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

КАФЕДРА ММСА

Department of Mathematical Methods of System Analysis

FOUNDATIONS OF SUSTAINABLE DEVELOPMENT

Working program of educational discipline (syllabus)

Requisites of educational discipline	
Higher education level	***Second (master)***
Knowledge domain	*17 Electronics, automation and electronic communications*
Speciality	*176 Micro- and nanosystem technology*
Educational program	*Micro- and nanosystems technology*
Status of the discipline	*Normative*
Form of education	*Full-time (day-time)*
Year of preparation, semester	*I course, spring 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	*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 MMSA* *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 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. Such a strategy of sustainable development as sustainable engineering is one of the ways to integrate 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 generate new ideas (creativity);
- the ability to search, process, and analyze information from various sources;
- the ability to abstract thinking, analysis and synthesis;
- the ability to communicate in a foreign language.

After mastering the discipline, students must demonstrate the following learning outcomes.
- determine directions, develop and implement modernization projects for the production of micro- and nanosystem equipment, taking into account technical, economic, legal, social and environmental aspects;
- apply specialized conceptual knowledge, including modern scientific achievements, as well as critical understanding of modern problems in the field of micro- and nanoelectronics, to solve complex problems of professional activity;
- communicate freely in national and foreign languages orally and in writing to discuss professional problems and results of activities in the field of micro- and nanoelectronics, presentation of research results and innovative projects;
- provide professional development of team members taking into account global experience and requirements for personnel in the field of development and operation of micro- and nanoelectronic systems.
In particular, know (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.
Be able to (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.

The discipline is closely related to the discipline "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** The latest provisions of the concept of sustainable development*

Topic 2 *Economic, social and environmental challenges in modern world*

Topic 3 *Sustainability analysis of development of the society*

Topic 4 *Resource management in the context of the technological dimension of sustainable development*

4. Training materials and resources

Basic literature

1. Dzhygyrey I. Sustainable Development: e-compendium for TØL4041course. Gjøvik University College, Norway. 2013. 255 pages. – Access link: http://sd.kpi.ua/2013sd.pdf
2. Sustainable Development Goals Ukraine. 2020 Voluntary National Review / MDETA, 2020. – Access link: 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. - Access link: https://sustainabledevelopment.un.org/content/documents/24797GSDR_report_2019.pdf

Additional literature

(elective / familiarization)

1. AR5 Synthesis Report: Climate Change / IPCC, 2014. – Access link: https://www.ipcc.ch/report/ar5/syr/
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. 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. (за запитом викладачу)
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. Sachs Jeffrey D. The Age of Sustainable Development. – Columbia University Press, 2015. — 544 p. (on request to the lecturer)
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. Sustainable Development in Practice: Case Studies for Engineers and Scientists. Eds. Adisa Azapagic, Slobodan Perdan. 2nd Ed. – Wiley-Blackwell, 2011. (on request to the lecturer)
13. The Global Risks Report 2021. 16th Edition / WEF, 2021. – Access link: http://www3.weforum.org/docs/WEF_The_Global_Risks_Report_2021.pdf
14. Tracey Strange and Anne Bayley. Sustainable Development: Linking economy, society, environment / OECD, 2008. – OECD Publishing, 2008. – 146 p. – Access link: https://www.oecd-ilibrary.org/environment/sustainable-development_9789264055742-en
15. 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)
16. 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 knowledge platform [Electron. resource] / UN. – Access link: https://sustainabledevelopment.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.ua.undp.org/content/ukraine/en/home.html
Publications / the Ellen MacArthur Foundation. – Access link: https://www.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 "Foundations of Sustainable Development".

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. 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
4	Seminar 2. Global problems of sustainable growth. Modular test (part I)
Topic 2. Economic, social and environmental challenges in modern world	
5	Lection 3. Modern scientific basis of climate change
6	Seminar 3. Key messages on climate change issue in the reports of international organizations
7	Lection 4. Implementation of the 2030 Agenda for sustainable development
8	Seminar 4. Modern worldwide challenges. Modular test (part II)
Topic 3 Sustainability analysis of development of the society	
9	Lection 5. Sustainable development metrics and indicator systems
10	Seminar 5. Indicators of sustainable development goals: current global and national trends
11	Lection 6. Aggregated evaluation and forward looking activities for sustainable development
12	Seminar 6. Assessment, simulation and forecasting of society's development Modular test (part III)
Topic 4 Resource management in the context of the technological dimension of sustainable development	
13	Lection 7. Principles, approaches, strategies and systems of the technological dimension of sustainable development
14	Seminar 7. Innovations for sustainable development
15	Lection 8. International standards for sustainable development
16	Seminar 8. Environmental, energy and risk management for sustainable production
17	Lection 9. Inclusive and sustainable industrial development
18	Seminar 9. Green growth and circular economy Modular test (part IV)

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 rating	≥ 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*	
Criterion	*Weighting points*	*Criterion*	*Weighting points*
Writing abstracts, articles, registration of course work as a scientific work	5-10 *points*	-	-

for participation in the competition of student research papers (on the subject of the discipline)			
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 as well as credited one report and one co-report presented by the student in seminars, and at least one electronic report. Students who have a rating of fewer than 60 points at the end of the semester or do not meet other conditions 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*

and others.

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 Mykolaivna

Approved by the Department of Mathematical Methods of System Analysis (protocol № 7 of 23.02.2022)

Agreed by the Methodical Council of the University (protocol № 4 of 07.04.2022)

Appendix A

List of questions to be submitted for semester control:

_ *aggregation of indicators of society's development;*
_ *an enterprise of the 21st century;*
_ *Bellagio principles;*
_ *carbon footprint;*
_ *circular economy;*
_ *classification of sustainable development assessment 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 footprint and biocapacity;*
_ *ecological labelling;*
_ *environmentally and socially adjusted national economic indicators;*
_ *energy management system and family of ISO 50000 standards;*
_ *enterprise risk management and the family of ISO 31000 standards;*
_ *environmental engineering and environmental technology;*
_ *environmental management system and family of ISO 14000 standards;*
_ *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;*
_ *foresight cycle and foresight rhombus*
_ *forward-looking activities;*
_ *general and supporting goals of sustainable development;*
_ *global climate change in international documents and reports;*
_ *global problems of society's development;*
_ *greenhouse gases and anthropogenic component in climate change;*
_ *High-level political forum on sustainable development;*
_ *inclusive sustainable industrial development;*
_ *industrial ecology and eco-industrial symbiosis;*
_ *integrated sustainable waste management;*
_ *internalization of externalities;*
_ *IPCC reports (5th synthesis report and its 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;*
_ *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 indicators' 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" of 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 ISO 26000 standard;*
_ *sustainable production, sustainable consumption, and responsible care;*
_ *technologies, methods, and approaches to climate change mitigation*
_ *the Agenda 2030 and sustainable development goals for 2016-2030;*
_ *the concept of a smart city;*
_ *the concept of decoupling;*
_ *the Environmental Performance Index;*
_ *the Happy Planet Index;*
_ *the Human Development Index, the Multidimensional Poverty Index;*
_ *the Living Planet Index;*
_ *the System of Environmental-Economic Accounting;*
_ *UN Framework Convention on Climate Change;*
_ *waste management and pollution prevention;*
_ *world energy trilemma index*