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

Power Supply Department of the Educational and Research Institute of Energy Saving and Energy Management

# BASICS OF ENGINEERING AND TECHNOLOGIES FOR SUSTAINABLE DEVELOPMENT

## Working program of educational discipline (Syllabus)

### Details of the discipline

| | |
|---|---|
| **Level of higher education** | ***Second (Master's)*** |
| **Field of knowledge** | *G Engineering, Manufacturing and Construction* |
| **Speciality** | *G3 Electrical Engineering* |
| **Educational program** | *Engineering of Intellectual Electrotechnical and Mechatronic Complexes* |
| **Discipline status** | *Normative* |
| **Form of study** | *full-time* |
| **Year of preparation, semester** | *I course, autumn semester* |
| **Scope of discipline** | *60 hours / 2 ECTS credits*<br>*(lectures – 16 hours, practical classes – 14 hours, self-study – 20 hours)* |
| **Semester control / control measures** | *Final test / Modular test* |
| **Timetable** | *on Fridays, 08:30-10:05 (https://meet.google.com/wak-rzia-vwj)* |
| **Language of instruction** | *English* |
| **Information about Course Leader / Instructors** | *Lectures, practical classes: Candidate of Technical Sciences,*<br>*Associate Professor Chernetska Yuliia,*<br>*J.chernetska-iee@lll.kpi.ua; +38 (068) 596-92-99 (Telegram) – working hours.*<br>*Consultations: on Tuesdays, 16:00-17:00: face-to-face – 111a-22; remotely – Google Meet link: https://meet.google.com/uut-vrgb-xov* |
| **Course Placement** | https://classroom.google.com/c/NTU3NTM0NDI3MTUw?cjc=wot7m3n |

### The program of the discipline

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

*Sustainable development is a broad concept of societal progress that emphasizes balancing the needs of the present with protecting the interests of future generations, particularly their right to a safe and healthy environment. The energy sector, known for its environmental impact, has been significantly influenced by sustainable development principles in recent decades. Global trends in innovation within the energy sector and final energy consumption are shaping an agenda to integrate environmental sustainability into educational curricula for future specialists. This discipline adopts an interdisciplinary, systematic approach to studying key issues related to human-environment interaction, modern lifestyles, and technological development, all from the perspective of sustainable development principles.*

***The purpose*** *of this discipline is to equip future masters with the knowledge and skills necessary to apply sustainable development principles and approaches within the technological field. This includes the rational and safe use of technology and the development of innovative environmental engineering solutions.*

***The subject*** *of the discipline covers organizational solutions in sustainable engineering and technology. It emphasizes goal-setting for enterprise operations, labour organization, and safety practices that improve*

*quality of life, promote efficient use of natural resources, and encourage environmental stewardship—all to support the sustainable development of society.*

***Program competencies:*** *(ЗК01) ability to search, process and analyze information from various sources; (ЗК06) ability to learn and master up-to-date knowledge; (ЗК07) ability to identify and assess risks; (ЗК09) ability to identify feedback and adjust your actions taking them into account; (ФК05) Ability to understand and consider social, environmental, ethical, economic, and commercial considerations affecting the implementation of technical solutions in the Electric Power Engineering, Electrotechnics and Electromechanics.*

***Program learning outcomes:*** *(ПРН09) to adhere to the principles and directions of the strategy for the development of Ukraine's energy security.; (ПРН10) to justify the choice of direction and methods of scientific research, considering modern problems in the field of Electric Power Engineering, Electrotechnics and Electromechanics; (ПРН13) to 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, labour 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. Sustainable Development Goals and 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*

***Chapter 2 Energy Transition for Sustainability***
*Topic 3. Principles, Approaches, Strategies and Systems of Sustainable Development in the Technological Dimension*
*Topic 4.* Energy decarbonization strategies

***Chapter 3 Environmental, Energy, Risk and Environmental Management of Production Systems***
*Topic 5. Environmental Management Systems in International and National Standards*
*Topic 6. International Standards for Enterprise Risk and Energy Management*

***Chapter 4 Applied Aspects of Sustainable Production***
*Topic 7. Green Technologies and Engineering Solutions*
*Topic 8. Sustainable waste management*

## 4. Training Materials & Resources

***Basic Literature***

*1. Foundations of sustainable development. Common issues of sustainable development. Seminar class [Electronic resource] / Igor Sikorsky Kyiv Polytechnic Institute; comp. Dzhygyrey I. M., Verlan A. A. – Kyiv : Igor Sikorsky Kyiv Polytechnic Institute, 2023. 58 p. URL: https://ela.kpi.ua/items/aca06714-df19- 41b0-b961-e95e943d8d9b*
*2. Environmentally sustainable industrial development. Edited by Shatokha V., Stalinskiy D., Coole T., De Lepeleer G., Karpash M., Kruhlenko L., Petrenko A., Saey P., Shvets I. Dnipro: Driant, 2017. 317 p. (the Denysenko Scientific and Technical Library)*
*3. Sustainable Development Analysis: Global and Regional Contexts / International Council for Science (ISC) and others; Scientific Supervisor of the Project M. Zgurovsky. K.: Igor Sikorsky Kyiv Polytechnic Institute, 2019. P. 1. Global Analysis of Quality and Security of Life (2019). 328 p. URL: http://wdc.org.ua/sites/default/files/SD2019-P1-FULL-EN.pdf*
*4. Sustainable Development Goals Ukraine. 2020 Voluntary National Review / MDETA, 2020. – Access link: https://sustainabledevelopment.un.org/content/documents/26294VNR_2020_Ukraine_Report.pdf*

*5. Times of Crisis, Times of Change: Science for Accelerating Transformations to Sustainable Development. Global Sustainable Development Report / UN, 2023. URL: https://sdgs.un.org/sites/default/files/2023-09/FINAL%20GSDR%202023-Digital%20-110923_1.pdf*

***Further reading** (optional / familiarization)*

1. AR6 Synthesis Report: Climate Change / IPCC, 2023. URL: https://www.ipcc.ch/report/sixth-assessment-report-cycle.
2. CP Toolkit (English) / UNIDO. URL: https://www.unido.org/cp-toolkit-english
3. OECD Series on Prevention and Control of Pollutant Releases. DOI: https://doi.org/10.1787/08fccc74-en
4. 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
5. Purvis B., Mao Y., Robinson D. Three pillars of sustainability: in search of conceptual origins. *Sustainability Science* (2019) 14:681-695. URL: https://doi.org/10.1007/s11625-018-0627-5
6. Kirchherr J., Reike D., Hekkert M. Conceptualizing the circular economy: An analysis of 114 definitions. Resources, Conservation and Recycling. 2017. Vol. 127. P. 221-232. DOI: https://doi.org/10.1016/j.resconrec.2017.09.005
7. Denysiuk, S., Chernetska, Yu. Current issues for the Ukrainian electric power system on its pathway towards energy transition. *International Journal of Global Energy Issues*. 2021. Vol. 43, Nos. 5/6. P. 458-476. DOI: 10.1504/IJGEI.2021.118943
8. The Global Risk Report 2025. 18th edition. World Economic Forum, 2025. 104 p. URL: https://reports.weforum.org/docs/WEF_Global_Risks_Report_2025.pdf
9. Sachs Jeffrey D. The Age of Sustainable Development. Columbia University Press, 2015. 544 p. (on request to the lecturer)
10. Rame Rame, Purwanto Purwanto, Sudarno Sudarno Industry 5.0 and sustainability: An overview of emerging trends and challenges for a green future. *Innovation and Green Development*. 2024. Vol. 3, Issue 4, 100173, URL: https://doi.org/10.1016/j.igd.2024.100173.
11. Narkhede, Pasi, Rajhans, Kulkarni Industry 5.0 and sustainable manufacturing: a systematic literature review Industry 5.0 and SM. *Benchmarking: An International Journal*. 2024. 32. 1463-5771. DOI: 10.1108/BIJ03-2023-0196
12. Goedkoop, M. & Oele, M. & Leijting, J. & Ponsioen, T. & Meijer, E., 2016, Introduction to LCA with SimaPro, PRé, URL: https://pre-sustainability.com/files/2014/05/SimaPro8IntroductionToLCA.pdf

***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
SaveEcoBot. URL: https://www.saveecobot.com

## Educational content

### 5. Methods of mastering the discipline (educational component)

*The discipline comprises 16 hours of lectures and 14 hours of practical (seminar) classes, as well as a modular test consisting of four sections, each lasting 0.5 academic hours.*

*Lectures are accompanied by electronic presentations to support the visualization of theoretical material. Additional interactivity and assessment of learning outcomes are ensured through frontal surveys conducted on the Sikorsky distance learning platform.*

*Practical classes are organized mainly in the form of seminars aimed at consolidating theoretical knowledge and developing competencies in applying modern concepts of sustainable development. Within this format, pre-formulated questions are discussed under the guidance of the lecturer. Students are expected to act as speakers, provide peer feedback, and participate in structured discussions. Interactive methods such as group work, case analysis, and situational tasks are applied; one seminar is conducted in the form of a business game.*

*The learning process is supported by modern information, communication, and networking technologies. Interaction with the lecturer is maintained through the "Electronic Campus" information system, the "Sikorsky" distance learning platform, and communication tools such as e-mail and WhatsApp.*

***Lectures***

| *No.* | *Title of the lecture topic and list of main questions (list of didactic tools, links to information sources)* |
|---|---|
| ***Chapter 1. Sustainable Development Goals and Circular Economy*** | |
| *Lecture 1* | ***Principles, Concepts and Current Problems of Sustainable Development*** *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.* *References: [1-5]* |
| *Lecture 2* | ***Current Perspectives on Climate Change and the Role of Engineering Science and Practice in Climate Change Mitigation and Adaptation*** *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.* *References: [1-5]* |
| ***Chapter 2. Energy Transition for Sustainability*** | |
| *Lecture 3* | ***Principles, Approaches, Strategies and Systems of Sustainable Development in the Technological Dimension*** *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.* *References [1-5]* |
| *Lecture 4* | ***Energy decarbonization strategies*** *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.* *References: [1-5]* |
| ***Chapter 3. Managing Environmental, Energy, Risk and Environmental of Production Systems*** | |
| *Lecture 5* | ***Environmental Management Systems in International and National Standards*** *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.* *References: [1-5]* |
| *Lecture 6* | ***International Standards for Enterprise Risk and Energy Management*** *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.* *References: [1-5]* |
| ***Chapter 4. Applied Aspects of Sustainable Production*** | |
| *Lecture 7* | ***Green Technologies and Engineering Solutions*** *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.* *References: [1-5]* |

| No. | Title of the lecture topic and list of main questions (list of didactic tools, links to information sources) |
|---|---|
| Lecture 8 | ***Sustainable waste management***<br>*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. Modular test, Part 4*<br>*References: [1-5]* |

***Practical classes***

| 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***<br>*Format: seminar or group work for trendspotting*<br>*References: basic [1-5], additional [5, 6, 9]* |
| Practical lesson 2 | ***Climate Change in the Reports of International Organizations and Strategic Documents Adopted in Ukraine for Decarbonization***<br>*Format: seminar. Modular test, Part 1*<br>*References: basic [1-5], additional [1, 8]* |
| Practical lesson 3 | ***Best Available Technologies to Achieve the Sustainable Development Goals****<br>*Format: seminar, introduction to the environmental chatbot SaveEcoBot*<br>*References: basic [1-5], additional [3]* |
| Practical lesson 4 | ***The role of energy technology in ensuring sustainable development***<br>*Format: seminar. Modular test, Part 2*<br>*References: basic [1-5], additional [2, 7]* |
| Practical lesson 5 | ***Prospects for the Energy Transition in Ukraine***<br>*Format: business game*<br>*References: basic [1-5], additional [2, 7]* |
| Practical lesson 6 | ***Life Cycle Assessment of Production Systems***<br>*Format: seminar, introduction to the SimaPro application software*<br>*References: basic [1-5], additional [12]* |
| Practical lesson 7 | ***Sustainable engineering***<br>*Format: seminar, work with cases. Modular test, Part 3*<br>*References: basic [1-5], additional [4, 10, 11]* |

**in particular*, SDGs 7, 9, 11, 12 and 13

## 6. Student's independent work

| No. | Type of independent work | Quantity SRS hours |
|---|---|---|
| 1 | *Preparation for in-class activities* | 20 |
| 2 | *Preparation for the modular test* | 4 |
| 3 | *Preparation for the final test* | 6 |
| | *Total* | 30 |

## Policy & Control

## 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 modular test. 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 university[1].*

***Academic Integrity Policy.*** *Teachers and students of 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

***Current control****: frontal surveys, participation in seminars, report, electronic reporting, modular test.*
***Calendar control*** *is conducted twice per semester to monitor the current progress in meeting the syllabus requirements.*
***Semester control****: final test.*

*1. The rating system uses a 100-point scale, accumulated throughout the semester based on the following assessments:*

- *frontal surveys at lectures (16 points);*
- *active participation in the seminar (work at a practical lesson) (14 points);*
- *preparation of a report and presentation at a seminar (12 points);*
- *group work, feedback on the report, business game (16 points);*
- *electronic reporting (10 points);*

[1] *Regulations on current, calendar and semester control of learning outcomes in Igor Sikorsky Kyiv Polytechnic Institute (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*

– *writing modular test (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 = 16 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 * 7 lessons = 14 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 – 12. The maximum number of points is 12 points * 1 report = 12 points.*

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

– *'excellent': creative approach to the task, fluent command of the material, relevant presentation materials – 12 points;*
– *'very good': in-depth exploration of the task, relevant information – 10-11 points;*
– *'good': well-founded disclosure of the task – 8-9 points;*
– *'satisfactory'": well-founded disclosure of the task – 7 points;*
– *'unsatisfactory': the topic is not disclosed – 0 points.*

*2.4 Group work, feedback on the report, business game: weight score – 4. The maximum number of points is 4 points * 4 lessons = 16 points.*

*During the semester, students participate in group work (practical classes No. 1 and No. 4), take part in a business game (practical class No. 5), and provide feedback on reports (practical classes No. 2, No. 3, No. 6, and No. 7). Assessment criteria:*

– *'excellent': fluent command of the material, well-founded and reasoned questions, remarks and comments – 4 points;*
– *'good': good command of the material – 3 points;*
– *'satisfactory': poor command of the material – 2 points;*
– *'unsatisfactory': the student does not have a good command of the material and does not participate in 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 modular test is held, which is divided into four parts (by sections). Each part 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 | Excellent |
| 94-85 | Very good |
| 84-75 | Good |
| 74-65 | Satisfactory |
| 64-60 | Sufficient |
| Less than 60 | Insufficient |

## 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 education[3], approved by order of 09.05.2023 No. NON/157/2023.*

**Working program of educational discipline (syllabus):**

**Developed by:**

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

*Associate Professor of the Power Supply Department, Candidate of Technical Sciences, Chernetska Yuliia*

**Approved** by the Department of Artificial Intelligence (Minutes No. 10 dated 26 March 2025); the Power Supply Department (Minutes No. 22 dated 25 June 2025).

**Agreed upon** by the Methodological Council of the IEE (Minutes No. 30 dated 25 June 2025).

[3] *Regulations on recognition in 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*