Національний технічний університет України
«КИЇВСЬКИЙ ПОЛІТЕХНІЧНИЙ ІНСТИТУТ
імені ІГОРЯ СІКОРСЬКОГО»

Power Supply Department,
Institute of Energy Saving and
Energy Management

BASICS OF ENGINEERING AND SUSTAINABLE DEVELOPMENT TECHNOLOGIES

Working program of educational discipline (syllabus)

Requisites of educational discipline

Higher education level	***Second (Master)***
Knowledge domain	*14 Electrical engineering, 18 Production and technologies*
Speciality	*141 Electrical energetics, electrical engineering and electromechanics, 144 Heat power engineering, 184 Mining*
Educational programme	*Energy management and energy efficient technologies (OH), Electrical power distribution systems engineering(OE), Energy management and Engineering of Thermal Power Systems (OT), Electromechanical and Mechatronic Systems of Energy Intensive Industries (OM), Engineering of Automated Electrotechnical Complexes (OA), Geoengineering (OC)*
Status of discipline	*Normative*
Form of education	*Full-time(day-time)*
Year of preparation, semester	*I course, autumn semester*
Teaching hours	*60 hours / 2 credits ECTS* *(lections – 18 hours, seminars – 18 hours, self students studying – 24 hours)*
Semester control / control activities	*Semester test / modular test*
Schedule	*http://rozklad.kpi.ua/*
Language of study	*English*
Information about supervisor of the course / professors	Lections and seminars are given by: Candidate of technical sciences, senior teacher Chernetska Yuliia, *J.chernetska@ukr.net; +38(068) 596-92-99 (Telegram).* *Consultations: on Mondays, 16:00-17:00*
Course link	https://classroom.google.com/c/MTQ2MDg3OTY1Mjgw (OA, OM, OC); https://classroom.google.com/c/MTc2NzIwNjQ5NTUw (OH, OE, OT)

Program of educational discipline

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

Sustainable development is a general concept of society's development, which determines the need to strike a balance between meeting the modern 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 negatively impacts on the environment and has been significantly transformed under the influence of the sustainable development concept over the past decades. Global trends of innovative development in the energy sector and areas of final energy consumption form the agenda for integrating the principles of sustainability into the curricula of future professionals. According to UNESCO, sustainable engineering requires an interdisciplinary approach in all aspects of engineering. All areas of engineering should cover issues of sustainability in their practice to improve the quality of life for all. The discipline is one of the newest educational courses and involves an interdisciplinary and systematic approach to the study of the main problems of human interaction with the environment, the development of modern life, and modern technologies in terms of the principles of sustainable development.

*The **purpose** of 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 technological dimension for rational and safe use of technology, creation, and implementation of new sustainable engineering solutions by masters.*

*The **subject** of the discipline is organizational solutions in the field of sustainable engineering and technology in the context of algorithms for setting enterprise policy and goals, workplace organization, and safety. This allows improving living conditions, rational use of available natural resources, and more environmentally friendly and sustainable development.*

*The discipline contributes to the formation of students with the following **competencies**:*

- the ability to learn and master modern knowledge;

- the ability to make informed decisions;

- the ability to generate new ideas (creativity);

- the ability to search, process, and analyze information from various sources;

- the ability to work in an international context;

- the ability to motivate people and move towards a common goal;

- the ability to act socially responsibly and consciously.

After mastering the discipline, students must demonstrate the following learning outcomes.

***KNOWLEDGE**:*

- the latest concepts and principles and current documents of the world community on sustainable development;

- basic information about the world's modern approaches and trends in resource conservation, resource efficiency, and sustainable waste management;

- basic information about the international experience of creating environmental, energy, and risk management systems at the enterprise;

- basic principles of inclusive sustainable industrial development.

***SKILLS**:*

- to be guided in the international various-scale experience of introduction of sustainable technologies and engineering approaches in organizational, administrative, and industrial activity;

- to calculate the indicators of eco-efficiency and safety of production, including the use of GIS technologies and life cycle assessment approach;

- to support the implementation of resource-efficient and cleaner production projects, development of environmental, energy, and risk management systems at the enterprise.

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

The study of the discipline bases on students' knowledge of the key concepts of physics, mathematics, economics, sociology, ecology, and training disciplines, and aims at developing skills of a systematic approach to the study and solution of problems of sustainable development and engineering techniques in technology, and the ability to properly assess the local and long-term consequences of decisions regarding the environment.

Computer simulation	*Effective methods of studying complex systems. Implementation of an abstract model of a system. Computer models as a tool of mathematical modeling and their application in solving practical problems.*
Politology	*Political institutions and their construction. Political consciousness and culture. Rights, freedoms, and responsibilities of citizens. Political processes. Global problems.*

Ecological disciplines	*Fundamental problems of the structural and functional organization of ecosystems. The impact of socio-economic factors on the environment. The most common essential properties, connections, and relations of society and nature, their knowledge and transformation by man to harmonize these relations.*
Life Safety	*The structure of the vital system and indicators of the general development of mankind. Dangers and consequences of their manifestation in the conditions of industrial and domestic activity. Emergencies and their impact on life. Fundamentals of state policy in the field of protection of the population and territories from emergencies.*
Disciplines of professional training	*Improving the resilience of industrial facilities in emergencies. Knowledge of techniques in the technology of design solutions used in professional activities.*
Economics and organization of production	*Enterprise in the system of market relations. Technological and organizational preparation of production*

The discipline is closely related to the doscipline "Scientific work on the topic of the master's dissertation" as it aims to develop skills of a systematic approach to the study and solution of sustainable development problems, and the ability to properly assess the local and long-term effects of decisions on the direct and indirect effects of human activities on the environment. The obtained competencies are used during the master's dissertation.

3. The content of the discipline

Topic 1 *Issues of sustainable development in the context of circular economy*

Topic 2 *Energy for sustainable development*

Topic 3 *Environment, energy, risk management and ecological aspects of production systems*

Topic 4 *Applied aspects of sustainable production*

4. Training materials and 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*

Additional literature
(elective / 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)*
10. *Sustainable Development Goals: Ukraine. National baseline report / MEDT, 2017. URL: https://me.gov.ua/Documents/Download?id=05822f66-290b-4b51-a392-347e76ebeb5f*
11. *Sustainable Development in Practice: Case Studies for Engineers and Scientists. Eds. Adisa Azapagic, Slobodan Perdan. 2 nd Ed. – Wiley-Blackwell, 2011. (on request to the lecturer)*
12. *The Global Risks Report 2021. 16th Edition / WEF, 2021. URL: http://www3.weforum.org/docs/WEF_The_Global_Risks_Report_2021.pdf*
13. *Tracey Strange and Anne Bayley. Sustainable Development: Linking economy, society, environment / OECD, 2008. – OECD Publishing, 2008. – 146 p. URL: https://www.oecd-ilibrary.org/environment/sustainabledevelopment_9789264055742-en*
14. *Walker Julia, Pekmezovic Alma, Walker Gordon. Sustainable Development Goals: Harnessing Business to Achieve the SDGs through Finance, Technology and Law Reform. – Wiley, 2019. — 437 p. (on request to the lecturer)*
15. *Weizsäcker Ernst Ulrich von, Wijkman Anders. Come On! Capitalism, Short-termism, Population and the Destruction of the Planet. A Report to the Club of Rome. — Springer Science+Business Media LLC, 2018. (on request to the lecturer)*
16. *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, No. 5-6. pp. 458-476 (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)

Seminars on the discipline are held to consolidate the theoretical provisions of the discipline "Basics of Engineering and Sustainable Development Technologies". Students gain 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 living conditions for humanity in the future, under the guidance of a teacher by preparing and discussing properly formulated seminar issues. Based on the distribution of time for the study of the discipline, nine seminars are recommended (taking into account the time for modular tests and tests).

Deadline (week)	*Titles of sections and topics*
Topic 1 Issues of sustainable development in the context of circular economy	
1	Lection 1. Principles, concepts and current issues of sustainable development
2	Seminar 1. Common issues of sustainable development and circular economy
3	Lection 2. Modern scientific basis of climate change: role of energy and engineering science in climate change mitigation and adaptation
4	Seminar 2. Key messages on climate change issue in the reports of international organizations and strategic documents adopted in Ukraine for decarbonization. Modular test (part I)
Topic 2 Energy for sustainable development	
5	Lection 3. Principles, approaches, strategies and systems of the technological dimension of sustainable development

Deadline (week)	*Titles of sections and topics*
6	Seminar 3. Best available techniques and its contribution to sustainable development goals*
7	Lection 4. Principles and instruments for decarbonizing the energy sustem
8	Seminar 4 (Business game). Perspectives of energy transition in Ukraine. Modular test (part II)
Topic 3 Environment, energy, risk management and ecological aspects of production systems	
9	Lection 5. Environmental management systems in international and national standards
10	Seminar 5. Life cycle assessment of production systems
11	Lection 6. International standards on risk management and energy management for industrial enterprises
12	Seminar 6. Energy management in industrial sector. Modular test (part III)
Topic 4 Applied aspects of sustainable production	
13	Lection 7. Green technologies and engineering decisions
14	Seminar 7. National problems of sustainable development in the context of circular economy
15	Lection 8. Industrial ecology and waste management
16	Seminar 8. Corporate social responsibility and waste management
17	Lection 9. Technogenic and environmental safety as important aspects of sustainable development
18	Seminar 9. Innovations for sustainable development. Modular test (part IV)

*sustainable development goals 6, 7, 9, 12, and 13

6. Self students studying

The self students studying includes preparation for surveys, preparation for seminars, reports, co-reports, electronic short information reports, modular control work.

Policy and control

7. Policy of academic discipline (educational component)

Attending classes. *Absence does not result in penalty points. The final rating score of the student is formed solely based on evaluation of learning outcomes. At the same time, the discussion of the results of the thematic tasks, as well as the presentation / public speech and participation in the discussions and additions to the seminars will be evaluated during the classroom sessions. To actively participate in the seminar, the student prepares for a particular seminar using the literature recommended by the lecturer. Participation in the seminar also involves the preparation of reports and co-reports within all classes.*

Missed evaluation control measures*. Each student has the right to work out missed for a good reason (sick leave, mobility, etc.) classes through independent work. Details on the link: https://kpi.ua/files/n3277.pdf.*

Procedure for appealing the results of evaluation control measures*. The student can raise any issue related to the control procedure and expect it to be considered according to predefined procedures. Students have the right to challenge the results of control measures, explaining which criterion they do not agree with according to the assessment.*

Calendar control *is carried out to improve the quality of student learning and monitor student compliance with syllabus requirements.*

Criterion		*First calendar control*	*Second calendar control*
Term of calendar control		Week 8	Week 14
Conditions for obtaining a positive assessment	Current raiting	≥ 10 points	≥ 30 points

***Academic integrity**. The policy and principles of academic integrity are defined in Section 3 of the Code of Honour of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute". Details: https://kpi.ua/code.*

***Norms of ethical behaviour**. Norms of ethical behaviour of students and employees are defined in Section 2 of the Code of Honour of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute". Details: https://kpi.ua/code.*

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

***Learning a foreign language**. During the assignments, students may be encouraged to refer to Ukrainian-language sources.*

***Assignment of incentive and penalty points**. According to the Regulations on the system of assessment of learning outcomes, the sum of all incentive points may not exceed 10% of the rating scale.*

Incentive points		*Penalty points*	
Croterion	*Weighting points*	*Criterion*	*Weighting points*
Writing abstracts, articles, registration of course work 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 academic discipline)	5-10 points	-	-
Organization and participation in events to disseminate information about the Sustainable Development Goals in Ukraine with a certificate (http://sdg.org.ua/)	5-10 points	-	-

Preparation for seminars and control activities is carried out during the self students studying with the possibility of consulting with the teacher at a certain time of consultations or using e-mail and messengers.

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

Semester certification is conducted in the form of a test. A 100-point rating system and a university scale are used to assess learning outcomes.

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

***Calendar control** is conducted twice a semester for monitoring of the current state of compliance with the requirements of the syllabus.*

***Semester control**: test. If the semester rating is more than 60 points, the student may not go to the test, and get a grade "automatically".*

***Modular control work**. Each of the four parts of the module test contains eight complex questions of the test, calculation or open (question that requires a detailed text answer) type, which are evaluated in one point. The student receives 1 point for the correct answer to the question, incorrect - 0 points.*

№	Evaluation control measure	%	Weighting points	Amount	Total
1.	Public report, participation in discussions and additions, e-reporting, frontal tests	68%	2;2;4;5;9	22	68*
2.	Modular control work	32%	32	1	32
	Total				100

** Weighing 68 points cover four components: participation in seminars, preparation of reports on selected topics as a speaker and co-speaker, electronic reporting, and the results of frontal tests.*

The first component is participation in the seminar. Active participation is assessed in 2 points. Inactive participation, incorrect questions, and comments (that indicates the unpreparedness for the lesson) reduce the grade for work in the seminar to 1 point or 0 points.

The second component is the preparation of a report on a given topic, which is evaluated at 9 points: "excellent", creative disclosure of the task, free possession of the material - 9 points; "good", deep disclosure of the task - 7-8 points; "satisfactory", reasonable disclosure of the task - 6 points. During the semester, each student prepares two performances based on the number of students in a group of 15 people. The co-report (opposition) is evaluated in 4 points: "excellent", free possession of the material, substantiated and reasoned questions, remarks, and comments - 4 points; "good", mastery of the material - 3 points; "satisfactory", poor mastery of the material - 2 points. During the semester, each student acts as a co-speaker twice.

The third component is two electronic reports on the results of self-studying of the application software SimaPro and ArcGIS cloud service, which are evaluated at 5 points each.

The fourth component is eight frontal tests on the content of lectures evaluated in 2 points each.

To receive credit for the discipline "automatic" you need to have a rating of at least 60 points. Students who have a rating of fewer than 60 points at the end of the semester and those who want to increase the grade perform a test. There are two options for writing a test of the student's choice.

Option 1. The test is performed on the distance learning platform for two academic hours and contains 120 closed test and open questions of varying difficulty with weight points from 0.5 to 2, the sum of which is 100 points.

Option 2. The written test performs within two academic hours. The test contains four questions of theoretical, systematic, and computational-analytical nature for each of the four topics of the discipline. Each question is evaluated in 25 points: "excellent" - creative, systematic, and full disclosure of the question, free possession of the material - 24-25 points; "Very good" - disclosure of the issue, free possession of the material - 21-23 points; "Good" - sufficient disclosure of the issue, mastery of the material - 19-20 points; "Satisfactory" - reasonable disclosure of the issue, incomplete mastery 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:

Points	Mark
100-95	Excellent
94-85	Very good
84-75	Good
74-65	Satisfactory
64-60	Enough
Less than 60	Unsatisfactory

9. Additional information on the discipline (educational component)

The list of questions submitted for semester control is presented in Appendix A.

Teaching methods and forms include traditional university lectures and seminars, elements of teamwork, brainstorming, and group discussions. Active learning strategies are used: problem-based learning methods (research method), personality-oriented technologies based on case technology and project technology, visualization technologies, information and communication technologies, electronic presentations for lectures. Communication with the teacher is built through the use of the information system "Electronic Campus", distance learning platform "Sikorsky", communication tools (e-mail, Telegram, and Viber). Modern information-communication and network technologies are used for training and interaction with students.

***Elective training**. For a better understanding of the principles, principles, and tools of sustainable engineering and technology, it is recommended to take online courses via web links:*

1. *https://coursera.org/learn/sustainable-development*
2. *https://coursera.org/learn/global-sustainable-development*
3. *https://coursera.org/learn/responsible-management*
4. *https://coursera.org/learn/global-sustainability-be-sustainable*
5. *https://coursera.org/learn/sdgbusiness*
6. *https://coursera.org/learn/corp-sustainability*
7. *https://coursera.org/learn/business-case-sustainability*
8. *https://coursera.org/learn/sustainability-through-soccer*
9. *https://coursera.org/learn/greening-the-economy*
10. *https://coursera.org/learn/sustainability*

There is no provision for grading control measures by transferring the results of online courses.

Working program of educational discipline (syllabus):

Developed by:

assoc. prof. the Department of Mathematical Methods of System Analysis, cand.of tech. science, assoc. prof., Dzhygyrey Iryna

senior teacher Power Supply Department, cand.of tech. science
Chernetska Yuliia

Approved by the Department of Mathematical Methods of System Analysis (protocol № 9 of 19.01.2021); Power Supply Department (protocol № 9 of 10.02.2021);

Agreed by Methodical Council of the university (protocol № 6 of 25.02.2021)

Appendix A

LIST OF QUESTIONS TO BE SUBMITTED FOR SEMESTER CONTROL:

Topic 1 Issues of sustainable development in the context of circular economy

1. Definitions of Sustainable development concept. Economic, ecological and social prerequisites of the sustainable development concept.
2. Sustainable development goals: global context and national dimension (on the example of Ukraine's sustainable development goals). Role of innovative technologies in achieving the sustainable development goals.
3. Main principles of circular economy; examples of their implementation in different industries and spheres of human life.
4. Modern views on climate change based on reports of international organizations, in particular, information from the Intergovernmental Panel on Climate Change.
5. Role of energy and engineering science and practice in climate change mitigation and adaptation. Examples of technologies that contribute to the reduction of greenhouse gas emissions.
6. Main provisions of international climate agreements (UN Framework Convention on Climate Change, Kyoto Protocol, Paris Agreement).

Topic 2 Energy for sustainable development

1. Requirements of Directive 2010/75/EC on industrial emissions and its implementation in Ukraine as part of the European integration process. The purpose and main aspects of the Directive.
2. The best available techniques, its application for different industries. Advantages and disadvantages of using the best available techniques.
3. Examples of the best available techniques for the energy sector, their impact on achieving the sustainable development goals.
4. Main strategies for energy decarbonization. Current state and opportunities for improving energy efficiency in Ukraine based on studying the experience of other countries.
5. Main strategies for energy decarbonization. Current state of use of renewable energy sources in Ukraine and the potential for increasing their share based on the experience of other countries.
6. Main strategies for energy decarbonization. Analyze the possibilities of further electrification of industry, transport and buildings in Ukraine based on the experience of other countries.

Topic 3 Environment, energy, risk management and ecological aspects of production systems

1. Environment standard. Types of environmental standards. Definition and tasks of environmental standardization.
2. Environmental management systems. PDCA scheme and environmental management model. Examples of ecological labeling in Ukraine.
3. Life cycle assessment - definition. What phases does the product life cycle cover? Give examples of product life cycle assessment.
4. Emergency situation. Classification of man-made emergency situations. Sources of danger of man-made emergency situations.
5. Technogenic safety. The main measures in the sphere of protection of the population and territories from man-made and natural emergency situations.
6. 6. The concept of "risk" and general characteristics of risks. Classification of risks, their mathematical definition.

Topic 4 Applied aspects of sustainable production

1. Cleaner production. Resource-efficient and cleaner production strategy. Basic principles of cleaner production.
2. Environmental management system and family of ISO 14000 standards.
3. Energy management system and family of ISO 50000 standards.
4. Enterprise risk management and family of ISO 31000 standards.