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	*Part-time*
Year of preparation, semester	*I course, autumn/spring semester*
Teaching hours	*60 hours / 2 credits ECTS* *(lectures – 4 hours, seminars – 4 hours, self-studying – 52 hours)*
Semester control/control activities	*Semester test, home control work*
Schedule	*https://schedule.kpi.ua/*
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 the Department of AI* *Dzhygyrey Iryna Mykolaivna, lab.mes@kpi.ua*
Course link	https://do.ipo.kpi.ua/course/view.php?id=4172

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 that emphasises the need to balance current human needs with the protection of future generations' interests, 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, systematic approach to examining key issues in human interaction with the environment, advancements in modern living, and technological development through the lens of sustainable principles.

*The **purpose** of mastering the discipline is to develop learners' abilities to apply the principles and approaches of sustainable development in technological contexts, thereby integrating sustainability concepts into engineering and technical activities aimed at creating and implementing innovative, environmentally and socially responsible solutions. This includes fostering the following competencies in applicants:*

Ability to search for, process, and analyse information from diverse sources;
Ability to learn and acquire up-to-date knowledge;
Ability to generate new ideas (creativity);
Ability to apply knowledge in practical situations;
And/or other competencies defined by the higher education standard of the relevant speciality and the professional competencies of the educational program.

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

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

- *demonstrate awareness of the state and current trends in the development of global society in the context of sustainable development, approaches and effective measures for increasing the sustainability of projects and existing objects and systems;*
- *determine directions, develop and implement modernisation projects for the production of micro- and nanosystem equipment, taking into account technical, economic, legal, social and environmental aspects.*

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, in applying engineering techniques to technology, and in accurately assessing the 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

Section 1: *The Latest Provisions of the Concept of Sustainable Development*

Section 2: *Economic, Social, and Environmental Challenges*

Section 3: *Sustainability Analysis of Societal Development*

Section 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. Kohut, Yu. I. (2024). Cyberwarfare and security of critical infrastructure objects: A practical guide (2nd ed., revised and expanded; ed. by A. S. Dovhopolyi). Kyiv: Sidkon; Dakor. 368 p. (in Ukrainian, the Denysenko Scientific and Technical Library)
6. 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
7. 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.
8. 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
9. 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)
10. 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.
11. 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)
12. Sustainable Development Goals: Ukraine. National baseline report / MEDT, 2017. Access link: https://me.gov.ua/Documents/Download?id=05822f66-290b-4b51-a392-347e76ebeb5f
13. The Global Risks Report 2024. 19th Edition / WEF, 2024. – Access link: https://www3.weforum.org/docs/WEF_The_Global_Risks_Report_2024.pdf
14. 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
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. Zaporozhets, T. V. (2024). State policy in the field of critical infrastructure protection: A textbook. Kyiv: DKS-Center. 186 p. (in Ukrainian) Available at: https://ipacs.knu.ua/pages/dop/391/files/a3113258-075a-40ea-8c62-facbf388f94d.pdf

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)

Discipline seminars are held to reinforce the theoretical principles of "Foundations of Sustainable Development".

Under a teacher's guidance, learners acquire the skills and experience necessary to engage with modern concepts in sustainable development, ensuring a 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, two seminars are recommended.

Deadline (week)	*Titles of sections and topics*
Section 1. The Latest Provisions of the Concept of Sustainable Development	
Topic 1. Core Principles of Sustainable Development based on the Values of Democracy, Rule of Law, and Social Responsibility	
1	**Lection 1.** Prehistory and Main Sustainable Development Concepts
2	**Seminar 1.** Sustainable Development and Civic Responsibility
Topic 2. Globalisation and Systemic Risks	
3	Self-work. Globalisation and Global Social, Economic, Environmental, Geopolitical, and Technological Threats
Section 2. Economic, Social, and Environmental Challenges	
Topic 3. Modern Worldwide Challenges to Sustainable Growth	
4	Self-work. Analysing Global Challenges and Institutional Governance
Topic 4. Climate change as a Global Challenge	
5	Self-work. Modern Scientific Basis of Climate Change
6	Self-work. Climate Change, Governance, and Ethical Decision-Making
Section 3. Sustainability Analysis of Societal Development	
Topic 5. Measuring, Assessing, and Forecasting Sustainability	
7	Self-work. Sustainable Development Metrics and Indicator Systems
8	Self-work. Assessment of Society's Development
9	Self-work. Aggregated Evaluation and Forward-looking Activities for Sustainable Development
Section 4. Sustainable Development in Technological Perspective: Strategies and Standards for Green Growth	
Topic 6. Innovation as a Driver of Sustainable Growth	
10	Self-work. Innovations for Sustainable Development
11	**Lection 2.** Principles, Approaches, Strategies, and Systems of Sustainable Development in the Technological Dimension. Safety and Resilience of Critical Infrastructure as a Component of Sustainable Development
Topic 7. Standards for Transition from Linear to Circular Economy	
12	**Seminar 2.** Environmental, Energy, Risk, and Anti-Bribery Management for Sustainable Production in Compliance with International Standards
13	Self-work. International Standards for Ensuring the Safety and Resilience of Production Systems and the Functioning of Critical Infrastructure
Topic 8. Circular Economy and Inclusive Approaches to Sustainable Industrial Growth	
14	Self-work. Green Growth and Circular Economy
15	Self-work. Inclusive and Sustainable Industrial Development
	Home control work

6. Self-studying

The self-learners studying include preparation for seminars, a report, an electronic information report, an information bulletin, and home control work.

№	Type of Individual Work	Number of Hours
1	Mastering the materials of the educational component and preparation for in-class activities	42
2	Preparation for the home control work	4
3	Preparation for the final test	6
	Total	52

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 preparing reports and co-reports during the sessions.*

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

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 them from completing 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 abstracts, articles, and registration of coursework as 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*	-	-

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 through 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 controls** are conducted twice per semester to monitor compliance with syllabus requirements.*

***Semester control**: test.*

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

***Home control work**. The home control work contains 20 complex questions from the test, calculation, or open (requiring a detailed text answer) types, which are evaluated at one point. The learner receives 1 point for a correct answer and 0 points for an incorrect answer.*

№	Evaluation control measure	%	Weighting points	Amount	Total
1.	Public report, e-reporting, e-bulletin	20%	10;5;5	3	20*
2.	Home control work	20%	20	1	20
	Total				100

** Weighing 20 points covers three components: preparation of reports on selected topics as a speaker, electronic reporting, and the preparation of an electronic bulletin.*

The first component involves preparing a report on a given topic, evaluated at a maximum of 10 points: "excellent" — creative task disclosure with mastery of the material (10 points); "good" — thorough task disclosure (8-9 points); "satisfactory" — reasonable task disclosure (6-7 points). During the semester, each learner delivers one presentation, assuming a group size of 15 learners.

The electronic bulletin is evaluated out of 5 points: "excellent" — mastery of the material, with substantiated and reasoned questions, remarks, and comments (5 points); "good" — mastery of the material (4 points); "satisfactory" — limited mastery of the material (3 points). Each learner prepares one e-bulletin per semester.

The third component is an electronic report based on a self-study of the application software SimaPro or the ArcGIS cloud service, evaluated on a scale of 5 points.

To earn credit for the discipline, learners must achieve a rating of at least 60 points.

There are two options for the semester test, allowing learners to choose their preferred method:

Option 1. Conducted on the distance learning platform over two academic hours, this test includes 60 closed and open questions of varying difficulty, with weights ranging from 0.5 to 2 points, totalling 60 points.

Option 2. A written test is conducted within two academic hours. It consists of four theoretical, systematic, and computational-analytical questions covering the discipline's four topics. Each question is evaluated up to 15 points: "excellent" — creative, systematic, and comprehensive disclosure with mastery of the material (15 points); "very good" — thorough disclosure of the issue with material mastery (13-14 points); "good" — sufficient disclosure with material understanding (11-12 points); "satisfactory" — reasonable but incomplete task disclosure (10 points); "enough" — partial task disclosure (9 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 are employed, including problem-based learning (research methods), personality-oriented techniques based on case studies and project-based approaches, visualisation methods, 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 utilised to support learner training and 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 № 11 of 18.02.2026)

Agreed by the Methodical Council of the University (protocol № 9 of 26.06.2026)

Appendix A

List of Questions for Semester Control:

- *Agenda 2030 and Sustainable Development Goals for 2016–2030*
- *Aggregation of indicators of societal development*
- *Basic principles of information security management and their importance for the resilience of modern organisations (ISO/IEC 27001)*
- *Bellagio principles*
- *Business continuity management system and its role in ensuring the resilience of critical and production systems (ISO 22301)*
- *Carbon footprint*
- *Circular economy*
- *Classification of sustainable development assessment systems*
- *Concept and role of critical infrastructure in ensuring the vital functions of society*
- *Concept of a smart city*
- *Concept of decoupling*
- *Concept of resilience and ensuring the continuity of operations of organisations and production systems*
- *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*
- *Importance of the rule of law and democratic values in the context of sustainable development*
- *Inadmissibility of corruption and other forms of misconduct in professional and societal activities*
- *Inclusive sustainable industrial development*
- *Industrial ecology and eco-industrial symbiosis*
- *Integrated sustainable waste management*

- *Interconnection of corporate social responsibility, professional ethics, and integrity principles*
- *Internalisation 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*
- *Management systems for anti-corruption (structure, requirements, and practical application of ISO 37001)*
- *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*
- *Principles of professional ethics in the field of sustainable development and innovation activities*
- *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*