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

Department of Artificial Intelligence

FOUNDATIONS OF SUSTAINABLE DEVELOPMENT

Working program of educational discipline (syllabus)

Requisites of educational discipline

Higher education level	***Second (master)***
Knowledge domain	*For all domains*
Speciality	*For all specialities*
Educational program	*For all educational programs*
Status of the discipline	*Normative*
Form of education	*Full-time (day-time)*
Year of preparation, semester	*I course, autumn / spring semester*
Teaching hours	*60 hours / 2 credits ECTS* *(lections – 16 hours, seminars – 14 hours, self studying – 30 hours)*
Semester control / control activities	*Semester test, modular test*
Schedule	*https://schedule.kpi.ua/* *1 hour of lectures and 1 hour of practical (seminar) classes per week*
Language of study	*English*
Information about supervisor of the course / professors	Lections and seminars are given by: *cand. of tech. sciences, assoc. prof., , assoc. prof. of Department of AI* *Dzhygyrey Iryna Mykolaivna, lab.mes@kpi.ua*
Course link	https://do.ipo.kpi.ua/course/view.php?id=4171

Program of educational discipline

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

Sustainable development is a broad concept of societal progress, emphasizing the need to balance current human needs with protecting the interests of future generations, particularly their need for a safe and healthy environment. Sustainable engineering, as a strategy within sustainable development, serves as a means to integrate sustainability principles into the curricula of future professionals. According to UNESCO, sustainable engineering necessitates an interdisciplinary approach across all aspects of engineering. Incorporating sustainability into engineering practices enhances the quality of life for all individuals. This discipline, one of the newest educational courses, employs an interdisciplinary and systematic approach to examining key issues in human interaction with the environment, advancements in modern living, and technology development through the lens of sustainable principles.

*The **purpose** of mastering the discipline is to develop learners' competencies in applying the principles and approaches of sustainable development in the technological dimension, essential for integrating sustainability concepts into engineering and technical activities, aimed at creating and implementing innovative environmentally and socially responsible solutions.*

*The **subject** of the discipline encompasses organizational solutions in sustainable engineering and technology, including algorithms for enterprise policy and goal-setting, workplace organization, and safety measures. This approach contributes to enhanced living conditions, rational utilization of natural resources, and more environmentally friendly and sustainable development.*

After mastering the discipline, learners (degree-seeking students) must demonstrate the following learning outcomes:

- *demonstrate an understanding of the current state and trends in societal development, approaches to managing resources, the environment, energy, waste, and risks based on the principles of sustainable and innovative development, as well as effective measures to enhance the sustainability of projects, existing objects, and systems.*
- *support the implementation of innovative and socially, ecologically, and economically efficient solutions in organizational, managerial, and production activities for sustainable growth.*

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 builds on learners' knowledge of key concepts in physics, mathematics, economics, sociology, ecology, and training disciplines. It aims to develop skills in systematically approaching the study and resolution of sustainable development problems and engineering techniques in technology, as well as the ability to accurately assess both local and long-term environmental impacts of decisions.

The discipline is closely linked to the components "Scientific work on the topic of a master's thesis" in educational and scientific programs and "Execution of a master's thesis" in educational and professional programs. It focuses on fostering systematic approaches to studying and solving sustainable development challenges while assessing the direct and indirect environmental consequences of human activities. These competencies are applied during the completion of the master's dissertation.

3. The content of the discipline

Topic 1 *The Latest Provisions of the Concept of Sustainable Development*

Topic 2 *Economic, Social, and Environmental Challenges in the Modern World*

Topic 3 *Sustainability Analysis of Societal Development*

Topic 4 *Sustainable Development from a Technological Perspective: Strategies and Standards for Green Growth*

4. Training materials and 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. – Access link: 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 KPI, 2019. — P. 1. Global Analysis of Quality and Security of Life (2019). — 328 p. – Access link: 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. - Access link: https://sdgs.un.org/sites/default/files/2023-09/FINAL%20GSDR%202023-Digital%20-110923_1.pdf

Additional literature

(elective / familiarization)

1. AR6 Synthesis Report: Climate Change / IPCC, 2023. – Access link: https://www.ipcc.ch/report/sixth-assessment-report-cycle/
2. CP Toolkit (English) / UNIDO. – Access link: https://www.unido.org/resources/publications/safeguarding-environment/industrial-energy-efficiency/cp-toolkit-english
3. Eco-Industrial Parks: Achievements and Key Insights from the Global RECP Programme 2012-2018 / UNIDO, 2019. – Access link: https://www.unido.org/sites/default/files/files/2019-02/UNIDO_EIP_Achievements_Publication_Final_0.pdf
4. Filho, Walter & Țîrcă, Diana-Mihaela & Al-Amin, Abul. (2017). Sustainable Economic Development: Green Economy and Green Growth. 10.1007/978-3-319-45081-0. (Available via SpringerLink only on the local network of the Igor Sikorsky Kyiv Polytechnic Institute; the Denysenko Scientific and Technical Library)
5. Melnyk, L., Dehtyarova, I., Matsenko, O. Social and economic trends of sustainable development in the conditions of digital economy/ Role of science and education for sustainable development. Monograph. Edited by Magdalena Wierzbik-Strońska and Iryna Ostopolets/Publishing House of University of Technology, Katowice, 2021. P 31-38. https://essuir.sumdu.edu.ua/handle/123456789/87169
6. Narkhede, Pasi, Rajhans, Kulkarni. (2024). Industry 5.0 and sustainable manufacturing: a systematic literature review Industry 5.0 and SM. Benchmarking: An International Journal. 32. 1463-5771. 10.1108/BIJ-03-2023-0196.
7. Okhrimenko, O. O. Social responsibility: lecture notes [Electronic resource] : Teaching manual for the students Specialty 051 "Economics" / O. O. Okhrimenko, T. V. Ivanova ; Igor Sikorsky Kyiv Polytechnic institute. – Electronic text data (1 file: 4,9 MB). – Kyiv : Igor Sikorsky Kyiv Polytechnic institute, 2020. – 182 p. – https://ela.kpi.ua/handle/123456789/33657
8. Peris-Ortiz, Marta & Bennett, Dag & Yabar, Diana. (2017). Sustainable Smart Cities: Creating Spaces for Technological, Social and Business Development. 10.1007/978-3-319-40895-8. (Available via SpringerLink only on the local network of the Igor Sikorsky Kyiv Polytechnic Institute; the Denysenko Scientific and Technical Library)
9. Rame, Purwanto, Sudarno. (2024). Industry 5.0 and sustainability: An overview of emerging trends and challenges for a green future. Innovation and Green Development. 3. 4. 100173. ISSN 2949-7531. 10.1016/j.igd.2024.100173.
10. Stark, Rainer & Bonvoisin, Jeremy. (2017). Sustainable Manufacturing, Challenges, Solutions and Implementation Perspectives. 10.1007/978-3-319-48514-0. (Available via SpringerLink only on the local network of the Igor Sikorsky Kyiv Polytechnic Institute; the Denysenko Scientific and Technical Library)
11. Sustainable Development Goals: Ukraine. National baseline report / MEDT, 2017. Access link: https://me.gov.ua/Documents/Download?id=05822f66-290b-4b51-a392-347e76ebeb5f
12. The Global Risks Report 2024. 19th Edition / WEF, 2024. – Access link: https://www3.weforum.org/docs/WEF_The_Global_Risks_Report_2024.pdf
13. Transnational Corporations. Educational textbook [Electronic Resource] / S. V. Voitko, O. A. Gavrish, O. O. Korohodova, T. E. Moiseenko ; Igor Sikorsky Kyiv Polytechnic Institute. – Electronic text data (1 file: 2.89 MB). - Kyiv : Igor Sikorsky Kyiv Polytechnic Institute, 2020. – 204 p. – https://ela.kpi.ua/handle/123456789/49843
14. 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)

Information resources

Sustainable development [Electron. resource] / UN DSDG. – Access link: https://sdgs.un.org/

The Eco-Innovation Observatory [Electron. resource] / EC. – Access link: http://www.eco-innovation.eu

Publications UN in Ukraine [Electron. resource] / UN in Ukraine. – Access link: https://ukraine.un.org/en/resources/publications

UNDP in Ukraine [Electron. resource] / UNDP in Ukraine. – Access link: https://www.undp.org/en/ukraine/publications

Publications / the Ellen MacArthur Foundation. – Access link: https://www.ellenmacarthurfoundation.org/publications

Educational content

5. Methods of mastering the discipline (educational component)

Seminars for the discipline are conducted to reinforce the theoretical principles of "Foundations of Sustainable Development".

Under the guidance of a teacher, learners acquire the skills and experience necessary to engage with modern concepts in sustainable development, ensuring proper understanding of societal progress and the creation of safe living conditions for future generations. This is achieved by preparing and discussing well-structured seminar topics. Based on the allocated time for studying the discipline, seven seminars are recommended.

Deadline (week)	*Titles of sections and topics*
Topic 1. The Latest Provisions of the Concept of Sustainable Development	
1	Lection 1. Prehistory and main sustainable development concepts
2	Seminar 1. Common issues of sustainable development
3	Lection 2. Globalization and global social, economic, environmental, geopolitical, and technological threats Modular test (part I)
Topic 2. Economic, Social, and Environmental Challenges in the Modern World	
4	Seminar 2. Modern worldwide challenges to sustainable growth
5	Lection 3. Modern scientific basis of climate change
6	Seminar 3. Key messages on climate change issue in the reports of international organizations Modular test (part II)
Topic 3 Sustainability Analysis of Societal Development	
7	Lection 5. Sustainable development metrics and indicator systems
8	Seminar 4. Assessment of society's development
9	Lection 6. Aggregated evaluation and forward looking activities for sustainable development Modular test (part III)
Topic 4. Sustainable Development in Technological Perspective: Strategies and Standards for Green Growth	
10	Seminar 5. Innovations for sustainable development
11	Lection 7. Principles, approaches, strategies and systems of the technological dimension of sustainable development
12	Seminar 6. Environmental, energy and risk management for sustainable production
13	Lection 8. International standards for sustainable development
14	Seminar 7. Green growth and circular economy
15	Lection 9. Inclusive and sustainable industrial development Modular test (part IV)

6. Self-studying

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

№	*Type of Individual Work*	*Number of Hours*
1	*Preparation for in-class activities*	*20*
2	*Preparation for the modular control work*	*4*
3	*Preparation for the test*	*6*
	Total	*30*

Policy and control

7. Policy of academic discipline (educational component)

Attending classes. *Attendance does not result in penalty points. The final learner rating is determined solely based on the evaluation of learning outcomes. However, classroom discussions of thematic tasks, presentations/public speeches, and participation in seminar discussions and contributions will be evaluated. To actively participate in a seminar, learners must prepare using the literature recommended by the lecturer. Seminar participation also includes the preparation of reports during the sessions.*

Missed evaluation control measures. *Learners have the right to independently work on missed classes due to valid reasons (e.g., sick leave, mobility). Further details are available via the link:: https://kpi.ua/files/n3277.pdf.*

Procedure for appealing the results of evaluation control measures. *Learners may raise concerns about the evaluation process and expect their issue to be reviewed according to established procedures. They also have the right to challenge evaluation results by specifying the criteria they disagree with, in alignment with the assessment guidelines.*

Calendar control *is conducted to improve the quality of student learning and to monitor the student's compliance with the syllabus requirements. It is carried out twice during the semester (in the 7th and 13th weeks of study).*

Academic integrity. *The policy and principles of academic integrity are outlined 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 for learners and employees are specified 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" is accessible to most individuals with special educational needs, except for learners with severe visual impairments that prevent the completion of tasks using personal computers, laptops, and/or other technical means.*

Learning a foreign language. *During assignments, learners may be encouraged to reference Ukrainian-language sources.*

Assignment of incentive and penalty points. *In accordance with the Regulations on the system of assessment of learning outcomes, the total incentive points may not exceed 10% of the rating scale.*

Incentive points		*Penalty points*	
Criterion	*Weighting points*	*Criterion*	*Weighting points*
Writing proceedings, articles, registration of course work as a scientific work for participation in the competition of learner 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	5-10 *points*	-	-

Preparation for seminars and control activities is carried out during learners' self-study, with the option to consult with the teacher at designated consultation times or via e-mail and messaging platforms.

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 evaluate learning outcomes.

Current control *includes frontal surveys, participation in seminars, reports, electronic submissions, and modular tests.*

Calendar control *is carried out twice per semester to monitor compliance with syllabus requirements.*

Criterion		*First calendar control*	*Second calendar control*
Term of calendar control		Week 7	Week 13
Conditions for obtaining a positive assessment	Current rating	≥ 10 points	≥ 30 points

Semester control*: test.*

If a learner achieves a semester rating exceeding 60 points, they may opt not to take the test and automatically receive a grade.

Modular control work *consists of four parts, each containing eight complex questions (including test, calculation, or open-ended questions requiring a detailed text response), with each correct answer earning 1 point, and incorrect answers receiving 0 points..*

№	*Evaluation control measure*	*%*	*Weighting points*	*Amount*	*Total*
1.	Public report, participation in discussions and additions, e-reporting, frontal tests	68%	2;3;5;12	18	68*
2.	Modular control work	32%	32	1	32
	Total				100

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

The first component is communicative engagement in group interaction and thematic task completion. This component assesses the learner's activity within group-based interaction, which includes completing thematic tasks (individual or group), presenting results, participating in discussions, and formulating comments, examples, questions, clarifications, or additions to the contributions of other participants. A learner receives 3 points if they have completed the thematic task (if applicable) and presented the results and/or actively participated in the discussion of the assigned topic; their contributions are relevant, meaningful, and well-reasoned; they provide examples, formulate questions, and offer alternative perspectives, demonstrating preparedness. A score of 1 point is given when the learner participates only partially or sporadically; their comments are superficial and lack a clear connection to the topic, indicating a moderate level of preparedness. A score of 0 points is given when the learner does not complete the thematic task (if applicable) and shows no activity (such as questions, comments, examples, clarifications, etc.), which indicates a lack of preparation for the respective learning component.

The second component is the preparation of a report on a given topic, evaluated at 12 points: "excellent" — creative task disclosure and mastery of the material (12 points); "very good" — thorough task disclosure (10–11 points); "good" — complete task disclosure (8–9 points); "satisfactory" — reasonable and sufficient task disclosure (7 points). During the semester, each learner prepares two presentations, based on a group size of 15 learners.

The third component is the preparation of two electronic reports based on independent learning of the SimaPro application software and ArcGIS cloud services, each evaluated at 5 points.

The fourth component consists of eight frontal surveys based on the lecture content, each evaluated at 2 points.

To receive an "automatic" credit for the discipline, learners must achieve a rating of at least 60 points, as well as complete the modular test, frontal tests, submit one report presented during a seminar, and at

least one electronic report. Learners who finish the semester with fewer than 60 points (provided all other conditions for credit are met) or those wishing to improve their grade are required to take the final control work.

There are two options for completing the final control work, chosen by the learner:

Option 1. The test is conducted on the distance learning platform over two academic hours and includes 120 closed and open questions of varying difficulty with weights from 0.5 to 2 points, totalling 100 points.

Option 2. The written test is conducted over two academic hours and includes four questions of theoretical, systematic, and computational-analytical nature for each of the four topics of the discipline. Each question is evaluated at 25 points: "excellent" — creative, systematic, and comprehensive disclosure of the question with mastery of the material (24–25 points); "very good" — thorough disclosure of the question and mastery of the material (21–23 points); "good" — sufficient disclosure and understanding of the material (19–20 points); "satisfactory" — reasonable disclosure with incomplete mastery of the material (17–18 points); "enough" — partial disclosure (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 for semester control is provided in Appendix A.

Teaching methods and formats include traditional university lectures and seminars, as well as elements of teamwork, brainstorming, and group discussions. Active learning strategies employed include problem-based learning methods (research method), personality-oriented approaches based on case studies and project-based techniques, visualization technologies, information and communication technologies, and electronic presentations for lectures. Communication with the teacher is facilitated through the information system "Electronic Campus," the distance learning platform "Sikorsky," and communication tools such as e-mail, Telegram, and Viber. Modern information, communication, and network technologies are utilized to support training and learner interaction.

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

Act further: Sustainable development for businesses
https://courses.prometheus.org.ua/courses/course-v1:Prometheus+SDB101+2021_T1_EN/about
Sustainable Digital Innovation
https://www.coursera.org/learn/sustainable-digital-innovation
Introduction to Sustainability
https://www.coursera.org/learn/sustainability
Global sustainability and corporate social responsibility: Be sustainable
https://www.coursera.org/learn/global-sustainability-be-sustainable
The Sustainable Development Goals – A global, transdisciplinary vision for the future
https://www.coursera.org/learn/global-sustainable-development
and others.

Assessment for certain control measures may be conducted by transferring the results of completed specified online courses and others, in accordance with the Regulations on the Procedure for Recognition of Learning Outcomes Acquired by Students of Igor Sikorsky KPI in non-formal/informal education (https://osvita.kpi.ua/node/179).

Working program of educational discipline (syllabus):

Developed by:

assoc. prof. the Department of Artificial Intelligence, cand.of tech. science, assoc. prof.,
Dzhygyrey Iryna Mykolaivna

Approved by the Department of Artificial Intelligence (protocol № 10 of 26.03.2025)

Agreed by Methodical Council of the University (protocol № 8 of 29.05.2025)

Appendix A

List of Questions for Semester Control:

- *Agenda 2030 and Sustainable Development Goals for 2016–2030*
- *Aggregation of indicators of societal development*
- *Enterprise of the 21st century*
- *Bellagio principles*
- *Carbon footprint*
- *Circular economy*
- *Classification of sustainable development assessment systems*
- *Concept of a smart city*
- *Concept of decoupling*
- *Cradle-to-cradle paradigm and pollution prevention*
- *Definitions and principles of sustainable development*
- *Depletion of the ozone layer in international documents*
- *Differences between end-of-pipe technologies and cleaner production*
- *Dimensions and components of sustainable development*
- *Eco-efficiency, Factor X*
- *Ecological footprint and biocapacity*
- *Ecological labelling*
- *Energy management system and the ISO 50000 family of standards*
- *Enterprise risk management and the ISO 31000 family of standards*
- *Environmental engineering and environmental technology*
- *Environmental management system and the ISO 14000 family of standards*
- *Environmental Performance Index*
- *Environmental, economic, and social approaches and strategies of sustainable development in the technological dimension*
- *Environmental, economic, and social principles of sustainable development in the technological dimension*
- *Environmentally and socially adjusted national economic indicators*
- *Foresight cycle and foresight diamond*
- *Forward-looking activities*
- *General and supporting goals of sustainable development*
- *Global climate change in international documents and reports*
- *Global problems of societal development*
- *Greenhouse gases and the anthropogenic component in climate change*
- *Happy Planet Index*
- *High-level political forum on sustainable development*
- *Human Development Index and the Multidimensional Poverty Index*
- *Inclusive sustainable industrial development*
- *Industrial ecology and eco-industrial symbiosis*
- *Integrated sustainable waste management*
- *Internalization of externalities*
- *IPCC reports (6th synthesis report and components: "Global Warming 1.5°C," "Climate Change and Land," "Ocean and Cryosphere in a Changing World") — Key conclusions*
- *Key events and documents in the field of climate change*
- *Key events and documents in the field of sustainable development*
- *Kyoto Protocol to the UNFCCC*
- *Lean production*
- *Living Planet Index*

- *Low-carbon innovations*
- *Millennium Declaration and global Millennium Development Goals*
- *Models of development of society and nature (weak sustainability, three-pillar model, strong sustainability)*
- *Models of the formation of sustainable development indicator systems*
- *National sustainable development goals*
- *New technologies and modern digital production*
- *Paris Climate Agreement 2015*
- *Planetary boundaries*
- *Prerequisites for the emergence of the concept of sustainable development*
- *Principles of cleaner production*
- *Recycling, reuse, recovery, regeneration, remanufacturing*
- *Renewable and non-renewable resources, renewable energy (current world and national conditions and trends)*
- *Report "Our Common Future" by the World Commission on Environment and Development*
- *Report "The Future is Now: Science for Sustainable Development" (UN, 2019)*
- *Resource-efficient and cleaner production*
- *Rio+20 final document, "The Future We Strive For"*
- *Scenario component of foresight research*
- *Social responsibility and the ISO 26000 standard*
- *Sustainable production, sustainable consumption, and responsible care*
- *System of Environmental-Economic Accounting*
- *Technologies, methods, and approaches to climate change mitigation*
- *UN Framework Convention on Climate Change*
- *Waste management and pollution prevention*
- *World Energy Trilemma Index*