: https://meet.google.com/uut-vrgb-xov</i>
Course Placement	<i>https://classroom.google.com/c/NjE3ODM4NTE5Mjgy?cjc=hs3ob3r</i>

The program of the discipline

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

Sustainable development is a general concept of society development, which defines the need to establish a balance between meeting the current needs of mankind and protecting the interests of future generations, taking into account their need for a safe and healthy environment. Energy is one of the sectors of the economy that has a negative impact on the environment and has been significantly transformed under the influence of the concept of sustainable development over the past decades. Global Trends in Innovative Development in energy sector and final energy consumption sectors form an agenda for integrating the principles of sustainability of the environmental dimension of social development into the curricula of future specialists. The discipline is one of the newest educational courses and involves an interdisciplinary and systematic approach to the study of the main problems of interaction between man and the environment, the development of modern life and modern technologies from the point of view of the principles of sustainable development.

The purpose of mastering the discipline is to form an appropriate level of knowledge and experience in operating the basic principles and approaches of sustainable development in the context of the technological dimension for the rational and safe use of technologies, the creation and implementation of new environmental engineering solutions by the future master.

The subject of the discipline is organizational solutions in the field of sustainable engineering and technology in the context of algorithms for setting goals for the functioning of enterprises, labor organization and safety, which make it possible to improve human living conditions, rationally use available natural resources and treat the environment more sparingly and ensure sustainable development of society.

***Program competencies:** (K01) ability to search, process and analyze information from various sources; (K06) ability to learn and master up-to-date knowledge; (K07) ability to identify and assess risks; (K09) the ability to detect feedback and adjust its actions taking it into account; (K15) the ability to understand and consider social, environmental, ethical, economic and commercial considerations influencing the implementation of technical solutions in the electric power, electrical engineering and electromechanics industries.*

***Program learning outcomes:** (PR09) adhere to the principles and directions of the strategy for the development of energy security of Ukraine; (PR10) to justify the choice of direction and methodology of scientific research, taking into account modern problems in the field of electric power engineering, electrical engineering and electromechanics; (PR13) identify the main factors and technical problems that may hinder the implementation of modern methods of control of electric power, electrical and electromechanical systems.*

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

The study of the discipline is based on the knowledge acquired at the bachelor's level of higher education, in particular on the results of mastering such normative educational components as general physics, industrial ecology, labor protection and civil protection. Competencies and program learning outcomes obtained in the process of studying the discipline are necessary for practice and master's thesis.

3. The content of the discipline

Chapter 1. Problems of Sustainable Development in the Context of a Circular Economy

Topic 1. Principles, Concepts and Current Problems of Sustainable Development

Topic 2. Current Perspectives on Climate Change and the Role of Engineering Science and Practice in Climate Change Mitigation and Adaptation

Section 2 Energy for Sustainable Development of Society

Topic 3. Principles, Approaches, Strategies and Systems of Sustainable Development in the Technological Dimension

Topic 4. Energy decarbonization strategies

Section 3 Environmental, Energy, Risk and Environmental Aspects Management of Production Systems

Topic 5. Environmental Management Systems in International and National Standards

Topic 6. International Standards for Enterprise Risk and Energy Management

Section 4 Applied Aspects of Sustainable Production

Topic 7. Green Technologies and Engineering Solutions

Topic 8. Sustainable waste management

Topic 9. Technogenic Safety as an Important Aspect of Sustainable Development

4. Training Materials & Resources

Basic Literature

1. Dzhygyrey I. Sustainable Development: e-compendium for TØL4041course. Gjøvik University College, Norway. 2013. 255 pages. URL: <http://sd.kpi.ua/2013sd.pdf>

2. Sustainable Development Goals Ukraine. 2020 Voluntary National Review / MDETA, 2020. URL: https://sustainabledevelopment.un.org/content/documents/26294VNR_2020_Ukraine_Report.pdf

3. The Future is Now: Science for Achieving Sustainable Development. Global Sustainable Development Report / UN, 2019. URL: https://sustainabledevelopment.un.org/content/documents/24797GSDR_report_2019.pdf

Further reading (optional / familiarization)

1. AR5 Synthesis Report: Climate Change / IPCC, 2014. URL: <https://www.ipcc.ch/report/ar5/syr/>
2. CP Toolkit (English) / UNIDO. URL: <https://www.unido.org/resources/publications/safeguardingenvironment/industrial-energy-efficiency/cp-toolkit-english>
3. Eco-Industrial Parks: Achievements and Key Insights from the Global RECP Programme 2012-2018 / UNIDO, 2019. URL: https://www.unido.org/sites/default/files/files/2019-02/UNIDO_EIP_Achievements_Publication_Final_0.pdf
4. Marolla C. Information and Communication Technology for Sustainable Development. – CRC Press, 2018. – 272 p. (on request to the lecturer)
5. McDonough Willam, Braungart Michael. The Upcycle. Beyond Sustainability. Designing for Abundance. -Farrar, Strauss and Giroux, 2013. – 227 p. (on request to the lecturer)
6. Mulder, K. Sustainable Development for engineers / K. Mulder. – Delft Un-ty of Technology, The Netherlands, 2006. – 288 p. (on request to the lecturer)
7. Philipp Weiß and Jörg Bentlage. Environmental Management Systems and Certification. Book 4 in a series on Environmental Management. – The Baltic University Press, 2006. – 268 p. (on request to the lecturer)
8. Robertson Margaret. Sustainability. Principles and Practice. – Routledge, 2014. – 370 p. (on request to the lecturer)
9. Sachs Jeffrey D. The Age of Sustainable Development. - Columbia University Press, 2015. – 544 p. (on request to the lecturer)

Information Resources

Sustainable Development. Department of Economic and Social Affairs. United Nations. URL: <https://sdgs.un.org>
 International Energy Agency. URL: <https://www.iea.org>
 International Renewable Energy Agency. URL: <https://www.irena.org>
 Ellen MacArthur Foundation. URL: <https://ellenmacarthurfoundation.org/publications>.

Educational content

5. Methods of mastering the discipline (educational component)

The academic discipline covers 18 hours of lectures and 18 hours of practical (seminar) classes, as well as the implementation of modular control work (MCR), which consists of four parts (by sections) lasting 0.5 academics. H. Each.

Lectures are accompanied by electronic presentations; for interactive interaction with students, frontal surveys on the Sikorsky distance learning platform are used.

Practical classes are conducted mainly in the form of seminars to consolidate the theoretical provisions of the discipline and acquire students' skills and experience to operate with modern concepts in the field of sustainable development, which are necessary for the correct perception of the direction of social progress and ensuring safe conditions for the existence of mankind in the future. During the seminar under the guidance of the teacher, pre-formulated questions are discussed; Students act as speakers, co-speakers, provide feedback to each other, learn to discuss and reasonably express their own opinions. Interactive methods such as group work, analysis of stories and situations are used; At one of the practical classes, a business game is held.

During training and for interaction with students, modern information, communication and network technologies are used to solve educational problems. Communication with the teacher is carried out through the information system "Electronic Campus", the distance learning platform "Sikorsky", as well as communication tools such as e-mail and Telegram.

Lectures

Salary No.	Title of the lecture topic and list of main questions (list of didactic tools, links to information sources)
Chapter 1. Problems of Sustainable Development in the Context of a Circular Economy	
Lecture 1	Principles, Concepts and Current Problems of Sustainable Development <i>The Doctrine of the Noosphere. Economic, environmental and social prerequisites for the emergence of the concept of sustainable development. United Nations Conference on Sustainable Development. Dimensions and components of sustainable development. Actual problems of sustainable development of society.</i> References: [1]

Salary No.	Title of the lecture topic and list of main questions (list of didactic tools, links to information sources)
Lecture 2	<p>Current Perspectives on Climate Change and the Role of Engineering Science and Practice in Climate Change Mitigation and Adaptation</p> <p>Climate Change: Causes and Consequences. Combating climate change. International climate agreements and Ukraine's participation in them. Definition of technology, its role in mitigating and adapting to climate change.</p> <p>References: [1]</p>
<p>Chapter 2. Energy for Sustainable Development of Society</p>	
Lecture 3	<p>Principles, Approaches, Strategies and Systems of Sustainable Development in the Technological Dimension</p> <p>Principles of sustainable entrepreneurship. Global trends in innovative development in the energy sector and final energy consumption areas. Energy transition. European Green Deal. Changes in Ukraine's energy sector as a component of European integration. Implementation of the best available technologies and management methods.</p> <p>References [1, 3]</p>
Lecture 4	<p>Energy decarbonization strategies</p> <p>The main task of energy in the context of sustainable development. Analysis of the current state and opportunities for improving energy efficiency, wider use of renewable sources, further electrification of industry, transport and buildings.</p> <p>References: [3].</p>
<p>Chapter 3. Managing Environmental, Energy, Risk and Environmental Aspects of Production Systems</p>	
Lecture 5	<p>Environmental Management Systems in International and National Standards</p> <p>Definition of "environmental standard", types of environmental standards. Tasks of environmental standardization. Environmental Impact Assessment. PDCA Scheme and Environmental Management Model. Examples of eco-labeling in Ukraine. Product life cycle assessment.</p> <p>References: [1]</p>
Lecture 6	<p>International Standards for Enterprise Risk and Energy Management</p> <p>International Risk Management Standard. Principles of risk management. Risk assessment methods. A series of international standards on energy management. Examples of implementation of energy management systems at industrial enterprises of Ukraine.</p> <p>References: [1]</p>
<p>Section 4. Applied Aspects of Sustainable Production</p>	
Lecture 7	<p>Green Technologies and Engineering Solutions</p> <p>International Concepts of Resource Conservation. Principles of implementation of environmentally friendly production. Resource Efficient and Cleaner Production Strategy. Ecologization of production. Examples of "green" projects.</p> <p>References: [1]</p>
Lecture 8	<p>Sustainable waste management</p> <p>Methods of waste management. Pollution prevention methods. Ecological approaches to pollution control. Guidelines for Sustainable Waste Management. Zero waste. Foreign experience in recycling. Methods of solid waste disposal.</p> <p>References: [1]</p>
Lecture 9	<p>Technogenic Safety as an Important Aspect of Sustainable Development</p>

Salary No.	Title of the lecture topic and list of main questions (list of didactic tools, links to information sources)
	Definition of "emergency". Classification of man-made emergencies. The main measures in the field of protection of the population and territories from man-made and natural emergencies. References: [1]

Practical classes

Salary No.	Title of the topic of the practical lesson and a list of the main questions (list of didactic tools, links to information sources)
Practical lesson 1	General Issues of Sustainable Development and Circular Economy Format: seminar or group work References: basic [1, 2], additional [1, 3, 5, 9, 11]
Practical lesson 2	Climate Change in the Reports of International Organizations and Strategic Documents Adopted in Ukraine for Decarbonization Format: seminar. ICR, Part 1 References: basic [1, 2], additional [8, 9, 11]
Practical lesson 3	Best Available Technologies to Achieve the Sustainable Development Goals* Format: seminar, introduction to the environmental chatbot SaveEcoBot References: basic [1-3], additional [4, 6, 9]
Practical lesson 4	The role of energy in ensuring sustainable development of society Format: seminar. ICR, Part 2 References: basic [1-3], additional [4, 6, 7, 13]
Practical lesson 5	Prospects for the Energy Transition in Ukraine Format: business game References: basic [1-3], additional [6, 13, 15]
Practical lesson 6	Life Cycle Assessment of Production Systems Format: seminar, introduction to the SimaPro application References: basic [4], additional [2, 5, 9]
Practical lesson 7	Energy management in production Format: seminar, work with cases. ICR, Part 3 References: basic [1-3], additional [12]
Practical lesson 8	National Problems of Sustainable Development in the Context of Circular Economy Format: seminar. ICR, Part 4 References: basic [1-3], additional [1, 9, 10, 13, 14]
Practical lesson 9	The Role of Business Social Responsibility in Realizing the Potential of Waste Format: seminar. Test work (optional) References: basic [1-3], additional [2, 9, 10]

*in particular, SDGs 6, 7, 9, 12 and 13

6. Student's independent work

Salary No.	Type of independent work	Quantity SRS hours
1	Classroom Preparation	16
2	Preparation for the ICR	4
3	Preparation of an electronic report on the completion of tasks using the SimaPro application	4

7. Academic discipline policy (educational component)

Attending classes. *Absence from a classroom lesson (lecture or practical) does not imply the accrual of penalty points, since the final rating score of a student is formed solely on the basis of the assessment of learning outcomes. At the same time, the results of frontal surveys at lectures, discussion of the results of thematic tasks, as well as presentation/public speaking and participation in discussions at seminars will be evaluated during classroom sessions.*

Rules of conduct in the classroom. *At the beginning of the semester, students register on the specialized Google Classroom platform. Each lecture ends with a short frontal survey in Google Classroom, which requires the use of means of communication with Internet access. For active participation in the seminar, the student is prepared according to the literature recommended by the teacher. Participation in the seminar also involves the preparation of a report and two co-reports within all classes.*

Assignment of incentive and penalty points. *According to the Regulation on the Learning Outcomes Assessment System, the sum of all incentive points may not exceed 10% of the rating scale.*

Incentive Points		Penalty points	
Criterion	Weight Score	Criterion	Weight Score
Writing abstracts, articles, design of a term paper as a scientific work for participation in the competition of student research papers (on the subject of the discipline)	5-10 points	-	-
Participation in international, all-Ukrainian and/or other events and/or competitions (on the subject of the discipline)	5-10 points	-	-
Organization and participation in events to disseminate information about the Sustainable Development Goals in Ukraine with obtaining a certificate	5-10 points	-	-

Deadlines and retakes policy. *Each student is obliged to comply with the deadlines for completing tasks within the schedule of classroom classes in the discipline. A mandatory assessment control measure for admission to the test is the MCR. A student who, for a valid reason (sick leave, academic mobility, etc.), has the right to do so during regular consultations with the teacher according to the schedule. The procedure for retaking the semester control is determined by the general rules of the university¹.*

Academic Integrity Policy. *Teachers and students of KPI. Igor Sikorsky Kyiv Polytechnic Institute are obliged to adhere to the provisions of the Code of Honor adopted at the university.²*

Inclusive education. *The acquisition of knowledge and skills during the study of the discipline may be available to most persons with special educational needs, except for applicants with severe visual impairments who do not allow them to perform tasks using personal computers, laptops and/or other technical means.*

Teaching in a foreign language. *Students may be encouraged to refer to English-language sources in the course of their assignments.*

8. Types of control and rating system for assessing learning outcomes (CRO)

Current control: *frontal surveys, participation in seminars, reports, electronic reporting, ICR.*

Calendar control: *it is carried out twice a semester as a monitoring of the current state of fulfillment of the requirements of the syllabus.*

Semester control: *credit.*

¹ Regulations on current, calendar and semester control of learning outcomes in KPI. Igor Sikorsky (Annex 1 to Order No. 7-137 of 08/00/2020). URL: https://kpi.ua/document_control

² Code of Honor of the National Technical University of Ukraine "Kyiv Polytechnic Institute". URL: <https://kpi.ua/code>

1. The size of the CRO scale is 100 points, which is formed during the semester based on the results of the following works:

- frontal surveys at lectures (16 points);
- active participation in the seminar (work at a practical lesson) (16 points);
- preparation of a report and presentation at a seminar (14 points);
- co-reporting (opposition), business game (12 points);
- electronic reporting (10 points);
- writing MKR (32 points).

2. Criteria for awarding points to the current rating:

2.1 Frontal surveys in eight lecture sessions: weight score – 2. The maximum number of points is 2 points * 8 lectures = 10 points.

The survey is conducted directly at the lecture, 5-10 minutes before its end, the answer is sent via Google Classroom. A complete answer is worth 2 points, a partial answer is worth 1 point, and no answer is worth 0 points.

2.2 Participation in the seminar (work at the practical lesson): weight score – 2. The maximum number of points is 2 points * 8 lessons = 16 points.

Active participation is estimated at 2 points, inactive participation, incorrect questions and comments that indicate the student's unpreparedness for the lesson, reduce the mark for work in the seminar to 1 point or to 0 points.

2.3 Preparation of the report and presentation at the seminar: weight score – 14. The maximum number of points is 14 points * 1 report = 14 points.

A report on a given topic, as a rule, is accompanied by a presentation (up to 10 slides). Evaluation criteria:

- "excellent": creative disclosure of the task, fluency in the material, appropriate presentation materials – 13-14 points;
- "good": deep disclosure of the task, up-to-date information – 10-12 points;
- "satisfactory": reasonable disclosure of the task – 8-9 points;
- "unsatisfactory": the topic is not covered – 0 points.

2.4 Co-reporting (opposition), business game: weight score – 4. The maximum number of points is 4 points * 3 lessons = 12 points.

During the semester, each student twice acts as a co-speaker (opponent), participates in a business game (practical lesson No 5). Evaluation criteria:

- "excellent": fluency in the material, reasonable and reasoned questions, remarks and comments – 4 points;
- "good": good mastery of the material – 3 points;
- "satisfactory": poor mastery of the material – 2 points;
- "unsatisfactory": the student does not know the material, does not join the work – 0 points.

2.5 Electronic reporting: weight score – 10. The maximum number of points is 10 points * 1 report = 10 points.

As part of Unit 3, each student prepares an electronic report on the results of independent mastery of the SimaPro application software. Evaluation criteria:

- "excellent": the report was made in accordance with the requirements, contains the necessary conclusions – 10 points;
- "good": the report was made in accordance with the requirements, some of the conclusions are incorrect – 8-9 points;
- "satisfactory": the report was made with minor errors – 6-7 points;
- "Unsatisfactory": the report does not correspond to the variant of the task – 0 points.

2.6 *Writing a Modular Test: the weight score of each part of the ICR is 8 points. The maximum number of points is 8 points * 4 parts = 32 points.*

During the semester, one ICR is held, which is divided into four parts (by sections). Each part of the ICR contains eight complex questions of test, calculation or open-ended type, which are evaluated at one point. A student receives 1 point for a correct answer to a question, and 0 points for an incorrect answer.

3. *Calendar control: the condition for a positive first and second calendar control is to obtain at least 50% of the maximum possible rating at the time of the relevant calendar control.*

4. *To receive credit in the academic discipline "automatically" 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 increase their grade, complete a credit test.*

Written test work, the tickets of which contain four questions of theoretical, systemic and calculation-analytical nature in each of the four topics of the discipline, is performed within 2 academic hours. Each question is worth 25 points: "excellent", creative, systematic and full disclosure of the issue, fluency in the material – 24-25 points; "very good", disclosure of the question, fluency in the material – 21-23 points; "good", sufficient disclosure of the issue, knowledge of the material – 19-20 points; "satisfactory", reasonable disclosure of the issue, incomplete knowledge of the material – 17-18 points; "enough", partial disclosure of the issue – 15-16 points.

Table of correspondence of rating points to grades on the university scale:

Score	Score
100-95	Perfectly
94-85	Very good
84-75	Well
74-65	Satisfactory
64-60	Enough
Less than 60	Disappointing
Admission conditions are not met	Not allowed

9. Additional information on the discipline (educational component)

The list of questions that are submitted for semester control is presented in the distance course.

A higher education applicant has the opportunity to take an online course(s) on one or more topics provided for by the syllabus of the discipline. The applicant can choose an online course independently or on the recommendation of a teacher. The applicant's rating may include certificates of completion of full-time or distance courses on the subject of the discipline in accordance with the requirements of the Regulation on recognition in Igor Sikorsky Kyiv Polytechnic Institute. Igor Sikorsky Learning Outcomes, acquired in non-formal/informal education³, approved by order of 09.05.2023 No. NON/157/2023.

Work program of the discipline (syllabus):

Compiled:

Associate Professor of the Department of Artificial Intelligence, Candidate of Technical Sciences, Associate Professor, Dzhigirey Iryna Mykolayivna

Senior Lecturer of the Department of Power Supply, Cand. Tech. Doctor of Science, Chernetska Yuliia Valentynivna

Approved by the Department of Artificial Intelligence (Minutes No. 13 dated 04.04.2023); by the Department of Power Supply (Minutes No. 21 dated June 7, 2023).

Approved by the Methodological Council of the IEE (Minutes No. 9 of June 22, 2023.).

³ *Regulations on recognition in KPI. Igor Sikorsky Kyiv Polytechnic Institute for learning outcomes acquired in non-formal/informal education were approved by order of 09.05.2023 No. NON/157/2023. URL: <https://kpi.ua/informal-education>*